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A New Framework to Assess Regional and Urban Impacts of Transport Infrastructure: The Case of High-Speed Rail in Portugal

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Abstract

This paper presents a comprehensive framework for modeling the impacts of large-scale transport infrastructure which have the potential to fundamentally alter the spatial interaction properties of regions, producing significant socio-demographic and economic modifications. This model is being developed as part of a broader research project to assess the impacts of the development of a high-speed rail (HSR) network in Portugal and to evaluate the best infrastructure and service configurations of the system. The framework will be applied to study a future HSR line between Lisbon and Oporto, exploring the concept of megalopolis formation for the corridor.
The expected impacts of HSR include rearrangements of the socio-economic structure of the region it serves, redefinition of the nature of the economic linkages to neighboring regions and other external regions, and changes to the urban forms of the various urban centers which will experience significant accessibility upgrades.
The framework calls for an agent-based formulation, with decision-making agents at various spatial scales and decision making levels interacting both in space and across levels, producing effects on upper and lower levels of spatial resolution and decision making. The model will include three main types of agents, which are linked to different scales of decision-making and spatial resolution, e.g. municipal, regional, and national.
This paper presents the framework of the model, characterizes the interactions among the various levels of decision-making and assessment, and describes the methodological formulation of all the sub-models proposed for this comprehensive simulation tool.
Keywords: High-speed rail; Modeling framework; Municipal Impacts; Regional Impacts; National Impacts.

Paper

1. Introduction

The High Speed Rail (HSR) system has been proven to have the ability of transporting large number of passengers more safely, comfortably and efficiently, due to its high capacity, short travel time and good quality of service. HSR has been introduced and planned in many countries for the past three decades, such as France, Germany, Spain, Italy, South Korea and China etc, after the success of the Shinkansen line between Tokyo and Osaka in Japan. In Europe, it has been encouraged, and financially supported by the European Commission. Several lines are in operation, and many others are under construction or waiting for approval.

Portugal is currently developing an important plan for the implementation of a HSR Network foreseen as a component of the Trans-European Transport Network (TEN-T). The Portuguese project is comprised of three priority links - Lisbon-Madrid,

Lisbon-Oporto, and Oporto-Vigo corridors - with a total length of about 650 km and an investment of around € 8 billion, including some significant and costly civil structures such as the Tagus Crossing in Lisbon. When the project is concluded, a large number of Portugal's major cities and the two most important border connections will be linked by HSR. Portuguese universities have been collaborating with the Massachusetts Institute of Technology (MIT) since 2006, on a range of research projects in five key focus areas as part of the MIT-Portugal Program (MPP) with the financial support of both the Portuguese government and industrial partners. Within the Transportation Systems focus area, one of the newest MPP efforts is the EXPRESS (EXploration of Portugal's high speed Rail and Economic development Strategy Solutions) project, which brings together Instituto Superior Técnico, University of Coimbra, MIT, and RAVE, Portugal's high-speed rail (HSR) development company. The EXRESS research project aims to study several aspects of the HSR deployment in Portugal, which is comprised of 5 work packages, each dealing with an important issue related to the planning and deployment of HSR.

This paper is a preliminary research for work package 3, which has its focuses on Urban and regional forms and megalopolis creation, considering that HSR will have profound impacts on the municipalities it serves and on the regions within which it operates, and hence nationwide. The introduction of HSR is considered to have spatial, social and economic impacts on municipal and regional development, such as increase in accessibility, attractiveness, employment, income, production and changes in land use patterns (Vickerman, 1997, Banister and Berechman, 2000). There are successful empirical studies confirming the theoretical expectation of the impacts resulting from HSR. Nakamura and Ueda (1989) found a high correlation between high growth rate of population and employment and the presence of HSR stations. Bonnafous (1987) argued that the arrival of the TGV in Lyon strengthened the city's business base, which is reflected in the tourism, service activities and the industrial locations. He concludes that in the longer term the impacts will take place indirectly through the improvements in accessibility, which then enlarges the market areas, increases the competitiveness and productivity of a connected region, and thus attracts new economic activities, more labor participations, tourists and residents. Moreover, megalopolis creation can improve productivity by expanding labour markets, commercial markets, and individual activity zones (Prud'homme, 2006). In Portugal, a Lisbon-Oporto megalopolis is possible due to the existent scale and cities' network in the corridor, and the economic impact of such a region has broad implications for transportation strategy (Abreu e Silva, 2008).This intention is also part of the national planning strategy (MAOTDR, 2007) There may also be negative development impacts for smaller cities served by HSR and the cities that are not served at all. For example, HSR stations in small cities in France did not stop the dispersion of economic activity (Facchinetti-Mannone, 2005). The right policy design can ensure that negative effects of HSR are minimized while benefits are maximized (Abreu e Silva, 2008).

This paper aims for proposing a model framework to quantitatively assess the impacts on different aspects of the development at municipal, regional and national scale due to the introduction of HSR service. The spatial impacts of HSR will also be assessed in the proposed modeling frameworks. In order to justify the additional long-term benefits of the HSR service and to include them in a full cost benefit framework, assessing the economic impacts is paramount. This paper is primarily organized by three sections. Firstly, a brief literature review is presented, covering the state of art and state of practice from municipal, regional and national levels. Secondly, conceptual models are presented and interpreted for different levels, as well as the global model framework which includes the information flows and interactions among the various levels. Finally, a case study is described, which comprises the general case overview, data requirements and expected outcomes.

2. Literature Review

The investment in transport infrastructure is considered to have positive impacts on both urban and regional development. The provision of transport infrastructure increases the accessibility to resources, goods and markets, thus improves the competitiveness of a region (Dodgson, 1974). Reduction of the distance impedance enlarges the potential market area, and thus removes the bottlenecks in production and trade, and enhances the economic integration (Blum, 1982; Rietveld, 1989). And, reductions in travel time and travel cost can also give rise to productivity growth through reinforcing the agglomeration benefits (Venables, 2004; Graham, 2007). In brief, regions may develop, because transportation infrastructure improvement increases the accessibility, which then increases the potential markets, production level, job participation area, and attracts new households and economic activities.

Beside the generative effects, the improvement of transportation infrastructures may also have implications and competition effects, which entail the uncertainty of the economic growth. One of the most important uncertainties is the spatial

distributive effects, which have received attentions more recently, arguing that reduction of transportation costs and travel times may also give rise to substantial redistribution effects among cities and regions. The changes in relative competitiveness and accessibility encourage economic activities and households to relocate. Hence, the growth of some municipalities/regions may be the result of the deterioration of poorer municipalities/regions. A lack of attention to these issues may lead to an overestimation of the total economic benefits stemming from transport infrastructure investments (Forkenbrock and Foster, 1990). However, Boarnet (1996) argued that, even if all increased output in one county is due to the production of firms which moved into the county, the increased output in the county must be larger than the indirect effect of decreases output in the other counties where the migrant firms were previously located. That is because each firm that moved into the new county is more productive, and thus can produce more output than they could have in previous locations.

The discussion about the impacts at national level are not exclusively listed in the literature review section, considering that most of the time, regional and national scales are transferable, for instance, the approach for regional scale in the United States or China may be applied as a national scale in some European countries. The impacts at national scale are normally reflected in a much aggregated manner, such as national GDP, national population, national employment etc. which in fact could be easily obtained with a bottom-up approach, summing up the overall regional impacts or municipal impacts. To systematically identify the impacts of transportation investment on municipal and regional development, and afterwards propose an assessment framework, we thus conduct a comprehensive literature review as in the following two sections.

2.1. Municipal Impacts of HSR

As a whole, HSR system provides better accessibility and potential development of economy, improves the quality of living environment, balances both spatial and social distributions and stimulates the organization capacity. (van den Berg and Pol; 1998). These aspects can be studied with various time scopes. Blum et al. (1997) discussed such effects respectively from short, medium and long term perspectives. The study raised that the integration of goods and labor markets, private services and leisure activities are influenced in short term while in a medium term view, the distribution of households and firms can be shifted. And the productions, especially in terms of freight and passenger transport, will be affected in a dynamic way with a long-term view.

Uršej and Kontić (2007) demonstrated the relationships between HSR planning and residential potential. The study introduced that HSR has both positive and negative effects on residential potential. Due to land acquisition and negative impacts on landscape, noise and urban segregation, HSR has negative impacts on residential potential. On the contrary, since the stations are included into the HSR network, the stations are supportive to the centralization of these areas. However, among the case studies in various urban areas and cities, focusing on the relationships between HSR and urban characteristics, we cannot arbitrarily judge in general that which aspects are certainly influenced by HSR or how HSR affects various characteristics. That is because the circumstances of each urban area are not the same. Debrezion et al. (2006) studied that the effects of the distances to the station and to the railway as wells as service frequency on the prices of houses in the Netherlands. They found that prices of houses increase when they are close to the station but such prices decrease when they are close to the rail, while the higher frequency also contributes more on the increase of house price. Nonetheless, in southern Taiwan, the impacts of HSR on the price of residential property are different from the Dutch situation. In this case, the HSR has hardly effect on house price due to the high share of ticket fares in the median monthly income and the high cost of moving to a new area (Andersson et al.; 2010).

HSR also affects various sizes of cities differently. In Southern Europe, e.g. France and Spain, the impacts of HSR on both large and small cities are studied. For big intermediate cities, three HSR projects in Lille, Córdoba and Zaragoza have been investigated. The study indicated that these projects create new images of cities and catalyze its modernization. The HSR stations also stimulate the land use development of household, employment, business and leisure surrounding their locations (Ureña et al.; 2009). For isolated small cities, there are some studies showing that HSR helps the development of such site since it is able to integrate them into the metropolitan area. A Spanish city named Ciudad Real is studied by Garmendia et al. (2008). The research found that the introduction of HSR to this city increased the level of income and population, while it of help to partially integrate Ciudad Real to the Madrid metropolitan area.

Besides the studies investigating the effects between HSR and urban form, many research dealing with the impacts of various local railway transport modes on urban configurations have been conducted as well. Some of these studies are summarized as following since we assume that, at

least in a comparative view, these researches are for reference to the exploration to the HSR impact. Ahlfeldt and Wendland (2011) explored the impact of urban railway network on the decentralization in Berlin, Germany, during 1890 to 1936. In this case, the study shown the development of the railway network decreases the travel time to the city centre, thereby being a main factor leading to a discount of land value closed to the CBD. Consequently, this rapid transport system resulted in the expanding and decentralization of Berlin. In Italy, Pagliara and Papa (2011) summarized the impacts of Naples urban railway system on the land-use and economy. This case study presented that, from 2001 to 2008, around the newly built stations in Naples, because reduction of transport costs, the residential and commercial property prices became higher than the prices in station control areas. What has to be noted is that such impacts may not be distinct in a short-term view. In Sunderland, U.K., Du and Mulley (2007) examined the shifts of land prices in one year after the opening of the Tyne and Wear Metro's extension. As a result, during the aiming time period, the study shown that the new project hardly changes the property prices positively.

2.2. Regional Impacts of HSR

Transport infrastructure investment could contribute to regional economic development in different ways. It increases the accessibility to resources, goods and markets, thus improves the competitiveness of a region (Dodgson, 1974). It reduces distance impedance, enlarges the potential market area, and thus removes the bottlenecks in production and trade, and enhances the economic integration (Blum, 1982; Rietveld, 1989). And, the reductions in travel time and cost can also give rise to productivity growth through reinforcing the agglomeration benefits (Venables, 2004; Graham, 2007).

To investigate the relationship between transport infrastructure endowment and the level of production, production function has been a widely adopted approach since 1970s. Aschauer (1989b, 1990) demonstrated that core infrastructures have the strongest statistical significance in estimated productivity relations. Positive impacts of transport infrastructure in particular were also found on the production levels (Nijkamp, 1986; Andersson et al., 1989; Munnell, 1990). The problem of traditional production function is that it ignores the network quality and properties, and treats all infrastructures homogeneously. In the case of HSR, the region may not have the HSR station but can still benefit from the one in adjacent regions. To account for this issue, Forslund and Johansson (1995) made use of a general production function including regionally specific accessibility characteristics as a part of the inputs. Besides the previous theories, there are other attentions on the agglomeration effects that brought by the transport infrastructure investment. Ciccone and Hall (1996) estimated that doubling employment density in a county increases average labour productivity by 6% for the United States, and 4.5% for European regions (Ciccone, 2002). Graham (2007) found the elasticity of production with respect to weighted average urbanization is 0.129 for the whole economy, 0.07 for manufacturing sector and 0.197 for service sector.

In terms of labor participation rate, with the HSR service, an individual is able to travel over longer distance to work, if he/she finds the job opportunities in further region more preferable. To investigate this effect, one common approach is to formulate it as such that regional employment is a function of the regional characteristics, such as wage rate, accessibility and labor availability etc. Dodgson (1974) related areal employment growth rates to transport costs and to other variables, and then tested a case using multiple regression techniques. Similarly, Botham (1980) used regression analysis to explain changes in zonal employment of 1961-66 in Britain. The conclusion showed that the road program has had a centralizing effect on the distribution of employment. The very recent study carried out by Ozbay et al (2006) analyzed New York /New Jersey metropolitan area with the similar method. The results showed that 1% accessibility improvement leads to 0.05% increase in employment. One main problem of this method is that transportation improvement in one region in general leads to an improvement in all regions, which does not mean that the employment in all regions will increase. With this specification, it may easily lead to an overestimate of the regional impacts of transport infrastructure. The problem was considered and solved by using a relative accessibility measure. Evers et al (1987) applied this concept to analyze of the effects of the proposed HSR line Amsterdam-Groningen-Hamburg on the employment by sector, assuming that changes in economic potential are directly proportional to their impact on the employment at risk.

The improvement in regional accessibility, growth in the regional productivity could induce more private investments to that region by expanding the existing businesses and attracting new economic activities. Aschauer (1989a) adopts a theoretical framework in which it states that public capital tends to crowd out private investment if it substitutes the private capital in production, and it tends to crowd in private investment, if the public capital serves by raising the return to private capital. His empirical study demonstrated that the net effect of a rise in public investment expenditure is likely to raise private investment. Erenburg

(1993) and Guild (2000) both confirmed that public infrastructure capital has an overall stimulating effect on private investment. A comprehensive analysis particularly about the effects of HSR on regional private investment was only found in the study of Sasaki et al (1997). The main idea of their model is that national investment is initially determined and then is distributed among regions according to their relative efficiency and requirement for investment. They found that Shinkansen network expansion leads to regional dispersion from developed regions to some extent.

Transport infrastructure is also an important location factor for households and firms when relocation happens in the long run. The spatial distributions of firms and households at regional level are normally reflected in terms of regional private investment or employment and population. Hansen (1959) first showed that a statistical relationship exists between accessibility and the residential development. Nakamura and Ueda (1989) found that at the prefecture level, the prefectures with a Shinkansen station have higher population growth than the ones without. The same conclusion was reached by Amano and Nakagawa (1990) through examining the impact of the Tokaido Shinkansen line. Carlino and Mills (1987) assumed equilibrium employment and population to be related endogenously to each other and to a variety of exogenous factors. Besides that, there are some other methods using disaggregated data, such as interviewing the location decision makers or estimating location choice models using stated or revealed choice data. Willigers et al (2003) conducted interviews among corporate decision makers to determine how a change in accessibility due to new HSR service is perceived and what impacts HSR connections have on firm location choices. Recently, Willigers et al (2005) estimated discrete choice models to study office relocations within regions and cities in the Dutch Randstad area due to the HSR service using both stated and revealed choice data. The results showed relocations can be expected to be more intraregional than interregional. Quigley (1976) was one of the first who used discrete choice models for housing location decision. Friedman (1981) extended the choices from houses to communities. He constructed a model of residential location choice, in which each household is assumed to select the community that maximizes the indirect utility function.

3. Methodology

Considering the findings of the literature review, in this section, we derived 2 conceptual model frameworks to represent how the provision of HSR service could potentially affect municipal and regional development in the long-term, and an additional global model of how these two levels could be systematically integrated to yield the national impacts. They will be used as the basis of for formulation and programming in the future. The global model is constructed with a systematic perspective, in which each level is represented with a sub-model. It includes the interrelations of the different aspects within the global system in order to represent the dynamics more realistically.

3.1. Municipal Modeling Approach

According to the studies summarized in section 2.3, research and studies attempting to investigate a general model framework in terms of the HSR impacts on urban forms and development are rarely found. In this paper, a new comprehensive modeling structure is built to explore such relationships, shown as Figure 1.

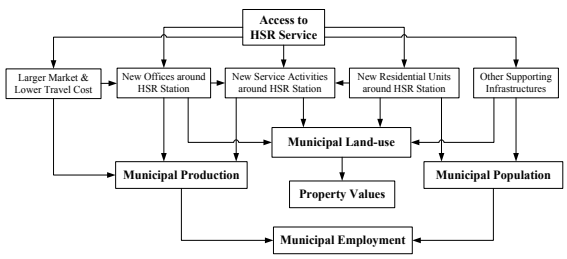

Figure 1: HSR and Municipal Development

With the introduction of HSR service, the municipalities that are served by the HSR stations directly generate higher accessibilities and become more attractive. They are thus to primarily affect the following five aspects:

1) The service of HSR depresses the travel cost due to the travel time savings. So, the lower cost can then catalyze the booming of the markets in the HSR service areas.

2) The HSR service is able to attract more commercial activities. To adopt the growing demand of the activities, more offices are likely to be located in these areas.

3) Besides the growing of commercial activities, the HSR service will also generate more private and leisure trips. Since new trips are created, the demand of these trips to be served will then be higher. This may lead to the raise of service activities surrounding the HSR station, together with the increase in number of offices.

4) In a long-term view, the surrounding area of HSR station will be attractive to people who have the willingness to live in this area and to commute to work in another city. Therefore, the attractiveness of HSR station may alter the distributional pattern of the residential units.

5) The HSR service also affects other supporting infrastructures, which are not mentioned above.

For instance, a local public transport station might be built to connect the HSR station to the other municipalities in the city.

The synthesis of various aspects is able to influence the municipal production, land-use and population, and thus shift the property values and municipal employment. The HSR service leads to a larger market, new employment opportunities and new service activities. These consequences together are likely to stimulate the growth of production in the municipality. Meanwhile, all new offices, service activities, residential units and other supporting infrastructures, e.g. a new public transsport line, attractive by the HSR service require the usage of land. These aspects will result in the shift of land-use patterns. Since the demand of land-use increases, the price of real estate may rise. Hence, the property values surrounding the station will ultimately affected. The introduction of new households to the municipality, plus the construction of some supporting infrastructures, the population will go up. Then, the supply of available labors will increase as well. Therefore, the joint effects of new supply of labor force and productions can bring new employment into this area.

3.2. Regional Modeling Approach

Drawing on the findings of the literature review, we thus derive a conceptual model framework as the basis for the future research. A diagram is constructed to represent how the provision of HSR service could potentially affect the regional development in the long-term (**Error! Reference source not found.**). It illustrates the dynamics between the five aspects at regional level, namely accessibility, production, private investment, employment as well as the land-use and spatial patterns. Different aspects are represented with sub-models and interact in a global environment.

With the inauguration of the HSR service, it reduces the generalized transportation cost and improves the household amenity. With the reductions in travel time and transport cost, it increases the accessibility for households to the service and economic activities, and the accessibility for firms to resources, goods, and markets. The productivity of firms will be enhanced through transporting the goods and people more efficiently and less costly and expanding the market areas more profitably. And HSR service is also considered as an improvement in production "environment" in the production function theory, suggesting that this could lead to an increase in production as well.

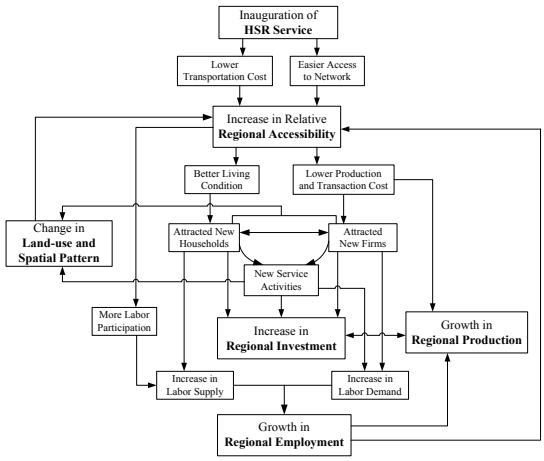

Figure 2: HSR and Regional Development

It is not easy to explain the complex interrelationships between all the five components. To be more logical and intuitive, we integrate them into the analysis of interactions between labor supply and labor demand. Labor supplies of the influenced regions tend to grow due to the response of accessibility and production improvement.

1) Higher accessibility would enable workers to increase the job searching area and commute longer distances for preferable jobs, thus increase the inter-regional labor participation.

2) In the long run, HSR service improves the amenity of households, which leads to the relocations of the households from other relatively underdeveloped regions, thus increase the population.

3) Growth in regional production can stimulate employment opportunities, which are bonded with attracting households, thus increase the population.

Therefore, HSR service could result in an increase in the regional population size and labor participation, which in turn increases the labor availability to supply the job market. Labor demands of the influenced regions will also grow thanks to the improvement in regional accessibility and production.

1) Firms become more productive and may take the advantages to serve larger markets that were not profitable for them before, due to the high shipping costs. To meet the raise in firm outputs, the demand for laborers will increase.

2) The growth in the regional production could induce more private investments to that region, and new firms also tend to locate to the regions where they have higher labor supplies.

3) Bigger population size and higher labor participation are always accompanied by new

service activities, which will inevitably enhance the labor demand.

The interaction between labor demand and labor supply leads to a higher regional employment level. The changes of land-use and spatial patterns and the growth in private investments occur as a result of the relocation and attraction of new households, new firms and new service activities. One must be aware that land price is a critical factor that limits households to move from one region to another, and also discourages the entry of new businesses and activities. And the introduction of HSR service tends to increase the land prices of the influenced regions. To model these linkages more realistically, the adjustment costs incurred by firms and households shall be carefully defined.

3.3. National Modeling Approach

The global model framework integrates the three different sub-models, in which the interactions and information flows within each sub-model and between them are represented (See Figure 3). In the municipal model, the provision of HSR service improves the accessibility at municipality level, which then improves the attractiveness the municipality, especially the areas around the HSR station. In the long run, the accessibility advantage will attract new residents, firms and service activities. The dynamic between land demand and land supply then yields the new urban form, which in turn influences the municipal accessibility.

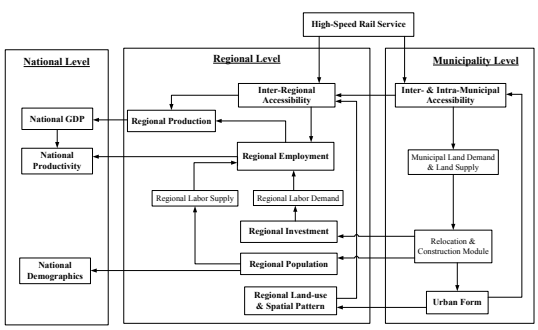

Figure 3: Integration of Municipal, Regional and National Scales

The urban form is directly related with the regional land-use and spatial pattern, which contributes to the changes in the regional accessibility. And, the relocation and construction module in municipal level not only gives the result of urban form, but also provides the input for regional investment and population. Thus, the regional model aggregates the impact form the municipal model, then produces the outcomes at its own level. Within the regional model, regional population influences the regional labor supply, while regional investment affects the labor demand, which then result in a new regional employment level. The new employment level then enhances the regional production together with the effect from the regional accessibility improvement.

Finally, the national model receives all the outcomes form the previous level and produces the corresponding indicators, in this case, national GDP, productivity and demographics.

4. Presentation of the Case Study

4.1. General Overview

The Portuguese Council of Ministers approved on 8 June 2004 the new railway network, which foresees 4 connections into Spain as previously discussed at the XIX Portuguese-Spanish Summit held in Figueira da Foz in November 2003. The connections are the following: Oporto/Vigo, Aveiro/Salamanca, Lisboa/Madrid and Faro/Huelva. The estimated investment for this project is of €1.5bn until 2009 for the high speed network, including the connections Lisbon-Madrid, Lisbon-Oporto and Oporto-Vigo.

HSR is viewed by the Portuguese government as a major strategic investment that could bring strong economic benefits and contribute to creating a megalopolis in the corridor between Lisbon and Oporto. The importance given to this project goes beyond current transport policies with ramifications in the public policies of research and development. This model tries to forecast the economic development from 3 different levels for Portugal brought by the introduction of HSR service between Lisbon and Oporto.

4.2. Data Requirements of the Model

To carry out this model, intensive data sets are required, including the data for calibration and validation of the model and the data for running the simulation. The four calibration periods of 1981, 1991, 2001 and 2010 are to be adopted for estimating the changes in parameter values over time. Each data item is collected at the municipality level, which are then to be aggregated to yield the results at regional scale and national level.

To predict the potential effects of Portuguese HSR at local level, it is helpful to consult the cases in other countries where HSR has already been constructed. In this study, the local impact about Madrid-Barcelona HSR line is studied as a benchmark model to contrast the Lisbon-Oporto line since Spain has the most similar situation to Portugal than any other countries, in terms of economy, culture, geographic position and population density etc.

In general, the following panel data can be obtained in the census block level over various time periods:

- Census data for population and household over the span of each decade.
- Annual changes of firms and employment according to the European Union National Classification of Economic Activities 2009

(CNAE 09).
- Economical indicators, e.g. value added taxes (VAT), in each year.
- GIS information for different Spanish cities connected by the Madrid-Barcelona HSR line.

Then, after the Spanish benchmark model is built, we then subtitute the same type of data from Portugal into the model to analyze the potential changes for the Portuguese cities.

The required data sets for regional level are presented in Table 4.1. For the firm and household location choice models, revealed choice data should be collected.

Population Data	Economic Data	Network Data
Population	GDP by sector	Land availability
Population growth rate	Industrial endowment factors	Road network
	Employment by sector	Conventional rail network
	Service Investment	HSR network
	Manufacturing Investment	

Table 4. 1 Data Items for Calibration

To assess the validity of the model, another data set is required as the reference with which the model results in the period between the base year and the present are compared. For example, municipality and regional data of 1985, 1995, 2005, 2010:

- Population
- GDP
- Employment
- Private Investment

To perform a systematic and quantitative analysis, a simulation approach is carried out in order to acquire better understanding of the impacts of HSR service on short-term and long-term development in Portugal. To perform the simulation, two sets of data are needed, the base year data of 1981 to initialize the simulation and the time series data from 1981 to 2021 to describe the exogenous transportation developments or other policies in order to control the simulation. The time-series data could be defined as:

- National fertility and mortality rates
- National population
- National GDP
- Municipal, regional endowment factors
- Changes in transportation network

4.3. Expected Outputs of the Model

The main outputs of the model are the ones from each sub-model, such as property prices, accessibility, GDP, population, employment, investment and land-use patterns at the year of simulation. However, a number of other indicators are generated during the simulation. These indicators can be analyzed and compared after the simulation runs, with which other type of assessment could be done, such as unemployment rate, labor productivity etc.

5. Conclusions

This paper gives an overview of the existing theories and methodologies about how to assess the economical and spatial impacts of transportation improvement at municipal and regional level, specifically aims for the assessment of corresponding impacts of HSR service. Drawing on the findings, two conceptual models for municipal and regional level respectively are proposed. Moreover, a global model of integrating these two levels into national scale is conceived. And, a case study is also discussed, including the case description, model inputs, and expected outputs, as the basis for later quantitative analysis.

The proposed conceptual models possess some innovative features. Firstly, the relationships between HSR and the various aspects of the municipal and regional development are represented with a relatively more realistic and dynamic manner. Secondly, the models are spatially more disaggregated. The bottom-up approach allows a more accurate assessment, aggregating from city blocks to municipalities, then to regions, and eventually to the nationwide. Thirdly, the models not only capture the generative effects, but also the distributive effects both intra- and inter-municipal and regional. Distributive effects, such as the relocation of households and the changes in employment and economic activities, will be analyzed and transformed into operational indicators to be incorporated into the models. Finally, since the local model is built based on the Spanish benchmark case, the comparisons with the HSR in other countries can be revealed.

However, the most critical drawback of the proposed modeling approach is the enormous required data. Constructing the complete database may take large amount of budget, time wise and financial wise. And, it does not exclude the fact that the expected positive effects might not be as significant as expected due to the redistributive effects and the reactions of the policy makers in anticipation of accessibility improvement. The municipal and regional development may not fully respond to the introduction of HSR services as expected during a short period of time, but rather with a longer time period.

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