Coronado, J.; De Ureña, J.; Miralles García, JL. (2019). Short- and long-term population and project implicacions of high-speed rail for served cities: analysis of all served Spanish cities and re-evaluation of Ciudad Real and Puertollano. European Planning Studies. 27(3):434-460. https://doi.org/10.1080/09654313.2018.1562652

Short- and Long-Term Population and Project Implications of High-Speed Rail for Served Cities: Analysis of all served Spanish cities and re-evaluation of Ciudad Real and Puertollano

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Abstract

Economic growth theories indicate that infrastructures are necessary but not enough for economic growth, providing the cities they serve with new comparative advantages. Today, 25 years after the first high-speed rail (HSR) services opened in Spain and after a complete economic cycle with the longest-running European HSR network, this network can be treated as a territorial laboratory for testing the relationship between new transport infrastructures and population growth. This article compares the population evolution of Spanish cities with and without HSR services, considering the population of each city as a good indicator of long-term trends.

Because the implications of transport investments have, for the most part, been studied only shortly before and after implementation, it is appropriate to re-evaluate these implications from a longer-term perspective. This article compares the population evolution of each HSR city with those of Spain overall, non-HSR municipalities, a random sample of non-HSR cities and similar non-HSR cities. This article also re-evaluates the implications for two small cities served by the first HSR line by means of analyses similar to those undertaken 10-15 years ago to evaluate both the long-term implications and those that are less permanent and have either changed or disappeared.

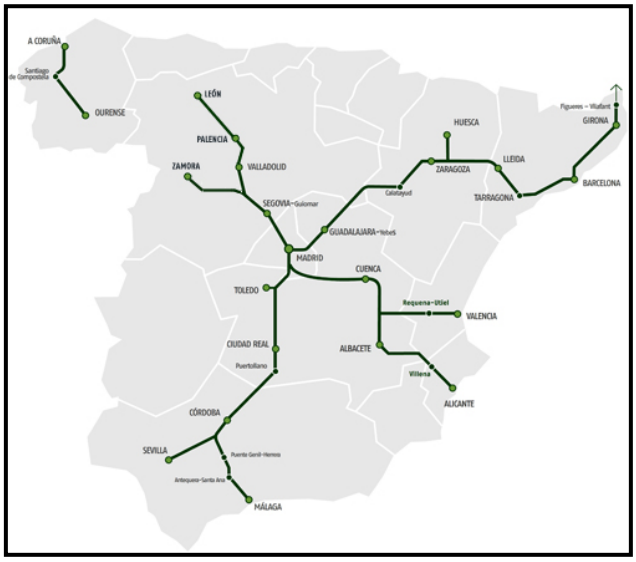
These analyses show that population growth depends on each city's degree of transportation changes, the time elapsed, and the location and size of the city. This article concludes that in the longer term, projects and strategies will be more or less successful depending on their relation to transport. Finally, the article concludes that HSR and non-HSR population comparisons can provide useful general conclusions and that a comparison of HSR cities with similar non-HSR cities yields more specific conclusions.

Keywords: high-speed rail, long-term effects, urban systems, small cities

1. Introduction

Spain inaugurated its first 471 km of high-speed rail (HSR), serving locations between Madrid and Seville, in 1992. The expansion of its HSR network between 1992 and 2017 increased the number of cities served from 5 to 34 (see Figure 1) and improved the connectivity of all cities, especially small ones. This change enabled several small cities to become “cities in movement”, with their inhabitants travelling frequently to other places for multiple purposes.

Figure 1. High-speed rail lines in operation in 2017 and cities with HSR stations.



Source: www.Adifaltavelocidad.es (visited December 4th, 2017)

Garmendia et al. (2012) reported that the most relevant interurban effect of HSR is the reduction in travel time between HSR cities, facilitating "integrated corridor economies", and that the specific implications depend on the characteristics of the operating services (stops, frequencies, schedules, fares...).

Evaluations of the opportunities created by and the implications of HSR for cities have generally been undertaken only shortly prior to or after this new service begins operation. The opportunity to reassess the implications several years later diminishes since other factors begin to contribute in combination with the new transportation investment; for this reason, ex post long-term studies are scarce.

Research on HSR implications often relies on different case studies, which makes comparison a difficult task; however, a systematic and homogeneous analysis of many cities would allow broader understanding of the territorial impact of HSR services (Garmendia, et al. 2012).

There are two options for evaluating the long-term implications of HSR: evaluating the variables with greater long-term influence or re-evaluating several years after the initial studies that are undertaken shortly before and/or after the arrival of HSR. This article seeks to cover both alternatives. First, the implications of HSR for population evolution are evaluated for all HSR-served Spanish cities, since population is a variable that reflects long-term consequences. Second, both the population evolution and the HSR-related projects that were observed 10 years after the arrival of HSR in two Spanish cities (Ciudad Real and Puertollano) are re-evaluated 15 years later; thus, the effects on these two cities 25 years after the arrival of HSR are evaluated. To reduce the influence of other factors that may confound the effect of the new transportation

investment when making short- and long-term comparisons, this article adopts two strategies. First, the two cities that are studied are still very isolated 25 years after the arrival of HSR, thus making short-/long-term comparisons more useful. Second, HSR cities are compared with similar non-HSR cities to reduce the influence of confounding factors.

This paper addresses three research questions. First, what types of population evolution comparisons yield effective visualizations of the implications of HSR? Second, do short- and long-term population growth comparisons and project/strategy studies for HSR cities indicate different implications of HSR? Third, what are the long-term implications of HSR?

This article is structured as follows. Section 2 presents a literature review as a basis for the research methodology. Section 3 explains the methodology used, and Section 4 presents three population evolution analyses: a homogeneous comparison of each HSR city with all HSR and non-HSR Spanish cities, a general comparison of each small HSR city with a random sample of all non-HSR small cities, and a systematic comparison of ten HSR cities with other similar non-HSR cities. Section 5 evaluates the HSR implications on projects/strategies for two case studies 25 years after the beginning of HSR services. Section 6 discusses the main results, and Section 7 is dedicated to the general conclusions of the article.

2. State of the art

2.1. Procedures for ex post evaluation

This section reviews the scientific literature on the short- and long-term implications of new transportation infrastructure. Blanquart & Koning (2017) present various approaches for analysing the local economic effects of HSR, differentiate short-, medium- and long-term effects and discuss the remaining doubts regarding the evaluation of these effects and how they depend on many factors (city size, amenities, industry structure, distance from the urban core, and stakeholders' strategies). According to these authors, it is necessary to examine the causes that explain the different effects.

Environmental assessments evaluate the immediate and long-term effects of the construction and operation of major transport infrastructure projects (Goodenough and Page, 1994) and major spatial planning projects (Ureña and Español, 2006) on the environment. In some countries, territorial assessments are compulsory and have similar immediate and long-term evaluation requirements. Their purpose is to evaluate not only immediate but also long-term envisaged effects and thus to aid in finding mitigation measures.

Ex ante evaluations of expected immediate and long-term effects are frequently conducted; however, there are fewer short-term ex post operation measurements of the effects of HSR and even fewer long-term ex post measurements of these effects (Coronado & Ureña, 2018). Long-term effect studies are frequently theoretical and lack empirical support (Bonatti & Campiglio, 2013).

Ojha et al. (2016) propose a system dynamics approach to explore the long-term (25-year) implications of highway quality on manufacturing growth by investigating several highway maintenance/repair/construction scenarios, considering that improved highways will promote the manufacturing and additional movement of goods and thus accelerate the deterioration of highways. The problem with many dynamic models is that their internal rationale is based on ex ante observations (regressions, etc.) but no ex post measurements.

Vickerman (1994) and Chen & Vickerman (2017) suggest that studies on the implications of major new transport infrastructures must consider several aspects:

-the uncertainty of impacts, since connectivity improvements usually apply in two directions, as well as the small contribution of transportation to total costs and its high substitutability;

-effects that show a multiregional, multitemporal basis;

-complex definitions of accessibility and greater concern for connectivity; and

-implications that depend on how individuals and policy-makers respond to opportunities.

An additional recommendation is to consider both objective (data) and subjective (policies, strategies) analyses. Feliu (2012) shows the importance of stakeholder dynamics in the local development of medium-sized cities when taking advantage of new HSR services. The author evaluates the possible new mobility behaviours to/from important nearby urban areas and the planning strategies associated with station location.

Berger & Enflo (2017) explore the short- and long-term impacts of railroads. They compare cities that did and did not gain access to the railroad and report that it is not straightforward to identify the impact of infrastructure because investments are typically allocated to already growing areas, whereas meaningful comparisons must include cities that are and are not growing. Martí-Henneberg (2017) studies the role of railways between the late 19th and mid-20th centuries in facilitating the integration of European countries.

Approaches that combine ex ante and ex post analyses to determine the influence of transport infrastructure investments are starting to be used, although ex post assessments are often performed only a few years (3 to 5) after complete implementation (Griskeviciute-Geciene & Lazauskaite, 2011). Additionally, ex post analyses are frequently conducted through cost/benefit analyses, concentrating on direct effects in terms of monetary values, without considering indirect socioeconomic effects or those that are broader in scope. Chen & Vickerman (2017) attempt to go beyond the usual measures of economic impact, namely, GDP/GVA changes and growth, to consider the transformational impacts of HSR on the economic structure. Figure 2 shows the best-practice criteria for ex post analyses, including both direct and indirect aspects.

Figure 2. Criteria for ex post assessments of transport infrastructure projects

Direct Impacts						
Travel Time Savings	Operating Costs	Safety	Induced Travel	Service Quality		
Environmental Impacts						
Noise	Emissions	Nature & Landscape	Natural Resources			
Economic Indicators						
Investment Costs	User Benefits					
Indirect Social Economic Impacts						
Land Use	Modal Split	Employment	Social Inclusion	Reliability	Accessibility	Efficiency Output

Source: adapted from Griskeviciute-Geciene & Lazauskaite (2011)

Optimally, three types of studies should be performed over time. First, ex ante studies should be performed to investigate the immediate and long-term expected effects of infrastructure projects. Second, ex post studies should be conducted shortly after the new infrastructure goes into operation to examine the immediate measured effects and to compare them with the expected effects. Third, ex post studies should be performed long after infrastructure operation begins to examine the measured long-term effects and to compare them with the expected long-term and measured short-term effects. This combined approach will highlight the differences between the expected and measured effects and can help to refine methodologies.

To study the implications of HSR, Serrano et al. (2006) suggest considering several distinct time periods, improving on what Fariña et al. (2000) proposed: before the planning of the new infrastructure, when it is known that the new infrastructure will exist, while the new infrastructure is being built, shortly after it goes into operation, and after ten years of operation. The present article addresses an even later time period: 25 years after initial operation. This late period is important because, as reported by Serrano et al. (2006) and Ribalaygua et al. (2004), the effects of new transport infrastructures on mobility occur rapidly, while territorial effects take longer to manifest.

2.2. Implications of HSR for population growth

A few years after the first HSR services started in Japan, HSR cities other than Tokyo showed higher population growth than did non-HSR cities (Haynes, 1997 and Rietveld, et al., 2001); this trend raised the question of whether HSR increased population growth or whether HSR stations were placed in the most dynamic cities.

Later studies found that the relationships between HSR services and population and economic growth are complex. Li & Xu (2016) conclude that population growth depends on the core vs. noncore status of cities; in addition, for noncore cities, growth depends on the distance to core cities. Thus, HSR can induce population agglomeration or diffusion. The authors also conclude that noncore cities at long distances from core cities tend to decrease in population, while those at short distances tend to increase in population.

Vickerman (2015 & 2018) also explains that the real relationship between transport, particularly HSR services, and the economy is complex. It is difficult to understand how and under what conditions HSR services can change transport demands and the locations of population and economic activity.

For HSR cities up to 100 km from main metropolises, Garmendia et al. (2012a) and Mohino et al. (2014) conclude that population growth is faster after the opening of HSR stations. In some cases, this growth is moderate, whereas it is more notable in other cases, with exceptions for the most recent stations. In all cases, however, population changes near HSR stations have been greater than those in the wider regions around such stations, indicating that extra-metropolitan HSR stations play an important role in promoting population growth.

For distances between 100 and 200 km from main metropolises, Mohino et al. (2018) conclude that population growth (in France) and housing prices (in Spain) in small cities with HSR are larger than those for similar non-HSR cities. However, HSR has no influence on these variables for very small and medium-sized HSR cities. The authors also report that HSR effects near HSR stations are stronger for medium-sized cities than for small cities.

2.3. Long-term strategies and project evaluation

HSR cities show high levels of activity in adapting themselves to HSR before its arrival and during its first years of operation (Ribalaygua, 2005). Usually, this process is more intense in medium-sized and small cities, as the changes introduced by HSR services are more important, in relative terms, in smaller cities. City planning is modified to concentrate activities close to stations or create economic poles around stations. Promotional campaigns for tourists or potential investors are deployed at the national or international level. Urban and regional public transport is adapted to better match the new situation. Generally, this initial impulse decays slowly as the

years pass; HSR becomes something that is taken for granted by the city, and the initial interest in HSR opportunities slowly fades out.

Since the opening of the Madrid–Seville HSR line in 1992, Ciudad Real and Puertollano have been very special cases of small HSR cities for two reasons: because they were previously isolated from the main metropolitan areas and because the RENFE provided services to these cities using special regional high-speed trains. Nevertheless, the scientific interest in studying these singular cases has also declined over time. For Ciudad Real and Puertollano, most of the previous literature studying the implications of HSR was published during the initial 15 years after HSR operations began. These implications have already been described in the literature (Ribalaygua, et al., 2004; Serrano, et al., 2006; Garmendia, et al., 2008, 2011 & 2011a; Ureña, et al., 2005; 2009; Ureña, 2012) and can be synthesized as follows:

- The growth expectations were not completely fulfilled. The population growth as though these cities were suburban metropolitan areas was not fulfilled.
- The travel times to the main settlements within the province became equal to those to settlements outside it, producing changes in territorial balance.
- New highly qualified professionals commuting from/to Madrid emerged.
- Quality services were attracted to the area along with highly qualified professionals commuting from Madrid.
- Projects related to transportation, leisure and other economic activities were developed.
- The residential locations of locals were not substantially influenced by the locations of HSR stations.

There are currently few cases of HSR cities where the long-term usefulness of their related strategies and projects can be assessed over a sufficiently long time. Thus, as discussed above, it is now time to look at these two cities to understand their evolution after 25 years of HSR.

3. Methodology

Twenty-five years after HSR services began in Spain, the longest-running HSR network in Europe can now serve as a territorial laboratory for testing the relationship between new transport infrastructure and socioeconomic growth. Furthermore, during this time period, economic trends in Spain have experienced a complete economic cycle: a crisis period in 1992-1997, an expansion period in 1998-2007, and a new crisis period in 2008-2016. This article compares the population growth of Spanish cities with and without HSR services, considering the population of each city as a good indicator of long-term trends.

The implications of HSR are studied through three analyses: a comparison of the population growth of HSR cities with that of all non-HSR cities, a comparison of the population growth of HSR cities with that of similar non-HSR cities, and a comparison of the urban/territorial projects in HSR cities 10 and 25 years after the start of HSR operations. This research does not consider HSR cities isolated from the main HSR network.

Several scholars (Plassard, 1992; Givoni, 2006; Hall, 2009) argue that the territorial/urban implications of HSR must be studied from dual perspectives: an “objective” perspective based on socioeconomic data and a “political” perspective based on projects/strategies. This article analyses population evolution to address the objective perspective and projects/strategies to address the political perspective.

The population growth rates of cities are likely to depend on their size. This article considers four size classes: very small cities with fewer than 20,000 inhabitants, small cities with between 20,000 and 100,000 inhabitants, medium-sized cities with more than 100,000 inhabitants, and large cities/metropolises with more than 0.8 million inhabitants.

The study focuses on the general population evolution of cities with HSR services. The possible influences of other factors, such as economic trends or competition from other modes of transport, are outside of the scope of this study.

The **first analysis** compares the population growth up to 2015 in all cities with more than a five-year history of HSR services (since 2011) to that in cities without HSR. The analysis involves two phases:

- Phase I: for all cities and regions with/without HSR services.
- Phase II: for small cities with/without HSR services.

The indicator IC reflects the population growth[1]:

$$IC_{n+1} = \frac{P_{n+1} + P_n}{P_n} IC_n$$

where P is the population in year *n+1* or *n* and IC is the growth index in year *n+1* or *n.* The year 1991 has been established as the base year, corresponding to a value of 100; that is, IC_{1991}=100 for all variables.

The first phase presents two problems. First, the cities with/without HSR services changes over time as HSR services begin operating in new cities[2]. To account for these changes, this analysis compares the annual growth rates in each case (i.e., for cities with/without HSR services) rather than the total population.

Second, how to account for metropolitan areas, since their metropolitan centres are often saturated urban municipalities, whose growth influences adjacent areas. This research considers entire provinces instead of only the corresponding metropolitan areas; the provincial population growth index is considered representative of the metropolitan area.

The second phase compares small HSR cities (all inland) with a randomly selected group of non-coastal small cities (in 1991) without HSR services that are not integrated into metropolitan areas. In such cities, the impact of new infrastructure may be more direct and produce greater changes. At a confidence level of 95%, the control group sample of 98 non-coastal cities has a standard deviation and error of ±20% for the results of the 20 small HSR cities.

The **second analysis** compares the population evolution of HSR cities with that of similar non-HSR cities. This comparison considers periods of at least 10 years prior to the arrival of HSR and 10 years after its arrival. In three cities, i.e., Ciudad Real, Córdoba and Puertollano, the analysis extends up to 25 years later.

Of the 34 cities served by HSR, several are excluded from this comparison for three reasons:

[1] The population reported in the Municipal Register is the population on the first of January of each year. Thus, the indicator IC calculated with these data reflects the growth during the previous year.
[2] For each year, a city is considered to be either with or without HSR services depending on the number of months with HSR services. Only when the number of months with HSR services is greater than six is the city considered to have HSR services in that year.

-metropolitan areas, because there are no similar non-HSR areas;
-cities that received HSR less than ten years ago, because territorial effects take longer to manifest; and
-cities with fewer than two HSR services per day, because of the low presence of HSR.

Therefore, this second analysis considers only 10 HSR cities: one very small (Calatayud), six small (Antequera, Ciudad Real, Guadalajara, Puente Genil, Puertollano and Toledo), and three medium-sized (Córdoba, Lleida and Tarragona).

The similarity between HSR and non-HSR cities is established according to their size, their distance from metropolises and large cities, whether they are located on transportation corridors, whether they are in inland or coastal locations, and their similarity in terms of overall population evolution phases and economic bases. In particular, Ciudad Real and Puertollano are compared with the same non-HSR cities considered by Fariña et al. (2000) and Serrano et al. (2006).

The **third analysis** considers only the small cities of Ciudad Real and Puertollano and compares the strategies/projects established and initiated with the arrival of HSR services and their degrees of development 10 and 25 years later. The objective is to understand which projects/strategies are temporary and which are more persistent and continue to affect the urban/territorial structure in the long term. The policies/strategies implemented in these two HSR cities are revisited today in the same way they were investigated by Ribalaygua et al. (2004) fifteen years ago.

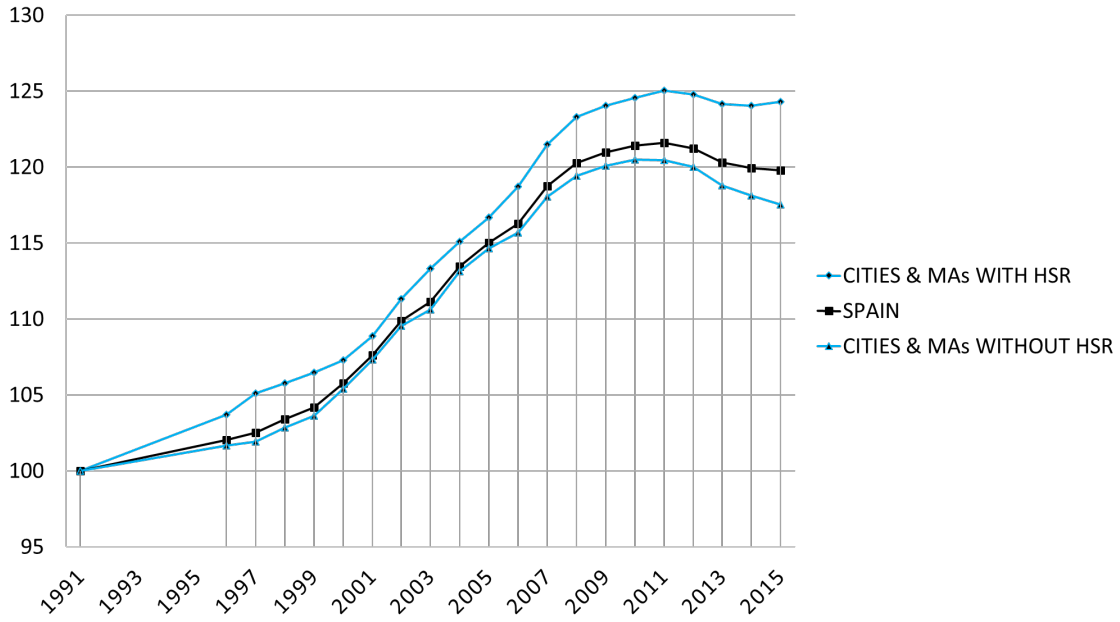
4. Results of comparing population data 10 and 25 years after HSR implementation

4.1. Population growth comparison of all cities and metropolitan areas with and without HSR services

Figure 3 shows that the evolution of the population growth indicator IC for all cities and metropolitan areas (MAs)[3] with HSR is greater than the evolution of IC for all those without HSR. However, the difference does not become significant until 2006, after which it increases continuously.

[3] The provinces considered as MAs are Alacant, Barcelona, Córdoba, Madrid, Málaga, Sevilla, Tarragona, Valencia, Valladolid and Zaragoza.

Figure 3. Population growth indexes of cities and MAs with/without HSR in Spain



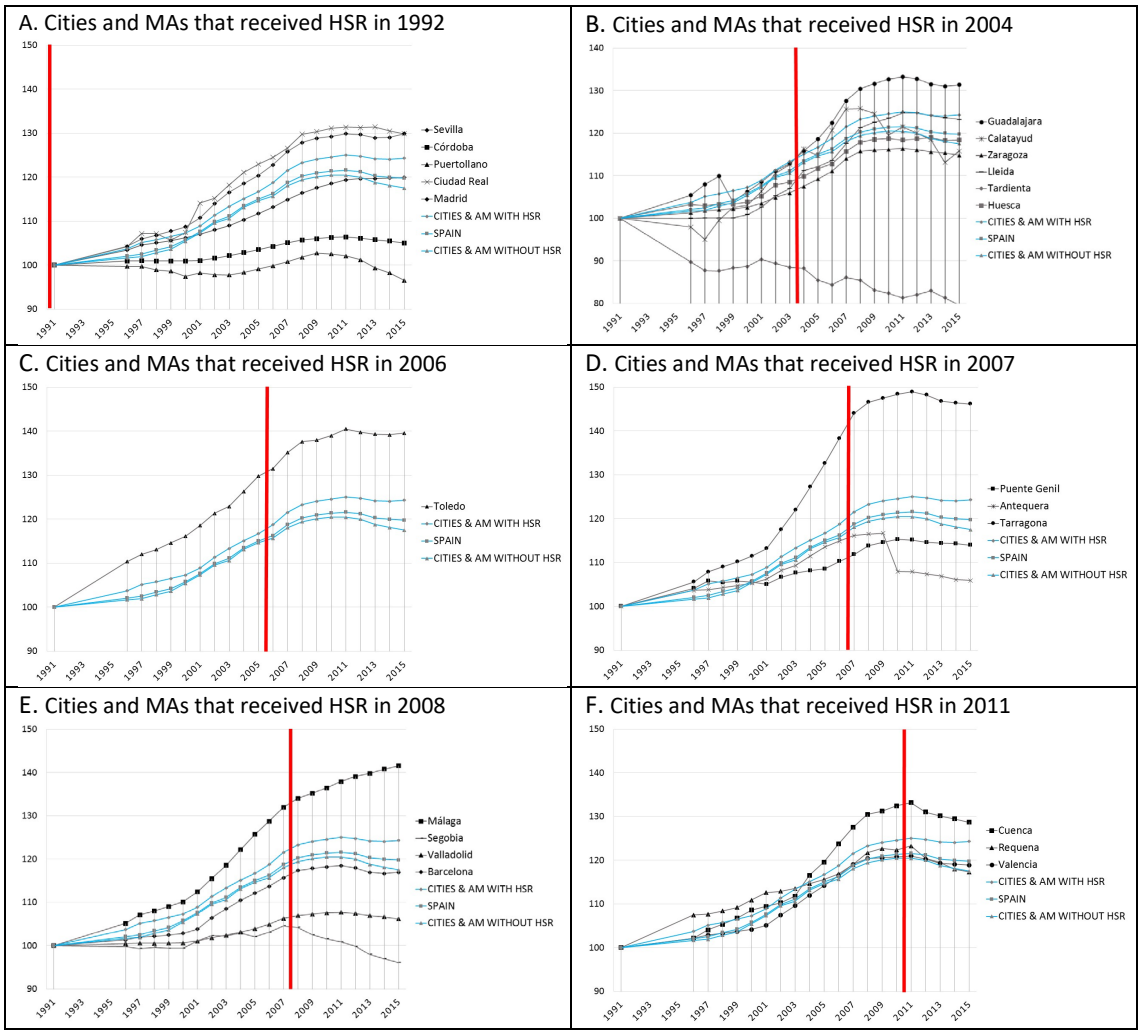
Cities and MAs with HSR experienced greater growth from 1996 to 2000 and after 2006 than Spain and cities without HSR. In addition, since 2011, the difference in growth between cities and MAs with and without HSR services has increased significantly. Data show that during periods of economic crisis, cities and MAs with HSR respond better than those without HSR.

The following question arises: has this higher growth been caused by the HSR services, or has HSR reinforced a global trend of expansion for cities and MAs that were already the most dynamic prior to the arrival of HSR? This question reiterates the doubt raised years ago in relation to Japan. The correct answer is probably a combination of both factors.

Figure 4 shows several patterns in the IC indicator evolution for each HSR city and MA compared to that of Spain and of all cities and MAs with and without HSR.

1. Cities and MAs that show a higher growth trend since the initiation of HSR services relative to the overall Spanish indicators: Madrid, Ciudad Real, Guadalajara, Toledo and Málaga.
2. Cities and MAs that show a lower growth trend since the initiation of HSR services relative to the overall Spanish indicators: Córdoba, Puertollano, Zaragoza, Tardienta, Antequera and Valladolid.
3. Cities and MAs that show a growth trend similar to the average trend of Spain but lower than the average trend for cities and MAs with HSR services: Huesca, Barcelona and Valencia.
4. Cities and MAs that show a trend smaller than or similar to that for all cities and MAs with HSR: Lleida.
5. Cities and MAs that show a lower growth trend since the initiation of HSR services: Segovia, Cuenca and Requena. In these three cases, the trend changed from increasing growth to decreasing growth after HSR services started.
6. Particular cases of Seville, Tarragona, Puente Genil and Calatayud: Seville has shown three different trends in different periods. Tarragona and Puente Genil have both shown trends towards stabilization since the initiation of HSR services; the trend for Tarragona is greater than that for all HSR cities, whereas that for Puente Genil is smaller than that for all HSR cities. By contrast, Calatayud shows an irregular trend.

Figure 4. Population growth index comparison for each HSR city and MA in Spain relative to all cities and MAs with and without HSR services



4.2. Population growth of small cities with HSR compared to a control group

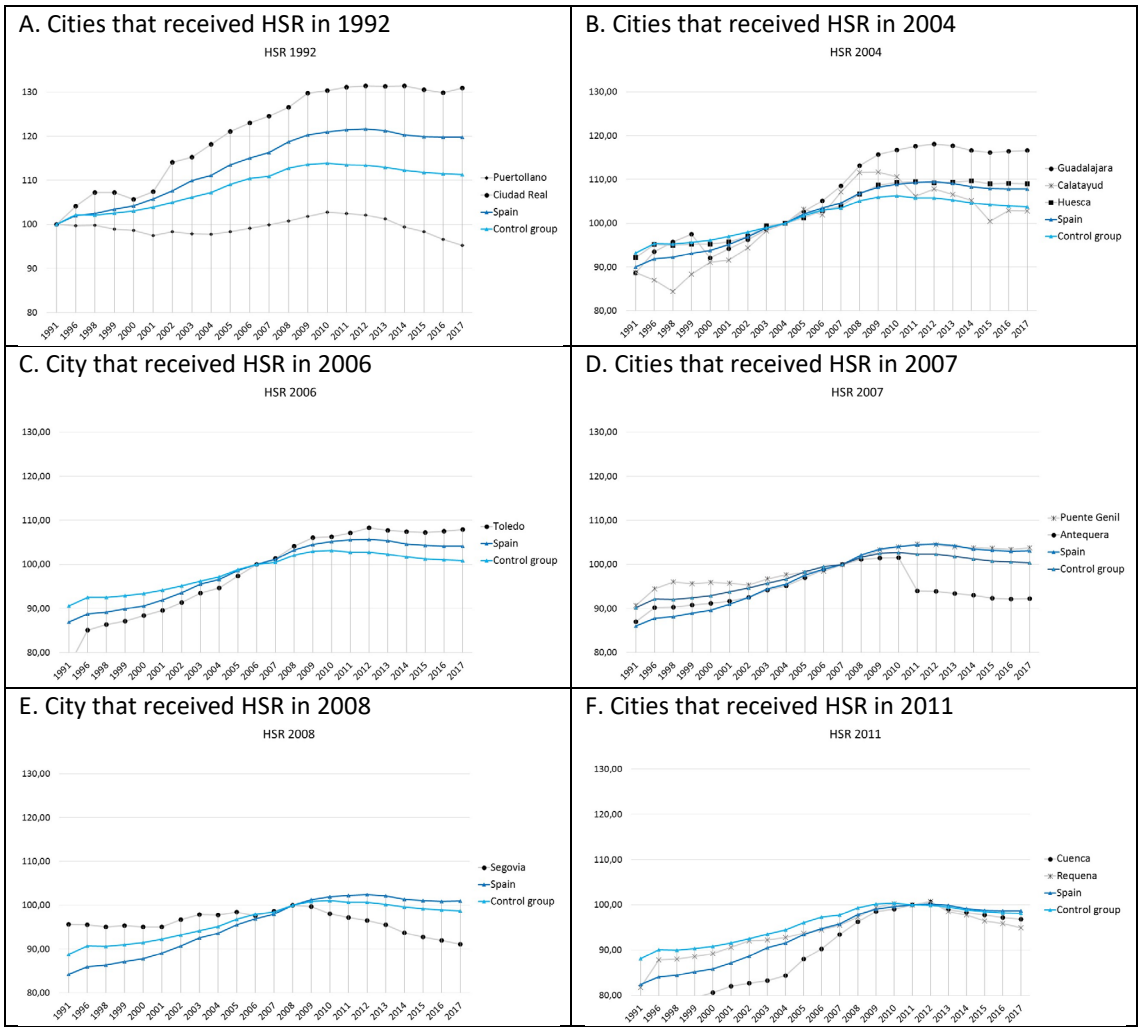
Figure 5 shows the evolution of IC for all small HSR cities and for a control group of small non-HSR cities from 1991 to 2016, with a base of 100 in the year that HSR services began in each city.

From these data, different cities' growth behaviours are identified. First, cities with a growth rate higher than those of the control group and Spain as a whole: Ciudad Real, the first stop from Madrid since 1992 and Toledo, with HSR services that enable commuting; Guadalajara, which is close to Madrid; and Huesca and Puente Genil, which exhibit this behaviour even though they are far from large MAs.

Calatayud shows intermediate behaviour with an irregular trend. From 1998 to 2008, before and just after HSR services started, its growth was very strong and greater than that of the control group. However, since 2008, its growth has slowed considerably, becoming less than or equal to that of the control group.

Finally, there is a group of cities that exhibit a growth rate lower than that of the control group after the initiation of HSR services. Antequera, Segovia, Cuenca and Requena all showed a change in trend from increasing to decreasing growth after the arrival of HSR.

Figure 5. Population growth indexes for small HSR cities and for a control group of non-HSR cities



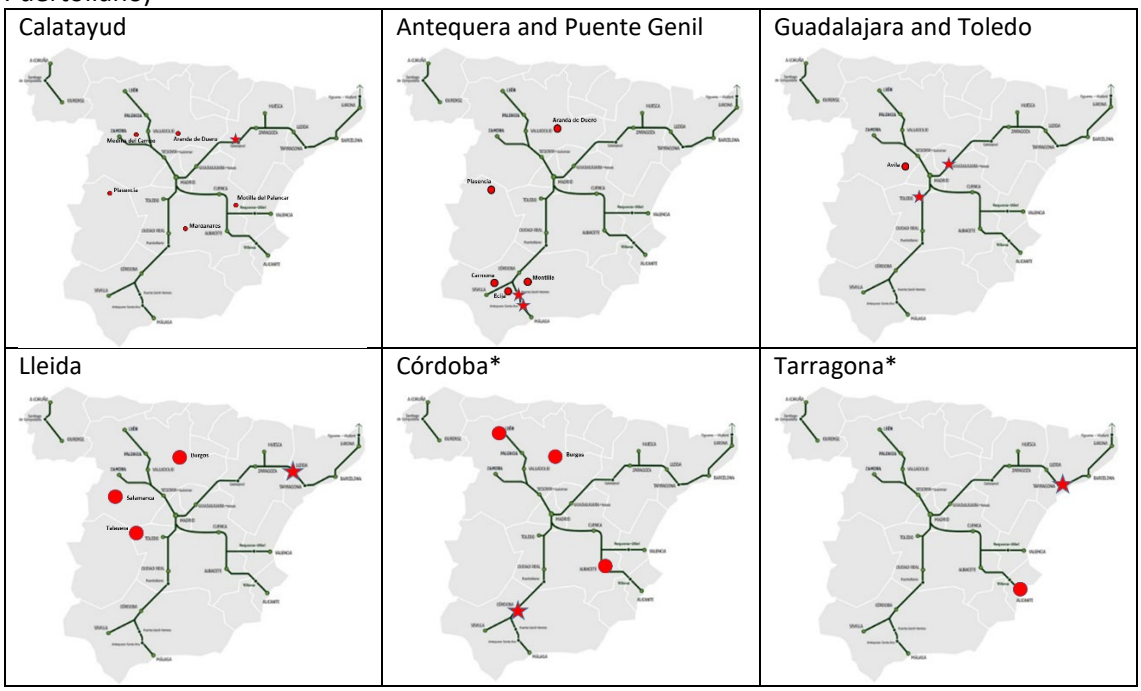
Figures 5E and F show the results for cities where HSR services started after the 2008 economic crisis in Spain. Thus, their evolutionary patterns might be expected to differ from those of the other cities, where HSR services started during a period of economic growth.

All these cases show that the territorial impact of HSR services relative to a control group of non-HSR cities can be very different for different small cities. Each city has its own economic dynamics, and HSR services can help to improve it. It is also possible that HSR services enable new economic activities and become an engine for economic growth. By contrast, it is also possible that HSR services contribute to the decline of non-competitive economic activities.

4.3. Comparison of the population evolution of HSR cities and similar non-HSR cities

As indicated in the methodology, this analysis considers 10 cities where a significant number of HSR services have been in operation for at least a decade. Each HSR city is compared with similar non-HSR cities (Figure 6). These comparisons are presented in Figure 7 (and Appendix 1), except those for Ciudad Real and Puertollano, which are discussed in Section 5.

Figure 6. Locations of HSR cities and similar non-HSR cities (except Ciudad Real and Puertollano)



* Albacete, Alicante and León are considered non-HSR cities since they received HSR only one to three years before the most recent population data.

The growth trend of the very small city of **Calatayud,** which is located on a reinforced transportation corridor and at considerable distances from metropolises, changed with the arrival of HSR in 2004; this city grew less before and more after HSR than all the other similar very small non-HSR cities considered for comparison (Figure 7A). However, its relative growth tendency after HSR was highest immediately after the initiation of HSR service.

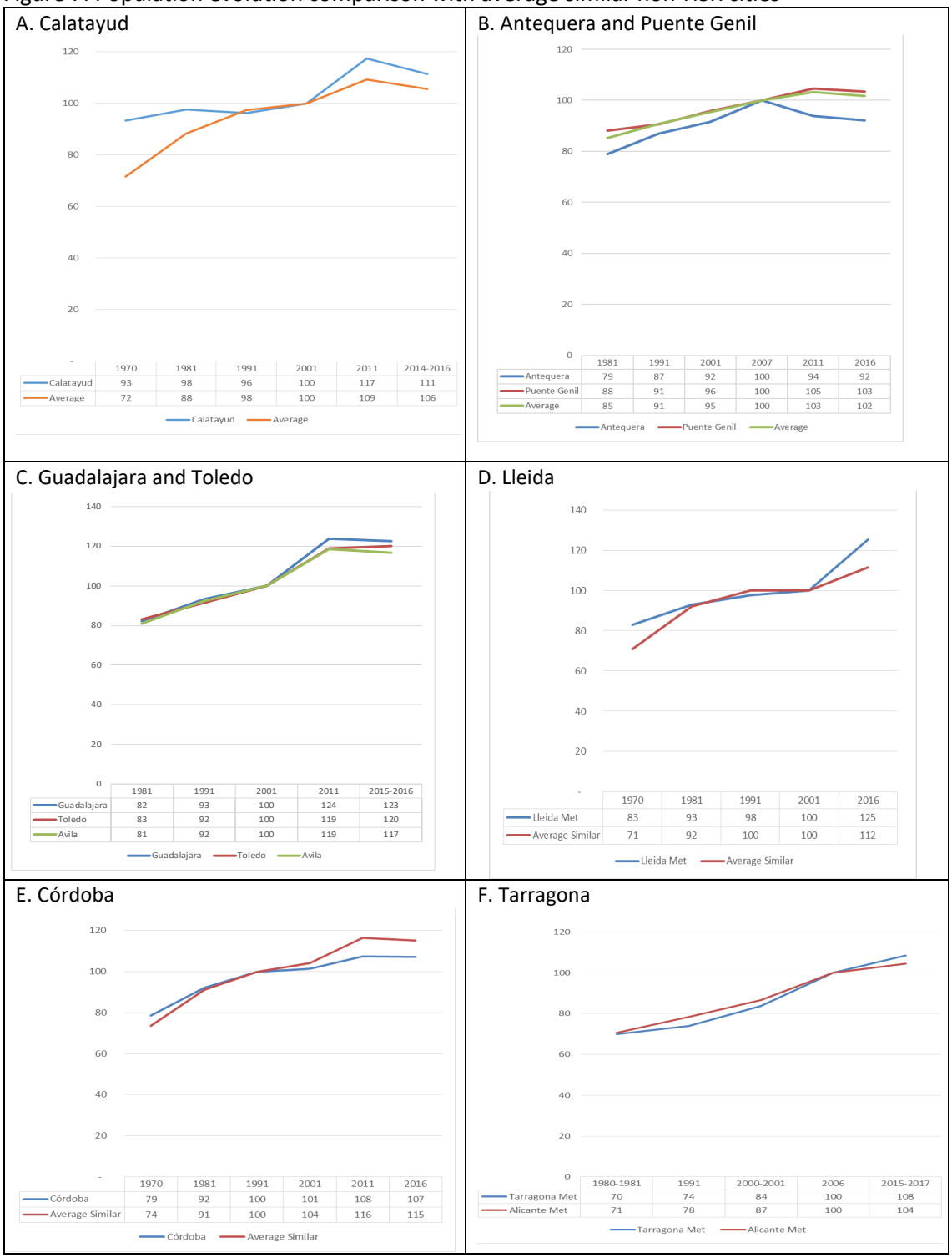
The small cities of **Antequera** and **Puente Genil**, which are not far from each other and are farther from the nearest metropolises or large cities, show opposite growth trends. Antequera grew at a rate slightly less than the average for similar non-HSR cities before HSR and at an even lower rate after, while Puente Genil grew faster than the average among similar non-HSR cities before HSR and exhibited almost equal growth after (Figure 7B).

The small cities of **Guadalajara** and **Toledo** are not far from metropolises and show similar relative growth behaviours. Both grew very slightly less than the similar non-HSR city of Avila before HSR and similarly or more after (Figure 7C).

The medium-sized cities/conurbations of **Lleida** and **Córdoba** are fairly distant from metropolises and show different behaviours. Both grew proportionally less than all other similar cities/conurbations before HSR; however, Lleida grew proportionally more afterwards, whereas Córdoba continued to grow proportionally less (Figures 7D and E).

Finally, the only medium-sized coastal city/conurbation, **Tarragona**, which is close to a metropolis, exhibited growth similar to that of the similar non-HSR city/conurbation Alicante before HSR and showed higher growth afterwards (Figure 7F).

Figure 7. Population evolution comparison with average similar non-HSR cities

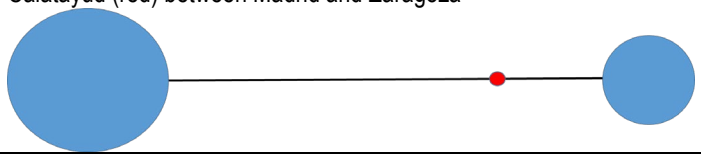
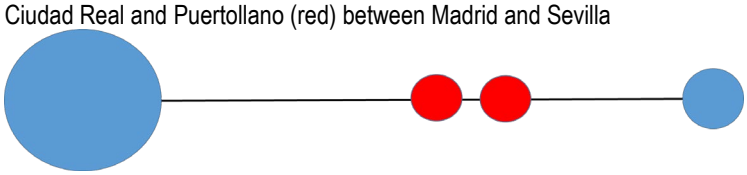
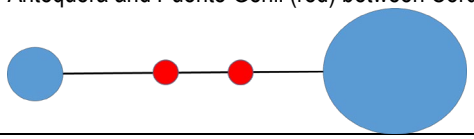
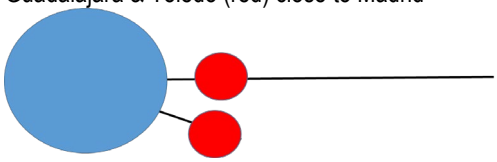
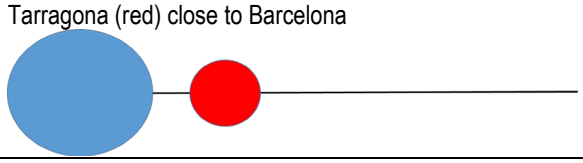
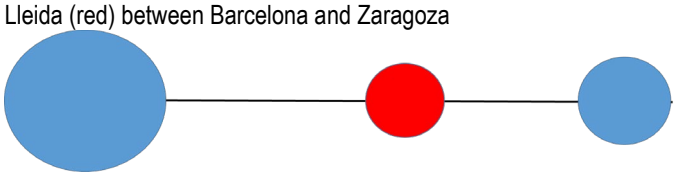
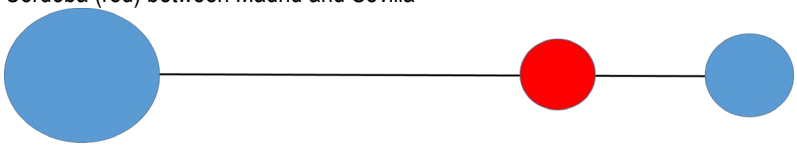


4.4 HSR and long-term population evolution: discussion of the results

In general, HSR cities grow faster than Spain and non-HSR cities on average. However, the differences are significant only after 2012, when economic activity started to slowly recover from the crisis period. In addition, cities with HSR have responded better and shown a greater increase in relative growth than those without HSR.

The population comparisons suggest that the influence of HSR on the population evolution of a given HSR city follows one of several patterns depending on that city's size and location (Figure 8). These patterns reinforce the conclusion of Li & Xu (2016) that population growth of noncore cities depends on their distance from core cities. In some cases, the authors contradict their conclusion that noncore cities at long distances from core cities tend to decrease in population.

Figure 8. Typologies of Spanish HSR cities

A. Very small inland cities with no administrative roles, along relevant transportation corridors, reinforced by HSR, at long distances from metropolises.	Calatayud (red) between Madrid and Zaragoza 
B. Pairs of small inland HSR cities close to each other, without or with only partial administrative functions, far from major cities/metropolises.	Ciudad Real and Puertollano (red) between Madrid and Sevilla  Antequera and Puente Genil (red) between Córdoba and Málaga 
C. Small inland cities and medium-sized coastal cities close to large MAs, either on main transportation corridors or not.	Guadalajara & Toledo (red) close to Madrid  Tarragona (red) close to Barcelona 
D. Medium-sized inland cities either far from or close to one large MA and closer to a smaller one.	Lleida (red) between Barcelona and Zaragoza  Córdoba (red) between Madrid and Sevilla 

Very small inland cities along relevant transportation corridors (reinforced by HSR) that are far from main metropolises and close to large cities or small metropolises (see Figure 8A) show a change in their population growth trends since the arrival of HSR. These cities have changed from exhibiting less growth relative to similar non-HSR cities before HSR to exhibiting more population growth after HSR. We conclude that HSR provides a clear benefit for very small, isolated cities.

Pairs of nearby small inland HSR cities, either slightly larger or smaller, with or without administrative functions and distant or less distant from major metropolises/cities (see Figure 8B), tend to show opposite (positive and negative) changes in population growth. Some of the

causes/explanations for this difference have been described by Ureña et al. (2005) on the basis of the cities' different economic bases and the first-stop effect from/to metropolises. Tertiary cities benefit more than industrial cities, and new commuting opportunities can be more efficiently exploited by the first stop. However, there is one case in which the economic bases are similar and the first-stop effect is not relevant since commuting to/from both nearby cities is feasible, yet the population growth trends are nevertheless opposite. Our explanation is that beyond the economic bases and the first-stop effect, in this case, the proximity between this pair of cities might explain the observed trends. Both cities are able to profit from the new HSR services, but one of them wins the competition and not only absorbs the new opportunities provided by the HSR services but also attracts part of the original activity from the other city since the HSR brings the two cities closer together, making them more similar and substitutable.

Small and medium-sized cities within areas of some metropolitan influence (60 to 100 km), either on main transportation corridors or not (see Figures 8C and D), show phases of population growth similar to those of the nearby large metropolises but at higher rates. These HSR cities exhibit rates of growth comparable to those of similar non-HSR cities before the arrival of HSR but increased relative growth rates after the arrival of HSR. This finding reinforces the conclusion of Li & Xu (2016) that noncore cities at short distances from core cities tend to increase in population.

The preponderance of these population growth trends seems, to a certain extent, to contradict the conclusions of Garmendia et al. (2012a) and Mohino et al. (2014) that HSR facilitates the generation of metropolitan subcentres only up to 30 km away from a metropolitan centre, while small HSR cities farther away (60-100 km from the metropolitan centre) do not succeed in becoming metropolitan subcentres. Conversely, our analysis is in accordance with the findings of Mohino et al. (2018) for small HSR cities at slightly greater distances from Paris, which show increased population growth tendencies.

The only Spanish case of a medium-sized city/conurbation within the influence of a metropolis shows a partial impact of HSR on its population growth rate. The general comparison shows a trend towards a stable higher rate of growth compared with all non-HSR cities, and the specific comparison also shows an increase in its growth rate compared with similar non-HSR cities after the initiation of HSR services. Conversely, a similar analysis by Mohino et al. (2018) yields no such conclusion for a medium-sized city within the influence of Paris (Reims, which is slightly farther away from Paris). Thus, additional research is needed on this type of medium-sized city.

Medium-sized inland HSR cities distant or not too distant from one large MA and less distant from a smaller one (see Figure 8D) experience different growth tendencies. A city closer to the larger metropolis experiences a positive change in population growth from before the arrival of HSR to after, while one that is farther away shows less population growth both before and after the arrival of HSR. The first case contradicts the finding of Mohino et al. (2018) that HSR has no clear influence on the population in medium-sized French cities up to one hour of HSR travel time from Paris (Le Mans, Reims, and Tours). However, these French cities, unlike the comparable Spanish cities, are not located along the most important transportation corridors and are not close to another small MA. It could be argued that their greater size and greater distance from the large metropolis exert too much of an influence for the HSR to drive an overall change in city growth.

It is interesting to note that although cities of this type exhibit several different population evolution paths, in all of them, both French and Spanish, very successful urban projects have been developed around their HSR stations (Ureña et al., 2009a; Bellet & Gutierrez, 2011; Bazin, et al., 2010).

5. Ciudad Real and Puertollano: a 25-year evaluation

Ciudad Real and Puertollano were the first small cities in Spain served by HSR. The quality of their rail connections was tremendously improved after they were connected to Madrid and other cities along the corridor in 1992. Today, they are connected to most HSR cities along the other HSR lines. They have high proportions of HSR passengers per year relative to their populations[4]. The HSR in these two small cities achieves excellent money/time efficiency, behind only Madrid and Córdoba (Coronado & Ureña, 2018).

5.1. Ciudad Real and Puertollano population growth trends re-evaluated 25 years after HSR

This section revisits the same analyses performed 10-15 years ago to evaluate the temporary and long-term implications of HSR. Ciudad Real[5] and Puertollano[6] are compared with the same similar non-HSR cities previously considered by Fariña et al. (2000) and Serrano et al. (2006), although the similarity criteria are not identical to those used in the previous section (4.3). Ciudad Real is compared with small provincial capitals, and Puertollano with small industrial cities. Neither city is close to the seaside nor to a large MA.

None of the cities considered for comparison had HSR when the two previous comparisons were performed. Some of those compared with Ciudad Real do have HSR now, but most of them received HSR only very recently: Albacete (2010), Cuenca (2010), Huesca (2005), Lleida (2003), Orense (2011) and Zamora (2015).

Fariña et al. (2000) and Serrano et al. (2006) performed comparisons using four variables: population; market share and tourism indexes from two banks; and housing numbers, including building years and numbers of empty dwellings, from the National Statistical Institute and the Ministry of Development. Fariña et al. (2000) compared the population during the first 5 years following the beginning of HSR services (from 1992 to 1996), a very short period, and they only the market share and tourism indexes for only one year before HSR (1991). Serrano et al. (2006) compared population numbers from 1975 to 2001, market share and tourism indexes between 1991 and 2002 and age, use and price of housing between 1991 and 2001.

The analysis presented here compares fewer variables but over more years. At present, market share and tourism index data no longer exist. Data for housing numbers, building years and empty dwellings are available, but the housing price data by municipality offered by the Ministry of Development have been discontinued. Therefore, this section compares only population data.

Ciudad Real has shown a total growth greater than that of every other capital except Albacete and greater than the average of these cities (Figure 9). Albacete is the largest city, with more than double the population of Ciudad Real.

During the period prior to the arrival of the HSR but after construction had begun (1981-1991), Ciudad Real grew more than all the other cities except Lugo. During the period just after the HSR opened (1991-2001), it grew more than all the other cities except Albacete. During the next fourteen years (2001-2014), it grew more than all the other cities except Cuenca.

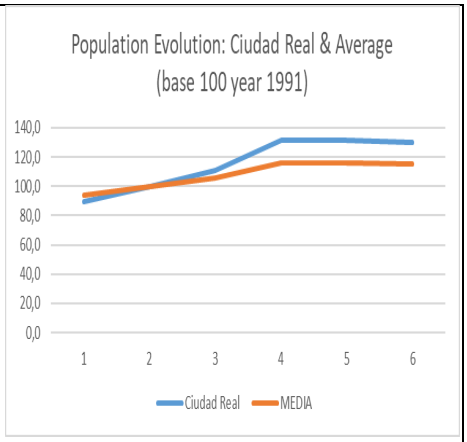
[4] The number of HSR passengers decreased by approximately 20% during the crisis years and recovered during the recent post-crisis years.

[5] Ciudad Real is compared with Albacete, Ávila, Badajoz, Cáceres, Cuenca, Huesca, Jaén, León, Lleida, Lugo, Orense, Palencia, Soria, Teruel and Zamora.

[6] Puertollano is compared with Andújar, Baeza, Bailén, Bolaños de Calatrava, Carolina (La), Daimiel, Linares, Manzanares, Pozoblanco, Solana (La) and Úbeda.

Figure 9. Population evolution of other provincial capitals compared to that of Ciudad Real (base 100 in the year 1991)

Municipality	1981	1991	2001	2011	2014
Albacete	90.1	100	114.5	131.5	132.7
Ciudad Real	89.6	100	110.9	131.3	131.4
Cáceres	96.3	100	110.9	127.4	128.5
Teruel	99.1	100	109.4	121.7	125.2
Badajoz	93.6	100	109.2	123.3	123.1
Jaén	93.4	100	109.0	112.4	112.2
Soria	99.0	100	108.6	123.1	122.1
Cuenca	97.6	100	108.2	130.3	130.2
Ávila	90.8	100	108.1	127.7	128.2
Lugo	88.9	100	106.2	117.1	118.4
Average	**93.5**	**100**	**105.4**	**115.6**	**116.2**
Huesca	100.5	100	104.7	115.9	119.0
Orense	93.5	100	104.6	103.4	104.0
Palencia	95.1	100	102.5	102.1	103.0
Zamora	92.6	100	100.6	100.5	99.9
Lleida	97.8	100	100.1	121.9	124.2
León	91.1	100	90.9	90.8	90.0



Source: Instituto Nacional de Estadística.

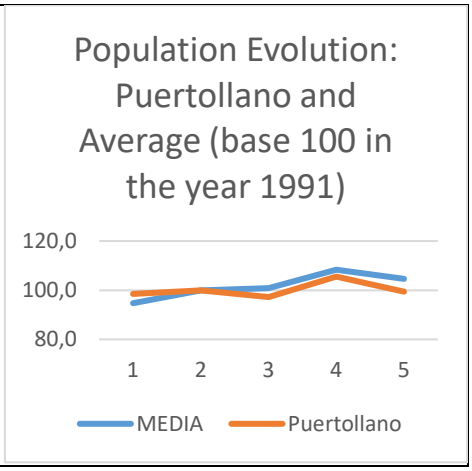
The provincial capital of Ciudad Real is the first stop on the Madrid-Seville HSR line. Ciudad Real has shown a positive growth path compared to similar provincial capital cities. For the first 20 years after the arrival of HSR, its relative growth was greater than the average of the other cities, and during the last four to six years, this positive growth difference has been maintained.

Puertollano grew less than all the other cities except for Baeza. During the period prior to the arrival of the HSR but after construction had begun (1981-1991), Puertollano grew less than all the other cities except Daimiel and La Carolina. During the period just after the HSR opened (1991-2001), it grew less than all the other cities except Baeza and Manzanares. During the next sixteen years (2001-2016), it grew less than all the other cities except Bailén, Andújar and Linares.

Puertollano grew less than the average, and its relative growth seems to have decreased further during the last few years (Figure 10). The industry of Puertollano is narrowly focused on petroleum energy, a sector with decreasing employment, while the other cities have more diversified industries.

Figure 10. Population evolution of other industrial cities compared to Puertollano (base 100 in the year 1991)

Municipality	1981	1991	2001	2011	2016
Bolaños	98.6	100	110.6	124.0	119.1
Úbeda	89.8	100	101.5	112.2	109.0
Pozoblanco	88.1	100	106.2	114.8	112.0
Solana (La)	96.0	100	106.2	116.9	113.7
Bailén	92.9	100	105.5	111.5	107.6
Daimiel	100.3	100	105.4	115.2	113.5
MEDIA	**94.7**	**100**	**100.8**	**108.3**	**104.6**
Baeza	83.7	100	86.3	92.8	91.0
Manzanares	96.7	100	96.3	105.0	100.8
Andújar	97.6	100	105.9	109.2	106.1
Carolina (La)	100.7	100	101.8	108.3	107.1
Linares	93.4	100	98.9	104.6	100.7
Puertollano	98.6	100	97.2	105.5	99.4



The industrial city of Puertollano is the second stop on the Madrid-Seville HSR line and shows a negative growth path in comparison to similar industrial cities. Because HSR is a means of transportation for people only and due to the proximity of Ciudad Real, which is also served by HSR, the HSR service is not very useful for the industrial city of Puertollano. In this setting, HSR is in fact detrimental to Puertollano while being beneficial to Ciudad Real.

A comparison with the population findings from the analysis undertaken 10 years ago by Serrano et al. (2006) reveals that the findings of the present longer-term analysis are not identical, but similar. Thus, it could be argued that the usefulness of long-term population evolution analysis is not substantial. Nevertheless, this longer-term analysis suggests that the growth population dynamics of Ciudad Real (an administrative city) have been maintained in relation to those observed ten to fifteen years after the arrival of HSR, while those of Puertollano (an industrial city) seem to have worsened relative to those observed ten to fifteen years earlier, even more so during the two periods of economic crisis. Thus, a longer-term population analysis can reveal additional qualitative differences.

5.2. Comparison of strategies and projects: revisiting the analysis of Ciudad Real and Puertollano undertaken 10-15 years ago

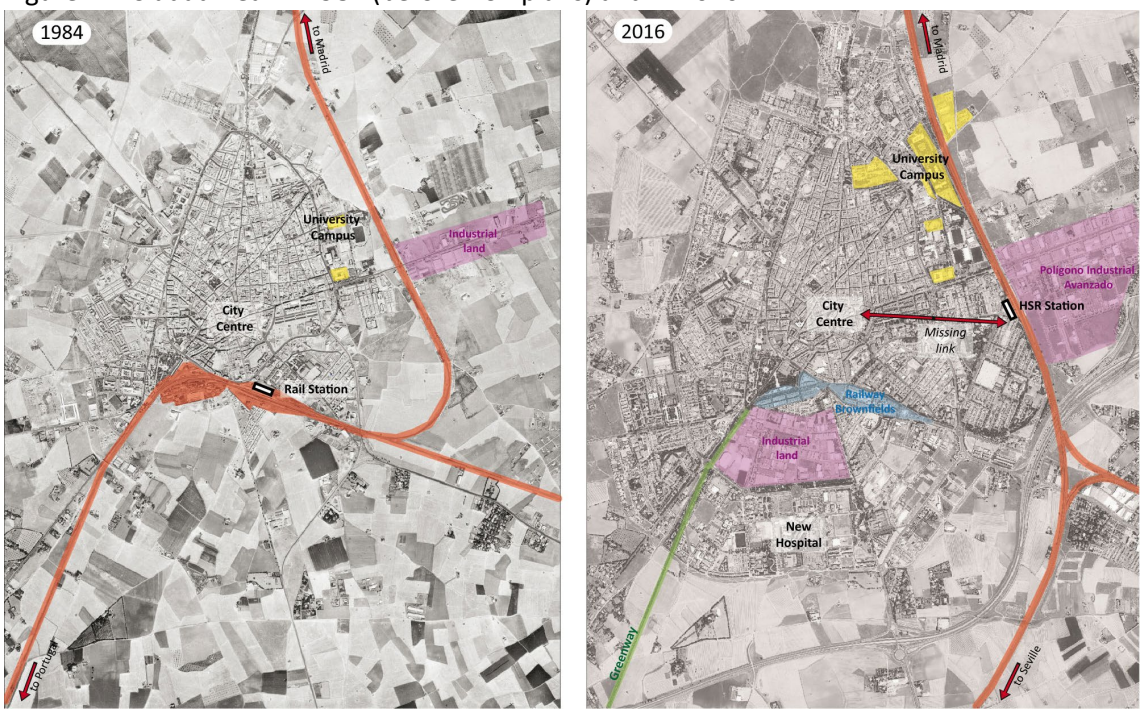
Usually, cities with new HSR connections attract and generate urban projects from the city and from external investors aiming to take advantage of the accessibility and image improvements. In this section, the policies and strategies implemented in Ciudad Real and Puertollano are re-evaluated in the same manner used in the study performed ten years ago by Ribalaygua et al. (2004), considering large projects that could only have emerged due to the close link to the HSR. Comparing project status 10 years and 20-25 years after HSR is relevant since mobility changes may occur rapidly, while territorial changes need more time to occur.

Ciudad Real overhauled its municipal urban development plan in 1988, and a new plan was approved in 1998, ten years before the Spanish real estate crisis; as a result, the new plan included abundant new urban expansion. In contrast, Puertollano started a new planning document in 2002, 18 years after the previous plan dating from 1984 and ten years after the arrival of HSR. This plan has not yet been definitively approved and underwent substantial changes after the 2008 real estate crisis.

In the case of Ciudad Real, the urban analysis performed by Fariña et al. (2000) concluded that the impact of HSR on planning was very important. The effects of HSR include not only the transportation itself and the opportunities it creates but also the new locations of tracks and stations. The strongest effects on the city were seen in the old railway brownfields, which were

transformed into residential land. Today, almost all this area has been developed (1,000 apartment units, a public library, a music school and a park). The suppression of the tracks and its strong urban barrier facilitated the development of new residential areas and the improvement of old marginal neighbourhoods on the "wrong side of the tracks", and a 4.5 km-long greenway along the old suburban tracks, which today is a highly appreciated facility (Figure 11).

Figure 11. Ciudad Real in 1984 (before HSR plans) and in 2016



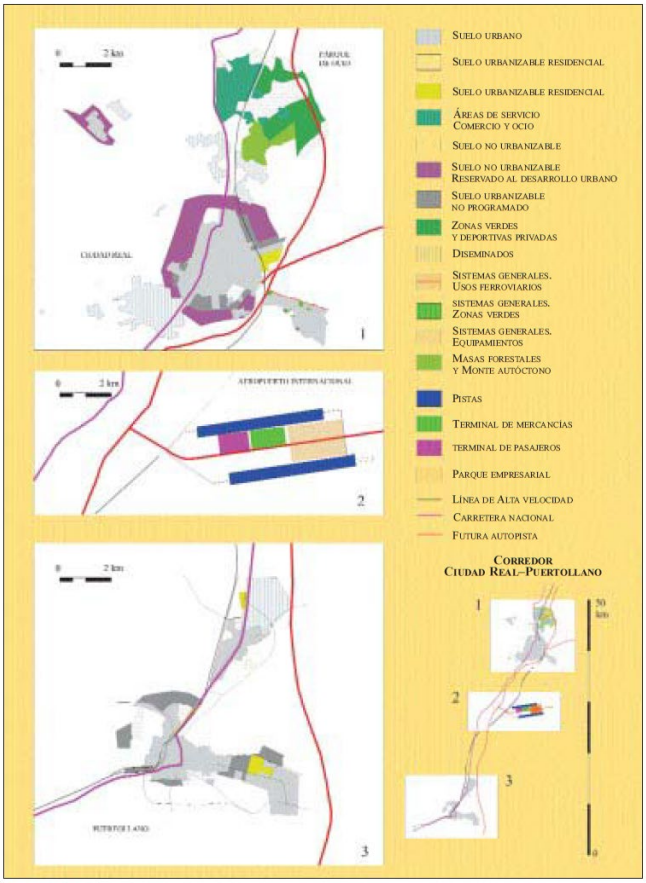
Nevertheless, the 1998 urban plan of Ciudad Real did not fully utilize the opportunities that might have arisen between the new station and the city centre. The plan left several barriers between them, and no intervention was planned to improve this connection to the station frontage area. In 2016, after the city became involved in an EU URBACT project “ENTER.HUB” (Terrin, 2016), the resulting local action plan considered the need to improve the street connecting the city centre and the station, trying to turn it into a more pedestrian- and bicycle-friendly “station avenue”.

In contrast, on the other side of the tracks and adjacent to the HSR station, the 1998 plan reserved land for tertiary and high-tech industrial activities (‘polígono industrial avanzado’), which received substantial financial support from the EU. Currently, this area is just above 50% occupied, most activities lack the expected technological focus, and has partially evolved towards a commercial park. Nevertheless, a few industrial/consulting activities have also developed in other parts of the city. It seems that proximity to the HSR station is not necessary since the entire city is sufficiently close to it, as previously observed by Garmendia et al. (2008) regarding residential locations. The university campus has attracted two international software consulting companies, Indra and Everis (550 and 190 employees) that take advantage of the university’s students and R&D capabilities.

The largest land consumption developments near both cities are two territorial-scale projects: a private airport between the two cities and a golf- and gambling-focused tourism resort. Ribalaygua et al. (2004) reported that the new urban plan of 1998 defined a city three times

larger than that considered in the 1987 plan, with a combination of very high- and very low-density areas. As a result, four main urban spaces emerged, changing the sub-regional structure: the compact urban nuclei of Ciudad Real and Puertollano, a tourism-focused urban development called “El Reino de Don Quijote”, and a private airport and its associated industrial area (see Figure 12).

Figure 12. Urban development plans: Ciudad Real-Miguelturra, Puertollano and the airport area.



Source: Ribalaygua et al. (2004)

When Ribalaygua et al. (2004) published their article, the airport was in its initial building phase alongside the HSR line (see Figure 12). The expectations were very high: relevant air cargo activity due to the large amount of available space and a runway length sufficient for the largest planes. Additionally, low-cost passenger airlines were expected to operate out of this airport due to the HSR connection to Madrid provided by a new station near the airport terminal. The airport was also to be located near the junction of two new motorways: the east–west between Lisboa and Valencia and a second north–south between Madrid and Córdoba. The transport connections to the new airport would also include the existing conventional rail system running parallel to the HSR line. The expectations were for this airport to become a secondary airport for Madrid. The large industrial area was designed to attract aero-spatial industries that never arrived.

The airport was inaugurated in December 2008 and closed in April 2012, declaring bankruptcy due to its large financial debt. Recently, the airport was sold at a very low price and it is in the process of being reopened. The new project is oriented towards freight and plane maintenance. There are no plans to operate passenger flights, and the HSR station is not a priority.

On the other hand, the 300-hectare tourist destination was included in the 1997 urban plan and was promoted by Harrah's Entertainment Co. and local entrepreneurs. In 1999, its area was doubled with casinos, hotels, a theme park, golf courses and 9,000 new housing units. It would have substantially increased the residential area of the city and changed its urban structure, since this facility was 8 km north of the existing nucleus. Obviously, this project had considerable synergies with the accessibility provided by the HSR and the airport. When Ribalaygua et al. (2004) wrote their article, the smaller 9-hole golf course and some of the infrastructure were under construction, while permits to start building the first residential development were being reviewed. Although an important portion of the infrastructure investment was completed, no houses were built. In 2008, the real estate crisis and the lack of financing caused Harrah's Entertainment to abandon the project and finally declare the project bankrupt in 2011. Today, the small golf course is operated by locals, and there are no further plans for the rest of the resort, which is in liquidation.

The conclusion is that Ciudad Real, although its accessibility has been greatly improved by HSR, has been able to transition out of its traditional role only at a very slow pace, much more slowly than expected. Its new roles are more closely related to transport than to other new activities. Only the activities that are synergistic with the university and, to some extent, the hospital have been successful.

Ribalaygua et al. (2004) did not consider any additional territorial projects in relation to Puertollano. Nevertheless, Puertollano has launched several small development initiatives, all of them initially proposed more than 10 years after the arrival of the HSR. These initiatives include an industrial incubator, a professional school of aviation mechanics and piloting, a university degree in airport management, several solar panel factories, and a mining museum. However, most of these initiatives lasted only a few years, as they were hit by the economic crisis. Since then, Puertollano has been struggling to maintain its population, as its main economic activity, industrial oil refinement, is not strong enough to compensate for the decline of other activities, such as coal mining, which definitively ended operations in 2018 with the demolition of two coal-based power plants.

6. Discussion

This article debates the usefulness of two complementary analyses: the comparison of the population growth of HSR cities with that of several groups of non-HSR cities and the analysis of the projects and strategies developed in HSR cities. These analyses are undertaken from two perspectives: each analysis in itself and a longer-term re-evaluation of the corresponding analysis undertaken in the literature 10-15 years ago.

The population evolution methodology considered four HSR and non-HSR comparisons. First, each HSR city was compared to Spain as a whole, to all HSR cities on average and to all non-HSR cities on average. Second, each small HSR city was compared with a control group of small non-HSR cities. Third, each HSR city served by a substantial number of HSR services and with an HSR history of more than 10 years was compared with similar non-HSR cities (where the similarity was assessed on the basis of location and size). Finally, the population evolution of two HSR cities (included among the cities considered in the third analysis) was compared to that of similar non-HSR cities at the time when HSR services started, 10 years later, and 25 years later.

The evaluation results vary depending on the type of comparison. While the first comparison yields irregular trends, the third comparison reveals a much clearer growth impact. The overall population evolution of Spain does not adequately reflect the evolution of very small cities; therefore, comparisons with similarly sized cities are necessary. These very small cities show a

very strong influence of HSR during the few years before and after HSR implementation due to the novelty of HSR and because very few of these cities receive HSR services. In the long run, the growth rates of very small HSR cities are improved, but only in comparison with similar very small cities.

Re-examining the population evolution comparisons undertaken at the time when HSR services started (Fariña et al., 2000) and 10 years later (Serrano et al., 2005) with the analysis performed 25 years later confirms the general trends while highlighting small differences:

> -a positive change in the tertiary city of Ciudad Real between 10 and 20 years after HSR that has tended to be maintained after these first 20 years, though with a slight diminution, and
> -a negative change in the industrial city of Puertollano at 10 years after HSR that tended to be maintained until 20 years after HSR and has subsequently worsened.

Although some differences appear among the four analyses, no large differences are evident. Thus, longer-term analysis of population effects is important but does not seem to be crucial. Nevertheless, these analyses have considered only the total population; thus, additional analyses of population age, employment, education level, etc., might provide further evidence.

All the comparisons between small cities near MAs show similar results; thus, general comparisons may be sufficient. Meanwhile, in medium-sized cities near MAs, the first comparison shows a trend towards stability after the arrival of HSR services, while the third comparison shows similar rates of growth before HSR and greater growth after. Thus, for medium-sized cities, specific comparisons with similar non-HSR cities suggest a greater influence of HSR. Nevertheless, as argued above, comparisons of HSR and non-HSR cities are problematic since it is difficult to clearly identify similar non-HSR cities, if, indeed, they exist.

Finally, for isolated medium-sized HSR cities, the first and third comparisons mainly yield the same implications in terms of population growth. However, the third comparison, which also includes time periods before and after the arrival of HSR, indicates a similar but more dramatic influence.

The second methodological approach has also demonstrate usefulness. Today, the projects and strategies that were considered promising 15 years ago by Ribalaygua et al. (2004) are seen to have followed three evolutionary paths (as noted by Coronado & Ureña, 2018), distinguishing those that can be considered more structural from those that can be considered only short-term/conjectural in nature, i.e., those that last from those that are ephemeral. First, projects oriented towards changing the territorial model have encountered considerable difficulties; those that have already been built and are related exclusively to transport have a difficult but promising future, whereas those that have not been completely built and are related to attempts to attract new activities have been cancelled. Second, improvements to the urban surroundings of stations are generally more successful, but they are not attracting new technologies. Finally, efforts to attract new activities are currently experiencing varying levels of success, greatly influenced by the type of city and the overall national economic dynamics. Thus, combining ex post short-term and long-term analyses of such projects and strategies is appropriate since such analyses yield additional relevant and complementary conclusions.

The overall conclusion is that compared to medium-sized HSR cities, small cities with HSR more often experience positive population growth relative to that exhibited by similar non-HSR cities. This is a logical conclusion since the effect of HSR is greater when the relative change in accessibility is greater, that is, when HSR produces substantial accessibility changes. The effect

of HSR on medium-sized cities may be smaller since most already have good transportation options for the distances at which HSR is competitive (i.e., the change in accessibility may not be as substantial) and since their size and dynamics are more difficult for a single new transportation mode to affect (even if the intraurban effects are relevant).

7. General conclusions

First, it is possible to identify two general temporal regimes of the territorial impacts produced by HSR services. Since beginning of HSR operations in 1992 to the beginning of the economic crisis in 2006, the growth indexes of cities with HSR services were not very different from that of other cities. Since the period of economic crisis (from 2007 to today), and especially since 2012, cities with HSR services have exhibited better population growth than cities without HSR, with differences increasing each year. This evidence shows that cities with HSR services have better conditions and a better ability to re-establish economic activities during and after a crisis.

However, this general conclusion must be further explained because, as seen from the different cases studied, the territorial impact of HSR services vary substantially for different cities relative to non-HSR cities. Consequently, understanding a specific situation requires a case-by-case study.

Second, a longer-term population analysis does reveal additional qualitative differences relative to an analysis carried out 10 years after the implementation of HSR. That is, the medium-term impact can be different from that in the longer term.

The conclusion for Ciudad Real and Puertollano is that, even though the accessibility of both cities has been significantly improved by the HSR, Ciudad Real has been able to transition away from its traditional role, although at a slower pace than initially expected, while Puertollano, due to its industrial dependency, has experienced more difficulty in changing its own dynamics. It is also clear that the administrative and tertiary profile of Ciudad Real and its status as the closest stop to Madrid have been to its benefit in the competition between these two cities.

The evidence reported here indicates that the territorial impacts of HSR are far from homogeneous. General trends are evident, but they are usually subject to exceptions. The causes of these exceptions can be very different and even very local; as the case of Ciudad Real and Puertollano shows, local economic dynamics and stakeholders' behaviours are very important. In other cases, such as Toledo and Segovia, cities of similar size at similar distances from MAs can exhibit different behaviours depending on the location of the HSR station and the other transport modes available in the corridor.

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Appendix 1

Population figures for HSR cities and similar non-HSR cities

Calatayud

	1970	1981	1991	2001	2011	2014-2016
Calatayud	16.915	17.666	17.432	18.109	21.264	20.191
Manzanares	15.692	17.721	17.916	17.648	19.239	18.475
Medina del Campo	14.327	16.518	20.006	20.029	21.607	20.774
Motilla del Palancar	4.268	4.392	4.863	5.163	6.216	5.092
Plasencia	27.174	32.178	36.060	38.576	41.392	40.663
Aranda de Duero	18.369	27.598	29.814	29.999	33.229	32.612
Average	79.830	98.407	108.659	111.415	121.683	117.616

Antequera and Puente Genil

	1970	1981	1991	2001	2007	2011	2016
Antequera	40.908	35.171	38.765	40.816	44.547	41.854	41.065
Puente Genil	26.442	25.615	26.387	27.843	29.093	30.424	30.072
Ecija	36.056	34.619	35.786	37.777	39.510	40.718	40.270
Carmona	24.378	22.779	23.617	25.793	27.578	28.679	28.595
Montilla	22.059	21.373	22.403	23.102	23.650	23.870	23.365
Plasencia	27.174	32.178	36.060	38.576	39.982	41.392	40.663
Aranda de Duero	18.369	27.598	29.814	29.999	31.940	33.229	32.612
Average	128.036	138.547	147.680	155.247	162.660	167.888	165.505

Guadalajara and Toledo

	1981	1991	2001	2011	2015-2016
Guadalajara	56.137	63.649	68.248	84.404	83.633
Toledo	57.769	63.561	69.450	82.489	83.459
Avila	40.173	45.977	49.712	59.008	58.083

Tarragona

	1980-1981	1991	2000-2001	2006	2015-20
Tarragona Met	279.322	294.542	333.812	398.818	432.546
Alicante Met	511.939	568.248	628.625	724.662	757.085
Barcelona Met	4.623.204	4.654.407	4.805.927	5.309.404	5.542.680

Lleida

	1970	1981	1991	2001	2016
Lleida Met	138.295	154.980	162.904	166.826	208.881
Salamanca Met	136.262	177.854	204.327	188.579	212.175
Burgos Met	131.897	166.204	169.347	178.163	197.536
Talavera	45.327	64.136	68.700	76.011	84.119
Average Similar	313.486	408.194	442.374	442.753	493.830

Sources for Conurbations

Lleida Met	http://www.xtec.cat/serveis/crp/c5990102/13-recsegria/treballcomarca/fitxers/did_poblacio.pdf
Salamanca Met	https://es.wikipedia.org/wiki/%C3%81rea_metropolitana_de_Salamanca
Burgos Met	https://es.wikipedia.org/wiki/%C3%81rea_metropolitana_de_Burgos
Talavera	Only the municipality of Talavera since its extension is very large

Non of the similar non-HSR cities/conurbations compele with all the characteristics of Lleida, in partular being located not too distant from a second small metropolitan area. But there are no other possible cases.

Córdoba

	1970	1981	1991	2001	2011	2016
Córdoba	264.943	310.941	337.389	342.352	362.769	361.807
Albacete Mun	93.233	117.126	135.889	148.934	171.390	172.426
Burgos	131.897	166.204	169.347	178.163	199.278	197.536
León	138.862	167.984	189.930	188.169	205.498	200.939
Average Similar	363.992	451.314	495.166	515.266	576.166	570.901

Sources of Conurbation definitions

https://es.wikipedia.org/wiki/Anexo:%C3%81reas_metropolitanas_de_Espa%C3%B1a	
Córdoba +Almodóvar+Guadalcázar+LaCarlota+Obejo+Villafranca+Villaharta+Villaviciosa	
Albacete	https://es.wikipedia.org/wiki/%C3%81rea_metropolitana_de_Albacete
Burgos	https://es.wikipedia.org/wiki/%C3%81rea_metropolitana_de_Burgos
León	https://es.wikipedia.org/wiki/%C3%81rea_metropolitana_de_Le%C3%B3n

Similar Cities/Conurbations include two cases that received HSR 3 and 1 year before 2016 since so few years are consider not to change their population growth tendencies