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# **TESIS DOCTORALES**

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ALVAREZ-PALAU, Eduard J.. *The railway network and city system: a long term quantitative analysis from the perspective of regional planning*. Department of Transport Infrastructure and Territory, Universitat Politècnica de Catalunya. December 2015. Directors: Manuel Herce, Francesc Magrinyà and Jordi Martí-Henneberg.

## I. INITIAL PROPOSAL AND RESEARCH HYPOTHESIS

The historical relationship between the railway and the city has been studied from numerous different disciplines, thereby enriching the academic debate. The present thesis focuses on long term interactions between railways and the territories that they serve, providing new data and methods for analysis.

The main objective of this thesis is to help improve our understanding of the role played by railway infrastructure as an instrument to support territorial development. It is evident that the railway has influenced the process that has shaped today's city system, but the precise mechanisms responsible for this have yet to be well defined. Two complementary approaches have been proposed to help do this. One of these involves using new databases, detailed at the local level but providing exhaustive coverage for each territory. These data series span a period stretching from the mid-19<sup>th</sup> century to the present day. Their subsequent analysis provides us with quantitative results, which offer a high degree of precision, for both the regional and national levels. The other implies carrying out a series of specific case studies that facilitate our understanding of certain discrepancies with respect to the generally observed patterns.

The hypotheses of this work examine the correlation between railway infrastructure and territorial development, the influence of the system used to promote infrastructure on the level of development, and the impact of the railway at the urban level.

## II. STRUCTURE OF THE CONTENTS

The thesis is presented as a compendium of eight publications which have been grouped together so as to present an introduction, the state of the art, the research hypothesis, a discussion of the results and the combined conclusions.

The first article, *Evolution of the Territorial Coverage of the Railway Network and its Influence on Population Growth: the Case of England and Wales, 1871–1931*, proposes an indicator of railway coverage at the municipal (civil parish) level and correlates this with population growth. The results obtained suggest that the municipalities with the greatest levels of railway coverage (2 or more stations) tended, on average, to grow more than those

with only one station (or located within an hour's travel from a station). The latter also grew more than those that were located over an hour from their nearest railway station.

The second article, *Cálculo de la accesibilidad territorial ferroviaria mediante instrumentos de análisis de redes. Aplicación en Inglaterra y Gales, 1871–1931*, develops an indicator for railway coverage and correlates this with the distribution of population at the municipal level. The results show how improvements in accessibility were linked to increases in population density. It is also possible to observe a reaffirmation of the centre-periphery model in intermediate cities, with a clear increase in the gradient of the centre-periphery curve for population density.

The third article, *Modelo morfológico de crecimiento urbano inducido por la infraestructura ferroviaria. Estudio de caso en 25 ciudades catalanas*, reconstructs the growth of the urban fabric of 25 areas in relation to their railway infrastructure. The analysis undertaken made it possible to define a six-stage morphological model for growth. This work began by focusing on the designing of infrastructure in relation to the pre-existing city. The city responds by growing towards the railway station until all the available land has been completely occupied. After this, growth is perpendicular until the pressure for further urban development makes it possible to grow beyond the railway barrier. The next stage explains the progressive consolidation of the land located on the other side of the tracks and the first steps towards their integration. The sixth, and final, stage corresponds to the integration of the infrastructure by absorbing it into the city.

The fourth article, *Integration or Balkanization? The evolution of the railway network in South Eastern Europe: 1850-2000*, uses spatial analysis instruments to quantify the relationship between the railway and territorial integration on the Balkan Peninsula from a historical perspective. The results obtained allow us to identify three specific periods. In the first, it is possible to observe the influence of external powers and their interest in promoting international commerce. The infrastructure constructed had a clearly integrating effect, with the establishment of the main international railway corridors. The second period was characterised by the territorial fragmentation of the empires. This brought with it a change of direction in the design of the railway network which was subsequently organised in line with meeting strictly national interests. During the third period, corresponding to the years after WW2, the railway network went into decline. However, another external actor, in this case the USSR, was then behind the only major improvements made to the network that were supranational in nature.

The fifth article, *Dos modelos, dos resultados para un mismo propósito: la colonización patagónica mediante infraestructuras ferroviarias públicas o en colaboración público – privada*, offers a comparison between two railway projects that were planned in similar contexts but which used very different management models. The railway project for the Alto Valle del Río Negro y Neuquén, which was a proposal for a public-private collaboration, became a key factor for regional development within the corridor. In contrast, the Ferrocarril Patagónico, was directly promoted by the Argentine Government and had frankly modest results, failing to even cover the initially foreseen route.

The sixth route, *A difícil inserção territorial das linhas elétricas de alta tensão: ferrovias, eletricidade e sistema de cidades no corredor fluvial do Nogueira Pallaresa (Lleida)*, is

presented as a case study that focuses on the interrelationship between railway infrastructure, a waterway system, high-tension electrical power infrastructure and demographic growth, in a mountainous territory. The results of the analysis show that the mere availability of infrastructure does not ensure regional development. Although well-equipped with infrastructure, the places located within the corridor did not experience any growth. Planning the different networks without attending to local needs restricted their potential connectivity and limited growth.

The seventh work, *La colonización del Alto Valle del Río Negro y Neuquén en Argentina: ferrocarril, obras hidráulicas y electricidad para consolidar el poblamiento*, is presented as a case study which had positive results. In this case, the promotor of the railway infrastructure was fully committed to promoting local and regional development. In parallel with the railway infrastructure, it also promoted such activities as: the construction of large reservoirs, an irrigation system to favour agriculture, property developments associated with agricultural plots, and the storage of crops and their commercialisation abroad. Taken as a whole, the territorial result was the establishment of a continuous metropolitan area along the river bank that still exists today, over a century later.

The eighth work, *Ferrocarril i distribució de població: Dades SIGH i indicadors per a l'anàlisi espacial*, corresponds to the initial draft for a chapter of the book: *The Routledge Handbook of Spatial History*. The text includes a synthesis of methods of analysis for correlating railway infrastructure with the distribution of population in Europe from a historical perspective. Indicators such as the length of the network, railway density, fractality, route factor, coverage and accessibility are just some of the methods presented in the text.

### III. DISCUSSION OF THE RESULTS

With respect to the correlation between railway infrastructure and territorial development, the analyses considered in the thesis show that railways made a notable contribution to development based on certain assumptions. The contribution was important when faced with a lack of competition from other forms of transport infrastructure and in regions with a certain degree of previous development. The railway acted as a force that favoured market integration, reduced inland transport costs, and acted as a catalyst for growth. The clearest examples of this were seen where this was associated with the reconversion of the productive system towards activities providing greater added value. Even so, seeking to generalise the relevance of this effect would be a mistake. Railway infrastructure was not only designed to meet economic objectives. Political and military decisions have also led to the construction of railway lines for strategic motives, without necessarily promoting development or with complementary investments. In such cases, trying to correlate the impact of the railway with development would be counterproductive. A clear example of this is provided by the frontier nodes that lie between states which this infrastructure either did not manage to connect or which were projected with different gauges. The need to transfer could have contributed to customs control, but it would certainly have limited economic integration, implying greater transport costs due to the need to transfer the cargo carried.

The relationship between the system of production and the level of development of the territories served is less evident. The analyses presented did not allow to come to any

definitive conclusions in this respect. A good number of the railway systems were designed to connect the most important nodes in the territorial system, and in these cases a good return on investment could be expected. In such cases, both public and private promotions produced similar results. Other railways were directly promoted by companies whose aim was to exploit an economic resource. In these cases, economic growth was generated, but not always demographic growth. In underdeveloped regions, the railway served the purpose of helping to spread the economic system to the interior of territories, thereby promoting development. The fifth article clearly shows how a public-private consortium proved better at meeting expectations than the actions of the public sector in opening connections in Argentine Patagonia. The consortium showed much greater interest in promoting development via complementary investments, as it would not otherwise have managed to obtain any returns on its investment. This example cannot, however, be extrapolated into a general theory. Finally, cases like the River Noguera Pallaresa corridor, in Lleida, show that railway projects planned by higher-level administrations have not always shown signs of wishing to integrate the territories affected. In this case, the consequences were evident: there was no associated local-level development.

The impacts that railways have had on cities have been more evident. The route followed by the railway has constantly generated interactions within the urban fabric and also influenced day-to-day relations with its inhabitants. Initially, the railway raised great expectations, inducing polarised growth, but it also imposed morphological restrictions. The choice of the route followed by the railway had important repercussions and these were crucial for facilitating its progressive integration within the city. Inadequate projects generated strong barrier effects and limited socio-economic relations between the two sides of the track. The subsequent cost of integrating the infrastructure has only so far been demonstrated to be within the possibilities of the largest cities.