Spatial Dimensions of High-Speed Rail: Intermediate Cities, Inter-jurisdictional Planning, and the Implications for High-Speed Rail in Portugal

By
Naomi E.G. Stein
B.S., Civil Engineering
Massachusetts Institute of Technology, 2010

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Author .....
Department of Civil and Environmental Engineering
Department of Urban Studies and Planning
May 20, 2013

Certified by .....
Joseph M. Sussman
JR East Professor of Civil and Environmental Engineering and Engineering Systems
Thesis Supervisor

Accepted by.....
P. Christopher Zegras
Chair, MCP Committee: Department of Urban Studies and Planning

Accepted by.....
Heidi M. Nepf
Chair, Departmental Committee for Graduate Students

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ABSTRACT

Globalization has magnified the role of regions, restructuring social and economic relationships into networks that span increasing distances. At the same time, greater attention is paid to urban quality, as non-vehicular modes and compact forms of development become critical in an environmentally conscious world. Within this context, increasing interest and adoption of high-speed rail (HSR)—a mode with spatial sustainability objectives—is unsurprising. HSR has the potential to integrate cities into mutually supportive networks across long distances while also supporting more sustainable forms of development. For HSR to become a sustainable investment, however, requires coordinated policy efforts across levels of government and at different points in a project's life-cycle.

This investigation spans multiple scales of the physical environment and institutional sphere, examines ways of coupling institutional change with technological change, and addresses the importance of uncertainty as a driver of system behavior. We focus on inter-jurisdictional relationships, with special attention paid to smaller intermediate cities brought within one-hour's travel time of a larger metropolis by HSR services. Mid-distance service (<250 km) has strong spatial implications and can expand connections to the scale of new *discontinuous regions*—single labor and commercial markets that spans long distances but do not include all intermediate areas. Both Portugal and the United Kingdom (UK) are planning HSR systems that will provide mid-distance service.

Through stakeholder interviews and a critical reading of the literature, this thesis develops a theory-based assessment of goals for regional restructuring, studies existing and planned Portuguese rail-commuter-cities, and compares HSR planning in Portugal and the UK. We see evidence that HSR can induce new ways of thinking about urbanization, regional connectivity, and governance. The scope of change that might be put into effect by HSR creates greater incentives for collaboration than those that normally exist. We find that local knowledge and policy will improve HSR design and implementation by helping to ensure smooth interfaces between HSR and existing urban mobility systems.

Developing decision-making structures that will work across geographic scales and sectors of government, and long-term uncertainty, will be critical in helping HSR achieve 3E—Economic, Environmental and Equitable—sustainability.

Thesis Supervisor: **Joseph M. Sussman**
Title: JR East Professor of Civil & Environmental Engineering and Engineering Systems

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1 Introduction

Globalization and the interconnectivity of the economy have magnified the role of regions, restructuring social and economic relationships into networks that span increasing distances.[1] At the same time, greater attention is paid to localized urban quality, as non-vehicular modes and compact forms of development become critical in an environmentally conscious world. Within this context, increasing interest and adoption of high-speed rail (HSR)—a mode that addresses multiple scales—is unsurprising. HSR technology is used to respond to existing trends of increased interconnectivity between urban centers and is simultaneously viewed as a tool to enhance economic connections both within already connected regions, and across megaregions too large to be fully integrated by the automobile.

HSR can change the time-space landscape, blurring the distinction between inter-city and intra-city travel, between urban and periphery, between global and local. HSR has greater potential than air travel to affect urbanization patterns because of its ability to directly connect city centers and avoid the significant security-driven pre-boarding time and weather-related delays associated with air travel. Its technology therefore is sought to enable network-based inter-city agglomeration. Mid-distance HSR service (< 250 km) has particularly strong spatial implications: at that scale new functional relationships between cities are most likely to be formed, thereby reorganizing hierarchies of space at the regional and megaregional level. Mid-distance services have already been implemented and their affects observed in a number of European countries, most notably Spain.

Looking to the future, both Portugal and the United Kingdom (UK) are planning HSR systems that will provide this type of service. This thesis focuses primarily on the plans for HSR in Portugal, while also using additional comparative case study material from the UK to further elucidate the influence of institutional structures on planning and implementation of HSR systems. In particular, this thesis focuses on smaller intermediate cities brought within one-hour's travel time of a dominant metropolis, either Lisbon or London, by planned HSR services.

[1] Severino Escolano, "Territory and High-Speed Rail: A Conceptual Framework," in *Territorial Implications of High Speed Rail: A Spanish Perspective*, ed. José Maria de Ureña (Farnham, Surrey ; Burlington, VT: Ashgate, 2012), 37.

Smaller cities are often disadvantaged in terms of planning resources and advocacy power; at the same time, they require explicit attention if HSR is to achieve its objectives. Implementation of HSR in Portugal is currently postponed for the immediately foreseeable future due to fiscal austerity. Nevertheless, lessons can be drawn from the process up to this point. The suspended action, moreover, may create space for new thinking on the role of HSR in regional development and the need for inter-jurisdictional planning.

This thesis has two overarching themes: space and relationships. We begin with the fundamental building block of urban and regional planning: *space*. High-speed rail (HSR) has had and continues to have a spatial (and distributional) agenda attached to its implementation. This thesis seeks to, first, refine the policy discussion surrounding the spatial agenda of HSR by defining its objectives more clearly. Second, we posit an agenda for high-speed rail of sustainable, and therefore equitable, growth and inquire into the ability of existing planning and implementation systems to achieve this agenda. To do this requires an investigation into the second theme of this thesis: inter-jurisdictional *relationships*. HSR is a technology aimed at bridging the barrier of distance and integrating urban areas into new functional networks. To do that requires planning and management that spans many jurisdictions, along a hierarchy from national (and sometimes international) to local, and across more than one sector—most notably transportation and land use.

High-speed rail, as transportation infrastructure endeavor, is unique in three primary ways: One, its intended purpose is of a socioeconomic nature, extending beyond the direct transportation investment purpose of reducing travel time to indirect effects not often accounted for in traditional benefit-cost analyses. "Indirect impacts encompass the long-term implications such as economic growth, productivity, employment level, labor markets and agglomeration effects resulting from changes in accessibility and proximity induced by transport investment."[2] Second, and related to HSR's unconventionality of purpose, the policies and initiatives required to achieve the aim of HSR extend beyond the jurisdiction of a single government entity; so much so that the failure to achieve proper inter-jurisdictional relationships will jeopardize the success

[2] Sevara Melibaeva, "Development Impacts of High-Speed Rail: Megalopolis Formation and Implications for Portugal's Lisbon-Porto High-Speed Rail Link" (S.M. in Transportation, Massachusetts Institute of Technology. Dept. of Civil and Environmental Engineering.), 19. 2010.

of a high-speed rail project. For example, local transit and land use policies are controlled by a collection of local and regional government entities, along with private sector actors.

Thirdly, high-speed rail has the potential to achieve such a degree of socieconomic restructuring across large geographic areas within a country that it offers incentives for more cooperation between units of government—incentives that would not be large enough for projects of a smaller scale. To take advantage of this potentially powerful incentive structure requires a more nuanced and clearer understanding of: a) stakeholder priorities and motivations, particularly the less attended to sub-national government stakeholders, and b) contemporary spatial processes and the resulting complexities associated with pursuing high-speed rail's spatial agenda.

Finally, even if priorities and interests were brought in line across sectors, space, and geographic scale—via an informed debate on possible objectives for high-speed rail implementation—there still remains the question of whether appropriate policy levers and institutional structures are in place to achieve the desired outcomes.

Evaluative complexity—the fact that "different stakeholders value different aspects of system performance in different ways, making decision-making difficult"—is unlikely to be resolved within the context of an academic thesis (nor should it be).[3] With that in mind, the aim of this thesis is to support a more informed political discussion of aims and objectives by more precisely outlining the relationship amongst: stakeholder priorities, the scientific underpinnings of potential objectives, and the institutional sphere constraining or enabling successful HSR implementation.

This thesis will be structured as follows. In Chapter 2, a literature review sets the stage with background material on key characteristics of HSR, its spatial intent, and ongoing socioeconomic processes influencing its implementation and outcome. Next, in Chapter 3, we review the specifics of the Portuguese HSR proposals and present information on the institutional and physical spheres within which the system is expected to operate. Chapter 4 uses interviews to investigate stakeholder priorities and motivation regarding HSR. Based on conversations with national and local officials in Portugal, we discuss ways in which HSR

[3] Joseph M. Sussman et al., *The "CLIOS Process": A User's Guide* (Cambridge: Massachusetts Institute of Technology,[2009]).

planning is changing attitudes towards regional identity and urban governance, including: the integration of national entities into local planning processes, the potential for new models of commuting, and the role of HSR as an exogenous catalyst for regional cooperation. Building on lessons learned, we then posit two forms of cooperation—national-local and local-local—as promising tools for guiding HSR-supportive policies.

Next, Chapter 5 uses evidence from field studies of current rail commuter cities in Portugal to expound on the local planning variables that are relevant to the experience of rail commuting. The chapter seeks lessons from a retrospective look at current urban and mobility patterns in Portugal and highlights the risks of failing to achieve proper inter-jurisdictional relationships in the course of HSR planning and implementation. Chapter 6 returns to the theoretical discussion begun in the literature review. By reexamining the definitions of and logic behind "polycentricity" as a contemporary spatial phenomenon, the chapter offers a clarified understanding of HSR's spatial objectives. The chapter connects local perspectives, introduced in Chapter 4 and 5, with a more macro view of the possible economic and distributional benefits of HSR at the regional or national level. Based on this new framework, Chapters 7 and 8 seek to tie together bundles of institutional and technical alternatives for HSR implementation. Focusing primarily on two secondary cities—Coimbra, Portugal and Birmingham, UK—while examining the planning environment in London, the analysis compares institutional contexts and mechanisms available for inter-jurisdictional HSR planning. Finally, Chapter 9 presents the overarching findings of the thesis, along with specific recommendations for HSR planning in Portugal, and a discussion of future research directions.

2 Literature Review: Spatial Impacts of HSR

To set the stage for an analysis of the spatial implications of HSR, this chapter provides a review of the literature. This chapter will:

- Define key characteristics of HSR, from a user, operator, and spatial perspective;
- Present the spatial and distributional aims attached to high-speed rail implementation, in both public policy and academic discourses; Discuss the case that can be made for HSR as a mode that supports sustainable mobility and growth;
- Summarize ongoing social and economic trends that provide the context for HSR implementation;
- And finally, argue that urban conditions and local policies are critical variables in the emergent behavior of an HSR system, its degree of impact, and its ability to support sustainable growth.

2.1 High-speed rail as an engineering system – key characteristics

This thesis will examine, in detail, the spatial issues associated with high-speed rail. But before beginning, we need to ask: What is high-speed rail? What purpose does it serve? What can we learn from prior cases of implementation? The European Union defines high-speed rail systems as those including specifically built lines operating at or above 250 km/h (155 mph) as well as upgraded lines with speeds on the order of 200 km/h (124 mph).[1] However, there is much more to understanding HSR than its maximum or average operating speed. HSR is in fact not one uniform "thing" but rather provides a variety of functionality across markets—depending on network configuration, connectivity, and other urban and service variables.

To adequately understand the complexity of an engineering system, deWeck, Roos, and Magee encourage the use of various viewpoints, namely: *scale/scope, function, structure, and temporality*.[2] The two viewpoints of *scale* and *temporality* help elucidate the function and

[1] "General Definitions of Highspeed." International Union of Railways (UIC), http://www.uic.org/spip.php?article971 (accessed March 5, 2013).

[2] Olivier L. de Weck, Daniel Roos and Christopher L. Magee, "(Re)Thinking about Systems," in *Engineering Systems: Meeting Human Needs in a Complex Technological World* (Cambridge, Mass.: MIT Press, 2011), 45-63.

purpose of a HSR system. Scale refers to the qualities of a system that can be measured quantitatively. It answers the question, "how much?" or "how many?" and can refer to aspects such as geographic coverage or demography. Basic scale factors for HSR are the distances between cities served and the relative size of those cities. Second, the lens of temporality requires us to think about time at multiple scales. The shortest relevant timescale is defined by travel times. Access and waiting times are, as with all mass transport, relevant, but not necessarily unique to a HSR system. HSR compresses space and extends the amount of geography accessible within a given period of time.[3] Longer timelines—for planning, implementation (including time to construct), ongoing management, and adaptive user behavior—are also of importance and will be considered throughout this thesis.

With these two variables, travel time and distance, the *function(s)* of high-speed rail can be categorized. Ureña uses four travel time intervals to describe the majority of HSR usage patterns in Europe:[4]

Table 2-1 Categorization of HSR Usage Patterns by Scope and Temporality (Source: Author, based on Ureña[5])

Distance	Travel time	Function	Competitive Mode
400-600 km	2-3 hours	Professional; one-day return travel	Competes successfully with air (50-80% mode share)
150-250 km	0.75-1.5 hours	Commuting; opens new labor market opportunities	Competes with conventional rail and road and induces new mobility patterns
600-800 km	3-4 hours	Professional, personal, and leisure	Competes with air
70-150 km	35-45 minutes	Suburban rail within a metropolitan area	Overlaps with existing metropolitan transport systems.

Ureña also notes that while HSR was initially planned to compete with air at distances of 400-600 km, it has proven able to capture some market share at both shorter and longer distances. Of particular interest to this thesis are the medium-distance services that enable commuting behavior and connect small and medium cities with each other and with larger

[3] Severino Escolano, "Territory and High-Speed Rail: A Conceptual Framework," in *Territorial Implications of High Speed Rail: A Spanish Perspective*, ed. José Maria de Ureña (Farnham, Surrey ; Burlington, VT: Ashgate, 2012), 43.

[4] José Maria de Ureña, "High-Speed Rail and its Evolution in Spain," in *Territorial Implications of High Speed Rail*, ed. José Maria de Ureña (Farnham, Surrey ; Burlington, VT: Ashgate, 2012), 5-7.

[5] Ibid.

metropolises. This mid-distance service is more relevant to the spatial implications of HSR because its scale is that at which new functional connections are most likely to be formed, thus reorganizing hierarchies of space at the regional and megaregional level.

In addition to travel times and distances, other system characteristics also influence HSR usage patterns and resulting spatial impact. For example, fare differentiation: In Spain, discounts for medium-distance service offer an incentive to high-frequency users. The fare is 0.06 Euros/km if more than 50 one-way trips are made monthly, while normal ticket pricing is 0.1 Euros/km. Additionally, home-to-work travel demands frequencies of six to eight trains per day, at minimum, with schedules that allow for commute trips at different times of day.[6] Reliability is also a factor in the attractiveness of HSR service, particularly for business travelers with constrained schedules.

Continuing with the deWeck et al. framework, the concepts of *scope* and *architecture* lead our analysis beyond HSR service characteristics to qualities of the urban and regional systems in which an HSR service operates. Structure (or architecture) is defined as the way elements of a system are interconnected; scope refers to the number of aspects that require consideration within the system.[7] The architecture of a HSR network includes design variables such as station location and intermodal connectivity; these determine how HSR interfaces with existing urban and mobility systems. Therefore, an adequately *scoped* consideration of HSR planning will necessarily take into account the layers of institutional arrangements that influence or control those interfaces, in addition to the more technical aspects of the system itself.

Menéndez et al. define a station typology for smaller cities (i.e. not dominant metropolises) with three simple categories: center, edge, and external.[8,9] Central stations are usually reused or expanded older rail stations and therefore are connected to the existing urban fabric. Central siting can be a challenge due to construction constraints in a dense urban context.

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[6] José M. Menéndez, Ana Rivas and Inmaculada Gallego, "Mobility Characteristics of Medium-Distance High-Speed Rail Services," in *Territorial Implication of High Speed Rail: A Spanish Perspective*, ed. José Maria de Ureña (Farnham, Surrey ; Burlington, VT: Ashgate, 2012), 114-115.

[7] de Weck, Roos and Magee, *(Re)Thinking about Systems*, 45-63

[8] Menéndez, Rivas and Gallego, *Mobility Characteristics of Medium-Distance High-Speed Rail Services*, 105

[9] J. M. Menéndez, B. Guiorao and J. M. Coronado, "New High-Speed Rail Lines and Small Cities: Locating the Station," in *The Sustainable City II : Urban Regeneration and Sustainability*, eds. C. A. Brebbia, J. F. Martin-Duque and L. C. Wadhwa, Segovia, Spain ed. (Southampton, UK ; Boston: WIT Press, 2002).

Locating the station at the edge of an urban center can offer greater redevelopment potential and may give private automobiles easier access while still being central enough to offer good connectivity for pedestrians, bicycles, and transit. Finally, external stations are usually located several kilometers outside a city. Decisions to build an external station have been guided by the desire to minimize station-to-station travel times and in some cases to avoid environmental impacts such as noise or other issues that affect abutters. The goal of minimizing travel time, however, can be misleading given that it does not take into account station access and egress times. In France and Spain, local operators experimented with shuttle service between external stations and a city's center (with schedule coordination to match train arrivals), but the services have proven difficult to maintain due to demand peaking, as well as lower than expected demand. Parking lots, meanwhile, run out of space and have to be expanded.[10] True, external locations may be easily accessible by car, but they do not cater to other modes. Intermodality, according to Menéndez et al. is a "key factor in the growth of mobility because it considerably increases the population that potentially uses the HSR station."[11] Finally, observations by Menéndez et al. of Mâcon, Le Creusot, Vendôme and Valence in France show that external stations are not nodes of activity (passengers tend to arrive just in time for their train) and therefore offer little potential in terms of commercial activity.[12]

Thus far we have characterized HSR according to design variables over which engineers and planners (at the national or local level) more or less have direct control: travel times, stations locations, intermodal station accessibility, fare, and frequency. Still, there is a significant degree to which the emergent behavior of an urban system, after HSR implementation, depends on initial conditions, which at best are indirectly influenced by decision-makers. Prior mobility conditions affect HSR's level of impact—the greater the increment in accessibility offered by HSR, the more likely its implementation will induce important modifications to existing spatial relations. According to Vickerman et al. (1999):

> The most important HSR territorial effects are not derived from changes in modes of transport (from air to HSR) or from reinforcements of existing relations (more trips between metropolises), which were the initial objectives of HSR, but from

[10] Ibid.

[11] Menéndez, Rivas and Gallego, *Mobility Characteristics of Medium-Distance High-Speed Rail Services*, 116

[12] Menéndez, Guiorao and Coronado, *New High-Speed Rail Lines and Small Cities: Locating the Station*

> new relations between cities where HSR has produced major transportation changes, not just marginal ones.[13]

Prior economic conditions and a city's regional role are also germane.[14] Of smaller intermediate cities, cities with a predominantly service-based economy, anchor institutions such as universities or hospitals, and a regional public administration function tend to attract higher HSR demand. Comparing HSR usage in the adjacent cities of Ciudad Real and Puertollano, Spain provides a case in point. While service between each city and Madrid is of similar frequency, with travel times of 53 and 73 minutes, respectively, demand is three to four times higher between Madrid and Ciudad Real than between Madrid and Puertollano.[15] The literature attributes this difference to the fact that Ciudad Real is a provincial capital with a university while Puertollano has no special regional status and its dominant economic activity is industrial. The fact that travel times to the major metropolis fall below and above a one-hour threshold, respectively, is also likely influential on relative magnitudes of trip inducement. Section 2.3 looks in more detail at the underlying economic processes driving differentiation between sectors.

This section has defined key characteristics of HSR, from a user, operator, and spatial perspective. Chapter 5 will examine some of these characteristics as present in current service on the conventional rail system used for commuting in Portugal, so as to situate lessons from the literature within the specific local context.

Next we turn to the claimed spatial intentions of HSR, as we take a step backward from *function*, to an examination of HSR's intended *purpose.*

2.2 The spatial and distributional agenda of HSR

This section focuses on two related but not identical territorial aspects of the motivation posited for HSR in public policy and academic discourses. Both are aimed at a form of "smarter" growth. First, HSR is touted as a sustainable mode that will enable economic expansion and

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[13] Cited in José M. Ureña et al., "Territorial Implications at National and Regional Scales of High-Speed Rail," in *Territorial Implications of High Speed Rail: A Spanish Perspective*, ed. José Maria de Ureña (Farnham, Surrey ; Burlington, VT: Ashgate, 2012), 129.

[14] Sevara Melibaeva, "Development Impacts of High-Speed Rail: Megalopolis Formation and Implications for Portugal's Lisbon-Porto High-Speed Rail Link" (S.M. in Transportation, Massachusetts Institute of Technology. Dept. of Civil and Environmental Engineering.), 189. (2010).

[15] Menéndez, Rivas and Gallego, *Mobility Characteristics of Medium-Distance High-Speed Rail Services*, 114-115

integration across large distances while minimizing negative environmental externalities. This claim is related both to the energy efficiency of the mode itself and to the spatial development patterns it theoretically supports. Second, the political discourse often takes the logical next step to say: given that we are trying to reorganize economic activity in space, HSR implementation also has a distributional—or more correctly, a *re*-distributional—goal, with corresponding social equity and cohesion aims attached.

2.2.1 Development patterns and environmental sustainability

The contemporary preoccupation in transportation planning with land-use and transportation interactions is evidence of the profession's realization that not all development patterns—and *therefore* not all systems of mobility provision—are identical or even similar from a sustainability perspective. While considerably freeing, the personal automobile is also blamed for enabling more isotropic fields of access that induce less than desirable forms of urban and regional growth. Road networks, development incentives, and decades of cheap fuel helped in many parts of the world to build a landscape of sprawling development. The speed of automobiles and near-ubiquity of road infrastructure mean that the rent-premiums of more central urban locations have eroded (although not disappeared, due to agglomeration economies).[16] Resulting low-density development patterns consume more land and contribute to fragmented ecosystems. These patterns also contribute to greater resource usage for both transport and utilities and increase the percentage of impermeable surfaces, with negative effects on runoff and water supplies. Growth is somewhat guided by the location of fast highway infrastructure but still stands in sharp contrast to the center-oriented mobility provided by rail and transit lines (or ports) and their limited points of access. Concerns with sprawl coincide with increased awareness of environmental issues, particularly global climate change.

At the same time, the emergence of a globalized service-economy has revived interest in agglomeration economies and urban patterns that facilitate face-to-face contact between firms and clients conducting complex information-based transactions. Sustainability and health advocates are joining forces with those interested in growth of the "information economy" to advocate for reinvestment in denser city centers, and for newer development based on the

[16] Edward L. Glaeser, "Are Cities Dying?" *The Journal of Economic Perspectives* 12, no. 2 (1998), 139.

walking-friendly form of pre-automobile cities.[17] Academics, practitioners, and policy-makers have begun to wonder: might we return to more centralized patterns of development? And is transportation policy and investment a tool with which to do that?

Current conversations and decisions to invest in high-speed rail transportation are very much a part of this ongoing discussion. And yet, the scale and degree to which HSR's benefits are framed in spatial and distributional terms is perhaps unprecedented. Not only is its intended purpose of a socioeconomic nature, thus extending beyond the direct transportation investment benefit of reducing travel time, its scale of desired impact extends far beyond the metropolitan scale at which most "transit-oriented development" planning occurs. Instead, HSR technology is seen as a way to further integrate metropolitan areas into polycentric mega-city regions.[18]

Assumptions about the sustainability of HSR implementation can be found embedded in policy discussions in both the United States and Europe. A recent U.S. Department of Transportation report on possible rail upgrades (including HSR) in the Northeast Corridor discusses the goal of achieving economic integration without environmental degradation. Referring to expected future growth, the report warns:

> If this new population is accommodated in the similarly land-intensive manner of recent decades, important rural and open spaces will disappear, putting pressure on ecological and natural systems…A passenger rail system would be part of a compact growth solution that concentrates new growth and development around stations, thus conserving land and easing pressure on natural resources.[19]

Similarly, advocates for the planned HS2 project in the UK claim that high-speed rail can lead to a paradigm shift in development:

> …a new pattern of development increasingly switching away from development on the urban periphery and beyond towards city centre and inner city locations. High speed rail can underpin adoption of the 'Smart Growth' agenda already being adopted in the USA (partly in response to higher energy costs).[20]

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[17] For example, the New Urbanist and "Smart Growth" movements.

[18] C. L. Ross and M. Woo, "The Identification and Assessment of Potential High-Speed Rail (HSR) Routes from a Megaregion Perspective," *Transportation Research Record: Journal of the Transportation Research Board, Transportation Planning* (2012).

[19] U.S. Department of Transportation, Federal Railroad Administration. Northeast Corridor (NEC) Passenger Rail Corridor Scoping Package, p. 11-12.

[20] Greengauge 21. "What will be the spatial effects of High Speed Rail in the UK?" Evidence submitted to the Independent Transport Commission. November 2012, p. 2.

Sustainable development is one of the four main strategic objectives of HSR system development within the European Union (EU)[21] and "changing the actual hegemony of road solutions" is one of the stated objectives of the HSR project in Portugal.[22] Like other parts of the world, Portugal has been struggling with the environmental degradation associated with unchecked motorization and greenfield development.[23] The HSR planning process is concurrent with and in part responding to these concerns.

Still, in the academic literature, that HSR is an environmentally sustainable mode is by no means agreed upon and depends on the specifics of network design and types of growth supported by HSR implementation. To summarize, the claim of sustainability has three logical components:

1) Transportation: HSR offers a less carbon-intensive mode that can support the increasing reach of commuting patterns and business relations without degrading the environment through increased vehicular use and congestion. In some cases released capacity on the conventional rail network may become available for freight, thus possibly reducing the use of more environmentally degrading trucking.[24]

2) Built form: HSR provides an opportunity for compact development around its stations. By reintroducing fixed routes with privileged points of access into a mobility system currently dominated by the spatially-flexible personal automobile, HSR reintroduces an incentive for centralized and contained development.

3) Ecosystem integrity: The possibility for discontinuous development patterns within regions integrated by HSR makes possible the maintenance of natural networks through the preservation of non-developed or less intensely developed land.

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[21] Melibaeva, *Development Impacts of High-Speed Rail: Megalopolis Formation and Implications for Portugal's Lisbon-Porto High-Speed Rail Link* (2010).

[22] "Portuguese High Speed Rail Project: General Overview and Status of the Project." Rede de Alta Velocidade (RAVE), http://www.efrtc.org/htdocs/newsite/events/Genmeet_2009_Porto_docs/2009.06.05_RAVE_EFRTC_PORTO.pdf (accessed March 6, 2013).

[23] Land use (Portugal). SOER 2010: The European environment – state and outlook 2010. European Environment Agency, November 2010.

[24] *High Speed Two: A Greengauge 21 Proposition* (London: Greengauge 21,[2007]).

The first claim is dependent on the energy mix used to supply HSR, the degree of mode shift from 'dirtier' forms of transport, modes used for accessing HSR, induced demand for long-distance travel, and interaction effects with air including freed up capacity for longer flights as a result of mode shift.[25] The claim that HSR supports compact development, and therefore spares currently undeveloped land from urban sprawl, has great potential but requires intentional policy, particularly at the local level.[26] Compact station-oriented development can reduce land consumption and costly expenditures on utilities and supports less carbon-intensive (and healthier, more active) modes of transport. However, that urban form only materializes if stations are accessible, zoning codes allow compact development, land is available in station areas, demand exists for development, and local policy actively promotes real estate investment that will incorporate a diversity of uses.

Tension remains in the wider discussion regarding megaregions between potentially conflicting objectives: Are we aiming for economic growth, even with the possibility of resulting sprawl? Will HSR enable economic growth at a regional level in keeping with sustainability principles or is *megaregion* synonymous with *megasprawl*? One quote from the recently published *Megaregions: Planning for Global Competitiveness* sums up the skeptics position:

> The focus on creating a globally competitive megaregion with expanding boundaries (through infrastructural megaprojects such as high-speed rail, region-wide airports, and other trade hubs) will probably trump efforts to promote environmentally sustainably and geographically contained ecoregions…The emphasis on megaregions will foreground some issues (e.g., economic competitiveness though larger-scale economies and large infrastructure networks) and push other issues into the shadows (e.g., traditional regional concerns for city-suburb social inequality).[27]

Chapter 6 will look in more detail at the theoretical arguments behind concepts such as megaregions and polycentric development in attempt to clarify the spatial objectives introduced

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[25] Regina Clewlow, "The Climate Impacts of High-Speed Rail and Air Transportation: A Global Comparative Analysis" (Doctor of Philosophy, Engineering Systems Division, Massachusetts Institute of Technology), 2012.

[26] Matt Nichols, *Policy Brief - Planning High Speed Rail Stations for Sustainable Urban Development: European Case Studies* (Washington, DC: Comparative Domestic Policy Program, The German Marshall Fund of the United States,[2011]).

[27] Scott Campbell, "The Imperative of Growth, the Rhetoric of Sustainability; the Divergence of the Ecoregion and the Global Megaregion," in *Megaregions: Planning for Global Competitiveness*, ed. Catherine L. Ross (Washington, DC: Island Press, 2009), 127.

here. The above quote also highlights social equity issues, which brings us to our next consideration: the (re)distributional agenda often attached to HSR implementation.

2.2.2 (Re)distribution and a social equity agenda

EU transport policy came out of a social cohesion and economic development agenda, not simply from the transport realm. At the time of the first White Paper on a Common Transport Policy (1990), the dominant programs for transport investment at the EU level were the Structural and Cohesion Funds aimed at a distributional goal of supporting development in lagging regions while relieving congestion in core regions.[28] In the last decade the EU has prioritized national and international high-speed rail connectivity. The program for the trans-European transport network (TEN-T) includes fourteen high-speed service projects out of thirty.[29] At the same time, European spatial policy incorporates explicit goals of promoting polycentric development, a concept related to that of "city-regions."[30] Built into much of the rhetoric surrounding HSR is the intention of distributing economic growth to reduce regional gaps and improve cohesion across Europe.[31]

At the national level, Portuguese HSR policy also very much fits this model of spatial intentionality. Among the stated goals of the project are to:

- Reduce the country's peripheral western position, by connecting Portugal to Europe
- Accelerate the country's economical and technological development, also at the regional level[32]

According to Pagliara et al., the goal is to enable a network of multidirectional support amongst Lisbon and Porto (the dominant metropolises) and other intermediate cities—to create a functionally linked system of cities that can better compete in the global market:

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[28] Roger Vickerman, "High-Speed Rail - the European Experience," in *Territorial Implications of High Speed Rail: A Spanish Perspective*, ed. José Maria de Ureña (Farnham, Surrey ; Burlington, VT: Ashgate, 2012), 17.

[29] *Trans-European Transport Network: TEN-T Priority Axes and Projects 2005*European Commission,[2005]).

[30] Harrison in C. L. Ross and M. Woo, "Megaregions and Mobility," *The Bridge on Urban Sustainability* 4, no. 1 (2011).

[31] Melibaeva, *Development Impacts of High-Speed Rail: Megalopolis Formation and Implications for Portugal's Lisbon-Porto High-Speed Rail Link*, 50-51 (2010).

[32] "Portuguese High Speed Rail Project: General Overview and Status of the Project."

> The project results from a voluntary approach to create a megaregion between Lisbon and Oporto that could transcend the small demographic dimension of Portuguese cities and put them in a paradigm of networked cities in order to dissociate the relations between dimension and urban functions.[33]

In this view, the ideal outcome would be to move beyond a competitive framework among Portuguese cities and instead create a network of complementary urban functions. The rationale and necessary conditions behind that goal, however, are somewhat murky and will be examined in more detail in Chapter 6.

Next, in the United Kingdom, the agenda for the HS2 project connecting London to the north of the country is pointedly (re)distributional:

> High speed rail would bring central London to within 49 minutes of central Birmingham, and within 80 minutes or less of Leeds and Manchester. By slashing journey times and linking to our major international gateways, it has the potential to help bridge the North-South divide that has for too long limited growth outside London and the South East.[34]

Here the agenda is two-fold: (1) the London economy is 'overheated' and needs an outlet to continue to grow, and (2) The rest of the UK is due some piece of the overall UK growth, a particularly salient issue given current nation-wide hard economic conditions and the need for economic stimulus.

Inherent to these various phrasings of a distributional agenda is some notion of equity. Including equity as an objective is a way of recognizing the difference between aggregate benefit (a strictly utilitarian calculus) and the distributional impacts of policy and investment. If defined geographically, equity refers to the uneven distributions of costs and benefits in space. Another common way of defining equity is among social groups, with the requirement that each group have equal opportunity to access whatever is being considered (travel, prosperity, jobs, services, etc.)[35]. That is, it's not enough for Lisbon or London to be successful drivers of their respective national economies. More peripheral regions are also due 'their fair share' of wealth and opportunity. Such an agenda has an obvious political logic to it, given that space is the unit of

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[33] F. Pagliara et al., "Megacities and High Speed Rail Systems: Which Comes First?" (Munich, Germany, mobil.TUM 2012 - International Scientific Conference on Mobility and Transport, 2012).

[34] Philip Hammond, *Foreword, High Speed Rail: Investing in Britain's Future* (London, UK: Department for Transport (DfT),[2011]).

[35] Jing Shi and Nian Zhou, "A Quantitative Transportation Project Investment Evaluation Approach with both Equity and Efficiency Aspects," *Research in Transportation Economics* 36, no. 1 (9, 2012), 93-100.

government. Still, setting policy based on goals of equity and fairness is obviously easier said than done. Moreover, it requires a deeper understanding of the relationships between urban economies, and the role HSR can play in shaping those relationships.

2.2.3 Positing a holistic sustainability agenda

We began this section with two spatial goals, environmental sustainability and social equity. Our analysis reveals, however, that HSR is really being offered as a "solution" to a three-pronged problem: unequal distributions of economic benefit, negative environmental impacts of existing growth patterns, and congestion and other constraints on the growth of cities and regions. These issues fall into the "3E" definition of sustainability: environment, equity, and economy. Space is critical to each aspect of this holistic (i.e. covering more than environmental protection) sustainability agenda:

- Economy: this is most often the starting point for advocates of HSR. The goal is to relieve congestion, overcome distance, and build competitive networks of urban areas that act as functional economic units in the global market;
- Environment: environmental sustainability acts in at least two spatial scales. HSR can support more compact localized urban form, which in turn can benefit regional ecosystems by helping to preserve habitats and protect watersheds.
- Equity: this may be the most difficult goal to define and achieve. The ambition is that by connecting central and peripheral areas, a more efficient economic system can be built that will bring benefit to all parts of a region, even including those without direct HSR service.

An intent of this thesis is to (a) investigate and refine the rationale behind the above three-pronged sustainability approach and (b) to inquire into the ability of existing planning and implementation systems to achieve such an agenda.

2.3 Ongoing social and economic trends – the context for HSR

Deployment of HSR technology is used both to respond to existing trends of increased interconnectivity between urban centers and to enhance economic connections within regions or mega-regions. The spatial agenda of HSR emerged from ongoing social and economic processes that are driving changes in the geographic patterns of human settlement and the mobility options

chosen to connect those conurbations. In order to project to the future and guide HSR implementation, we must first attempt to understand the general trends that affect current and future socioeconomic relations.

2.3.1 Begin at the beginning: transport and metropolitan definition

The relationship between mobility and metropolitan form is much studied and, at least at a basic level, well established.[36,37,38,39] The spatial definition of a metropolitan region is the result of millions of individual decisions regarding residential, employment, and business enterprise location. When aggregated, these decisions create a complex web of activity locations and the mobility infrastructure connecting them. The dominant activity for many people is employment; therefore, metropolitan regions can to a first approximation be defined in terms of labor market reach. Given the stability of people's daily travel time budget[40], changes in transport technology result in changing metropolitan form. HSR is the latest in a long history of technology changes altering the relationship between space and time, and therefore the feasible realm of daily activities.

And yet, the last century has witnessed changes in economic geography that are about more than just faster technology altering the size of daily activity zones. Along with a dispersion of activity, as enabled by faster transport, other simultaneous processes have re-concentrated activity into structure of networked urban centers; the monocentric model of urban economics is no longer adequate to describe the realities of a polycentric world. Based on the morphological observation that hierarchy is becoming a less dominant feature of urbanized space[41]—and that this shift is correlated with globalization and the post-industrial economy[42]—the field of urban economics began using polycentricity as an organizing concept for theories of contemporary

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[36] Peter O. Muller, "Transportation and Urban Form: Stages in the Spatial Evolution of the American Metropolis," in *The Geography of Urban Transportation*, ed. S. Hanson, 3rd ed. (New York: Guildford Press, 2004), 59-85.

[37] A. Schafer, "Regularities in Travel Demand: An International Perspective," *Journal of Transportation and Statistics* (2000), 1-31.

[38] H. W. Richardson, *The New Urban Economics: And Alternatives* (London: Pion, 1977).

[39] D. J. Forkenbrock, "Transportation Investments and Urban Form," *Transportation Research Record: Journal of the Transportation Research Board* 1805 (2003), 153.

[40] Schafer, *Regularities in Travel Demand: An International Perspective*, 1-31

[41] Martijn Burger and Evert Meijers, "Form Follows Function? Linking Morphological and Functional Polycentricity," *Urban Studies* 49, no. 5 (Apr 2012, 2012), 1130.

[42] Escolano, *Territory and High-Speed Rail: A Conceptual Framework*, 36-37

geography. Observations of polycentricity may have emerged first at the urban level with investigations like Garreau's highly influential *Edge City* (1992) but have since extended to the inter-urban scale. The Randstad region of the Netherlands is the most frequently referenced example at the larger scale. This extension begs the question of whether underlying processes influencing new spatial patterns are the same or differentiated across geographic scales.

2.3.2 Demise of the monocentric model at the intra-urban level

In order to tackle the concept of polycentricity at the scale of the "megaregion"[43] or "mega-city region"[44], we must first understand the unraveling of the traditional monocentric model at the urban scale. The monocentric model described industrial cities with 19th century transport technology. Rail lines radiated out from central business districts. Goods movement was still central to the organization of cities that grew up around ports or railroad terminals. Moreover, the handling of goods was the dominant form of production. Households often had single earners; daily single-destination commuting to work was the only form of transportation considered relevant to the organization of urban areas.[45]

The erosion of this model is not new. For decades we have been grappling with the notion of "sprawl." Automobiles and trucking enabled decentralization of both residences and commercial activity to cheaper land. The freight mobility system is no longer tied to city centers. Decentralization does not in itself invalidate the monocentric model but auto-mobility *is* far less directionally constrained than older radial systems of mass transport. Commuting across metropolitan areas, rather than inwards and back out, is now typical. Multiple-earner households participate in more complex joint housing and employment decisions. Perhaps most importantly, the dominant urban activity has changed from goods handling to the handling of information and many business location choices are now determined by trade-offs between the need for face-to-face contact and the expense of centrality, in terms of rents and the cost of moving people. [46] Moreover, where cities could once be explained in dominantly physical terms, globalization and

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[43] Ross and Woo, *The Identification and Assessment of Potential High-Speed Rail (HSR) Routes from a Megaregion Perspective*

[44] P. Hall and K. Pain, *The Polycentric Metropolis: Learning from Mega-City Regions in Europe* (London: Earthscan, 2006).

[45] R. C. Kloosterman and S. Musterd, "The Polycentric Urban Region: Towards a Research Agenda," *Urban Studies* 38, no. 4 (2001), 623-633.

[46] Ibid.

information technology have created non-physical networks of linkages that are now overlaid onto the physical systems of built urban form and transport.

2.3.3 The persistence of agglomeration economies

Despite the phenomenon of dispersion and increases in land-consumptive development patterns (enabled by cheap mobility and information technology) the new urban landscape is nevertheless still shaped by agglomeration. Agglomeration is the benefit that firms and workers gain from being in proximity to other firms and workers. Most of the literature focuses on the production side of agglomeration—that is, how much productivity does a firm gain if its access to the activity of other firms, to a labor supply, or to customers increases? Agglomeration economies can be broken down into three categories:[47]

- Sharing – Firms can reduce fixed costs and reduce risk by sharing facilities, intermediate suppliers, labor, and consumers. The ability to share depends on proximity and transport/communication costs.
- Matching – In a larger denser labor market, matching between jobs and workers is more efficient, thus leading to higher productivity. Density of economic activity reduces the risk that skill specialization will lead to job instability and therefore encourages employees to invest in developing skills. The matching process occurs mostly within areas defined by feasible commute distances (with additional flexible support from telecommunications).
- Learning – Transfer of knowledge, skills, and information is a key component of production, and in particular innovation. While communications technology facilitates this transfer, proximity is still the best way to achieve a frequent exchange of complex information.

Studies of agglomeration economies traditionally conceived of proximity *in space* as the enabling factor for these interactions. However, high-speed communication and transport technology are motivating a reconsideration of these forces, as are a reshuffling of the kinds of

[47] Daniel J. Graham and Patricia C. Melo, "Assessment of Wider Economic Impacts of High-Speed Rail for Great Britain," *Transportation Research Record: Journal of the Transportation Research Board* 2261 (2011), 15.

interactions driving our contemporary globalized economy. Daniel Graham summarizes the importance of technology:

> Reflecting on the mechanisms described above, it is clear that agglomeration economies depend crucially on the flows of goods, people, or information between locations. Therefore, the geographical scope of agglomeration economies will depend on the rate at which these flows decrease with distance.[48]

Other researchers are more focused on the rising importance of information-based economic transactions and are therefore arguing that the transfer of complex information is becoming a more dominant benefit of the agglomeration process. In particular, face-to-face contact is critical to what Hall and Pain call "Advanced Producer Services" or APS:

> Specialized services that service other service sectors; knowledge-intensive; disconnected from material production; agglomerates because of the need for face-to-face contact and to benefit from the overlapping demand of multiple sectors[49]

APS firms are the primary subjects of interest for the POLYNET study (published in 2006) and for others interested in polycentricity because they are "the most significant expression" of the shift towards a globalized information economy—and it is that shift that researchers point to as a major driver of mega-regional and polycentric development.[50]

In 1890, Marshall had already outlined the theoretical underpinnings of agglomeration economies: cities exist to reduce transport costs for goods, ideas, and people.[51] And while the concepts still pertain, the relative importance of various agglomeration forces to the physical form of cities has changed substantially. The cost of moving material goods is less important to the organization of urban areas. Freight transport is still vital to the economy of cities but its correspondence to urban form is not as direct as it once was. Increasingly, raw inputs, intermediate products, and final products are not material at all but composed of information, the transmission of which depends mostly on the movement of people and on information technology. Electronic communications enable programmed information exchanges while

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[48] Ibid.

[49] Hall and Pain, *The Polycentric Metropolis: Learning from Mega-City Regions in Europe*

[50] Ibid.

[51] G. Ellison, E. L. Glaeser and W. Kerr, "What Causes Industry Agglomeration? Evidence from Coagglomeration Patterns," *National Bureau of Economic Research* Working Paper 13068 (2007).

unprogrammed exchanges require face-to-face interaction.[52] Despite the ease of communication via the Internet, technology does not substitute for face-to-face interaction. As digital networks reach further and support more complex business networks, the demand for personal contact may in fact increase.[53] Trust-building client-provider relationships demand face-time. So too do knowledge spillovers and the management of layered and fluid relationships between firms that serve as "both service providers to, and clients of, each other."[54] And as discussed before, concentration within metropolitan areas also enables labor market pooling, which supports the development of more productive skill specialization. Skill specialization is, somewhat paradoxically, still of the utmost importance in an economy increasingly based on flexible modes of production.[55]

Meanwhile, quality-of-life assets such as good infrastructure, public facilities, and amenities require a certain population density to be viable and are becoming more important decision variables in residential decisions, particularly for the young intellectual class sought by APS firms. Firm and worker location choice are mutually reinforcing processes. The "creative class," to use the name coined by Richard Florida[56], is highly mobile and much sought after by both firms and the cities that want to attract and keep high-value business activity. It is important to remember, however, that the people for whom the 'urban-good-life' argument applies may be a small percentage of the overall population, if an admittedly economically powerful and growing one. Some have gone so far as to call urbanism the new trickle down economics[57]—arguing that policy-makers have not solved the problem of how to makes sure that 'a rising tide lifts all boats,' when it comes to urban development and infrastructure expenditures. That challenge has important implications for the social equity agenda of HSR investment.

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[52] Hall and Pain, *The Polycentric Metropolis: Learning from Mega-City Regions in Europe*

[53] Glaeser, *Are Cities Dying?*, 149

[54] Hall and Pain, *The Polycentric Metropolis: Learning from Mega-City Regions in Europe*, 108

[55] Escolano, *Territory and High-Speed Rail: A Conceptual Framework*, 33

[56] Richard Florida, *The Rise of the Creative Class: And how it's Transforming Work, Leisure, Community and Everyday Life* (New York: Basic Books, 2002).

[57] Aaron M. Renn, "Is Urbanism the New Trickle-Down Economics?" Newgeography, http://www.newgeography.com/content/003470-is-urbanism-new-trickle-down-economics (accessed March 7, 2013).

2.3.4 Functional networks and the economic drivers of inter-urban polycentricity

That "the death of distance"[58] has not negated the utility of cities is no longer a surprise. But as discussed above, the agglomeration economies of today are not the same as those of the industrial city. Our cities are growing in multiple senses of the word: more of the world's population now lives in urban areas than ever before but urbanized areas also encompass more of the world's land area than at any previous point in history. Notably for HSR, dispersion, expansion, and the creation of new nodes within the urban systems did not end at the metropolitan scale but now manifests at the inter-urban scale, incorporating both new and existing centers. Functional relationships between multiple urban centers, the backbone of increasingly globalized and dispersed economic networks, lead to questions about the scale at which urbanization externalities act.

The "borrowed size" argument states that smaller cities that are part of a networked region are better off than independent entities of comparable size.[59] This networked perspective frames things in functional (as opposed to morphological) terms—what matters are relationships between centers, not the composition of urban space. Functional networks can be defined by many kinds of flows. In the case of HSR, one might think about the difference between daily commuting trips, one-day business trips, or even part-time commuting patterns, and resulting implications for regional function and identity.

Granting that networked smaller cities are better off than isolated ones still does not explain why polycentricity has more recently emerged as an organizing phenomenon for regions. Agglomeration economies continue to demand spatial proximity and thus negate complete dispersion. As forces driving urbanization increase, why have cities not simply continued to agglomerate as larger but still contiguously developed and mostly monocentric entities? Put differently, is there a limit to the amount of growth a megacity like London can accommodate within a contiguous urban area? Meijers et al. argue that the geographic scale of operation for positive urban externalities is different from that of their negative counterparts. Negative

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[58] Coined by Frances Cairncross: The Death of Distance: How the Communications Revolution Is Changing our Lives

[59] Evert Meijers and Martijn Burger, "Urban Spatial Structure and Labor Productivity in U.S. Metropolitan Areas" (Leuven, Belgium, Regional Studies Association annual conference 'Understanding and Shaping Regions: Spatial, Social and Economic Futures', April 6-8, 2009).

externalities (pollution, congestion) seem to be more spatially constrained than positives ones (knowledge spillovers, labor pooling, etc.). "(Positive) external economies are not confined to a well-defined single urban core, but, instead, can be shared among a group of functionally linked settlements."[60]

It is transport technology like HSR that enables discontinuous network-based forms of agglomeration. Therefore, defining the formation criteria for functional linkages and the degree to which they substitute for proximity should be an important goal for both theorists and decision-makers interested in efficient investments in transportation infrastructure. Daniel Graham investigated the degree to which accessibility improvements *between* cities can have similar agglomeration benefits as improved *intra*-urban connectivity. The innovation of his method is to use a metric very similar to the accessibility metrics found in transportation studies to account for transport costs (in time) instead of the simple straight-line distance-based calculation used in prior efforts. Thus, changes in transport technology, such as HSR, can be accounted for.

His initial "illustrative calculation" yields quite low estimates of benefit. Yet, as Graham is careful to point out, the literature on agglomeration in general yields a relative large range of elasticities: "in 531 statistically significant elasticity estimates of urban agglomeration economies obtained from 33 studies…estimates vary between −0.570 and 0.658, and the unweighted mean (median) is 0.057 (0.044)."[61] Moreover, our understanding of the decay function describing the drop-off of agglomeration benefits with increased transport costs, as well as the dependence of the gradient on the different underlying mechanism of agglomeration, remain inadequate for making conclusive recommendations. Very few papers have sought to estimate the decay gradient, as it is a new research area.

Again, according to Graham "There are no obvious characteristics of the sources or mechanisms described in the agglomeration literature that would limit their generation over longer distances."[62] The UK's analysis and approval of the Crossrail project was groundbreaking in that explicitly calculated benefits due to agglomeration were a dominant factor in the cost-

[60] Ibid.

[61] Graham and Melo, *Assessment of Wider Economic Impacts of High-Speed Rail for Great Britain*, 16

[62] Ibid.

benefit analysis. Even at the urban scale used for the Crossrail calculations, the existing methodology is still rather simplistic. Graham also notes that current practice does not attempt an intermediate stage of analysis, which should theoretically look at the relationship between transport accessibility and sources of agglomeration. Graham begins to address the gap by separately examining commuting trips, which he associates with labor market matching, and business trips, which are assumed to have more to do with the sharing and learning mechanisms of agglomeration. Chapter 4 discusses expectations about changing patterns of commuting, including part-of-the-week and/or multi-destination commuting, which may require revision of this analytical framework.

Finally, assessment methodologies tend to struggle with the need for land-use/transport interaction (LUTI) modeling, a data-hungry and uncertain endeavor. Projections of benefit from agglomeration tend to be based on existing or simplistically extrapolated land use patterns (with some assumptions about induced demand and mode shift) while capturing less completely, or not at all, the implications of reorganized population and job distributions that could result from longer-term adaptation to new transport infrastructure.

Rather than asking what the benefit *will* be, one might also switch perspectives and instead inquire into the conditions necessary to maximize such benefits as have the *potential* to occur. Empirical studies demonstrate that the characteristics of both the links and of the nodes connected by HSR are determinants of likely impact. Rail stations are privileged access points[63] to a mobility network that *may* extend the reach of agglomeration forces across greater distances. But capturing potential agglomeration benefits will only happen if the connected nodes have the economic foundation to take advantage of face-to-face interactions and spatial clustering that HSR supports. Returning to the case of Ciudad Real and Puertollano in Spain, sectoral differentiation is likely to be the cause of Ciudad Real's higher relative HSR demand. Industrial production—the basis of the Puertollano economy—does not, as a rule, gain as much from agglomeration economies as do other more "information-based" sectors of the economy like the university and administrative activities in Ciudad Real[64]. Clustering in a HSR station-area is unlikely to be comprised entirely of firms that use the service on a frequent basis. Rather, HSR

[63] Ureña et al., *Territorial Implications at National and Regional Scales of High-Speed Rail*, 129

[64] Daniel J. Graham, "Agglomeration, Productivity and Transport Investment," *Journal of Transport Economics and Policy* 41, no. 3 (2007), 317–343.

can be though about as a catalyst for the clustering of firms that wish to take advantage of inter-firm interactions within a higher density urban environment. Some will locate there because of HSR; others will follow those initial firms regardless of whether they are users of HSR or not. The goal of station-area development is to provide the initial conditions needed to kick-start a positive agglomeration-based feedback loop.

The spatial sustainability agenda of HSR and the importance of urbanization externalities to HSR's economic case both demand that adequate attention be paid to longer-term land use dynamics, despite their high degree of uncertainty. To that end, and building on the generalized objectives and theory presented thus far, we now turn to a closer examination of local urban conditions and policies.

2.4 Emergent behavior and the importance of local policy

The socioeconomic system discussed above should offer not only the motivation or need for HSR but also the building blocks for its successful implementation. Section 2.3 demonstrated that agglomeration economies have much to do with localized urban quality. Increased concern over the negative environmental impact of growth also points us towards local conditions. The growing consensus in the literature is that urban/regional conditions and sub-national policies are important variables in the emergent behavior of HSR systems, including their degree of impact and ability to support sustainable growth. Here we revisit those local conditions and then make the transition from descriptive studies to the policy-oriented perspective that guides investigations in the remainder of this thesis.

In changing travel times, HSR alters accessibility and the relationships between connected (and unconnected) areas. New transport behaviors, particularly at the geographic scale of mid-distance (<250 km) service, alter regional spatial dynamics. Long-term re-distribution of economic activities can result from changes in mobility patterns, accessibility, and even from the less tangible perception or 'image' effects of HSR[65]. Ureña et al. sums up the spatial implications of HSR as three broad processes: "changes in functional integration of HSR cities, spatial and urban hierarchy reorganisation, and city restructuring" (Figure 2-1). Functional integration refers to new or augmented interurban relations including commuting under the one-hour travel time

[65] Ureña et al., *Territorial Implications at National and Regional Scales of High-Speed Rail*, 132

threshold. Spatial and urban hierarchy reorganization relates to the observation that HSR alters not only the accessibility of a city with HSR service but also the relative accessibility[66] of all cities within a region or megaregion. Finally, city restructuring refers to the (re)development potential of an HSR station-area.

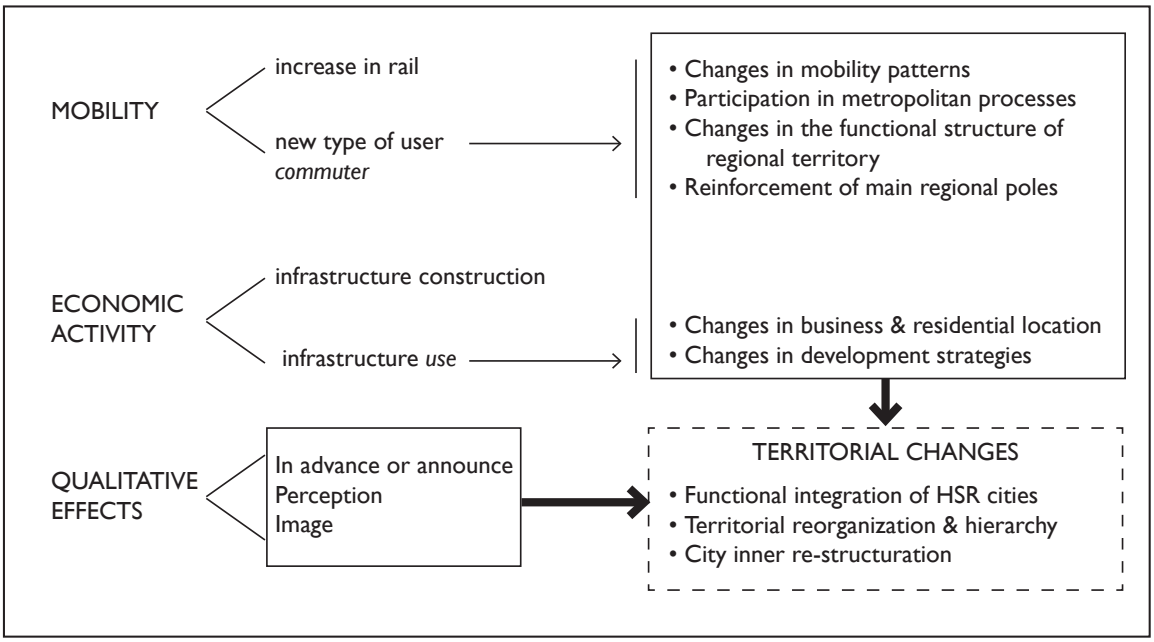

Figure 2-1 Understanding effects of new HSR lines (Adapted from Ureña et al.[67])

All three processes depend on conditions at the regional or local level. Ureña et al. divide the relevant conditions into two categories, (1) territorial and infrastructure, and (2) city or agglomeration factors (Table 2-2). This is yet another way of classifying the key characteristics introduced in Section 2.1. It is important to remember, however, that territorial and urban conditions are fluid and influenced (if not dictated) by public investment and public policies (see Figure 2-2).

That is, HSR's success at achieving its spatial and distributional objectives must be the result of more than free-market processes. In the interest of taking scientific knowledge beyond the descriptive and into the prescriptive realm, we have to ask ourselves, what are the important policy levers or points of intervention in the HSR implementation process? How can strategic

[66] Guineng Chen and de Abreu e Silva, João, "The Regional Impacts of High Speed Rail: A Review of Methods and Models," *Proceedings, European Transport Conference* (2011), 6.

[67] Ureña et al., *Territorial Implications at National and Regional Scales of High-Speed Rail*, 133

decision-making support a threefold sustainability objective (the 3E's) and where, institutionally, should those decisions be made?

Table 2-2 Spatial factors related to the role and challenge of HSR (Source: Author, based on Ureña et al.[68])

Territorial and infrastructure factors	City or agglomeration factors
• City location and travel time to nearby metropolises – HSR can allow the appearance or consolidation of relationships. Commuting within 1 hr travel time is a key example. • Prior transport conditions – in some cases HSR provides and significant increment in accessibility, while in others it simply supports already dominant positions. • Network conditions – intermediate, end-of-line, and transfer stations all provide different types of services and therefore structure possible interurban connections. • Station location within a city – station location is a strong determinant of development potential and affects ease of access by modes other than the automobile	• A city's economic base - Because of agglomeration economies, tertiary cities tend to have more synergies with an HSR station than do industrial ones. • The existence of unique services (regional capitals, business headquarters, universities, hospitals, etc.) • Urban quality – public and private services, environment, and culture • Local entrepreneurship environment

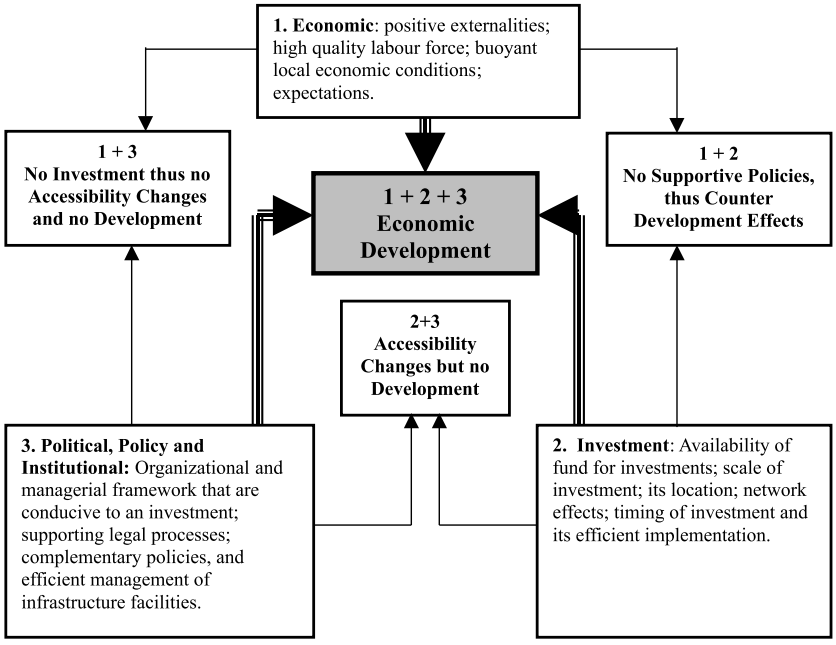

Figure 2-2 Necessary Conditions for Economic Development (Source: Banister and Berechman[69])

[68] Ibid.

"The literature argues that high-speed rail almost never generates new processes but rather accelerates or consolidates existing dynamics or strategies".[70] Notably, this quote points to both the "dynamics" of underlying socioeconomic processes *and* to "strategies." Dynamics may be taken to mean socieconomic processes, as discussed in Section 2.3. Strategies on the other hand are the plans and policies used by stakeholders to try to achieve their respective goals. Dominant metropolises are much more likely to have the resources and expertise to capitalize on an HSR station and service. Smaller cities, on the other hand, tend to be disadvantaged in terms of financial resources, local expertise, and advocacy power with the national government. In countries with currently operating networks, HSR has already "created new relations between big and small cities that force them to start competing in a common market."[71] Experience shows that policy, and its adequacy in addressing local and regional issues, is distinctly not neutral to the outcome of this competition.

Therefore, we end this literature review with a statement to motivate what follows: taking seriously the objectives outlined in Section 2.2—of addressing unequal distributions of economic benefit, negative environmental impacts of existing growth patterns, and congestion and other constraints on the growth of cities and regions—demands that decision-makers remedy the disadvantage of smaller cities when planning for and managing HSR implementation. This thesis focuses intentionally on the category of often-neglected but vital intermediate cities. We will begin first with cities to brought within one hour's travel time of a large metropolis by HSR (Évora, Leiria, and Coimbra in Portugal and Birmingham in the UK), and later expand our perspective to include the regions surrounding intermediate HSR cities (the Centro region of Coimbra and the West Midlands in the UK). Our hope is that by bringing the dual perspectives of space and relationships to bear on national-local, national-regional, and local-local relationships, this work will help support improved decision making regarding HSR implementation, in Portugal and elsewhere.

To prepare for the analytical portion of this thesis, Chapter 3 introduces HSR in Portugal and presents details of the current physical and institutional context in the country.

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[69] David Banister and Yossi Berechman, "Transport Investment and the Promotion of Economic Growth," *Journal of Transport Geography* 9, no. 3 (9, 2001), 210.

[70] Ureña et al., *Territorial Implications at National and Regional Scales of High-Speed Rail*, 133

[71] Ibid.

3 High Speed Rail in Portugal

Moving beyond generalities about HSR, this chapter reviews the specifics of the Portuguese HSR proposals and presents information on the physical environment and institutional sphere within which the proposed system is expected to operate. The chapter will:

- Describe the European TEN-T network and the planned routes for Portuguese HSR;
- Summarize the history of the Portuguese HSR project and its current status;
- Review Portugal-specific manifestations of global social and environmental trends;
- Characterize the institutional system of Portugal, with a focus on land and transit planning and regulation; and
- Introduce Évora, Leiria, and Coimbra, the cities subsequently examined in Chapter 4.

3.1 The TEN-T network and Portuguese HSR axes

Plans for HSR in Portugal are part of the overall TEN-T Network of high priority EU projects (Figure 3-1). Financial support for the TEN-T projects comes from the EU's Structural and Cohesion Funds and from European Investment Bank loans.[1] Portugal in particular is a target of investment because of its peripheral status relative to the rest of Europe. There are a number of axes planned for HSR in Portugal, two of which will be the focus of this analysis (Figure 3-2). The first is an east-west connection between Lisbon and Madrid. The EU is interested in this axis because of European cohesion goals. The route is also intended to improve connectivity between Portugal's major ports on the Atlantic coast (in Sines, Setúbal, and Lisbon) and markets in the rest of Europe, by avoiding the need to switch between Iberian (used for conventional rail in Portugal and Spain) and standard gauge.[2] Unlike conventional rail in Portugal and Spain, new HSR would be constructed using standard gauge, which is used in the rest of mainland Europe and on all existing European HSR systems. The second axis is a north-south route through the most densely populated coastal area of Portugal, connecting the major

[1] Sevara Melibaeva, "Development Impacts of High-Speed Rail: Megalopolis Formation and Implications for Portugal's Lisbon-Porto High-Speed Rail Link" (S.M. in Transportation, Massachusetts Institute of Technology. Dept. of Civil and Environmental Engineering.), 50.

[2] Ibid.

cities of Lisbon and Porto. As EU priority projects, both axes were to receive approximately twenty percent of their funding from the EU.

Figure 3-1 HSR Trans-European Transport Network (Adapted from RAVE[3])

[3] "Portuguese High Speed Rail Project: General Overview and Status of the Project." Rede de Alta Velocidade (RAVE), http://www.efrtc.org/htdocs/newsite/events/Genmeet_2009_Porto_docs/2009.06.05_RAVE_EFRTC_PORTO.pdf (accessed March 6, 2013).

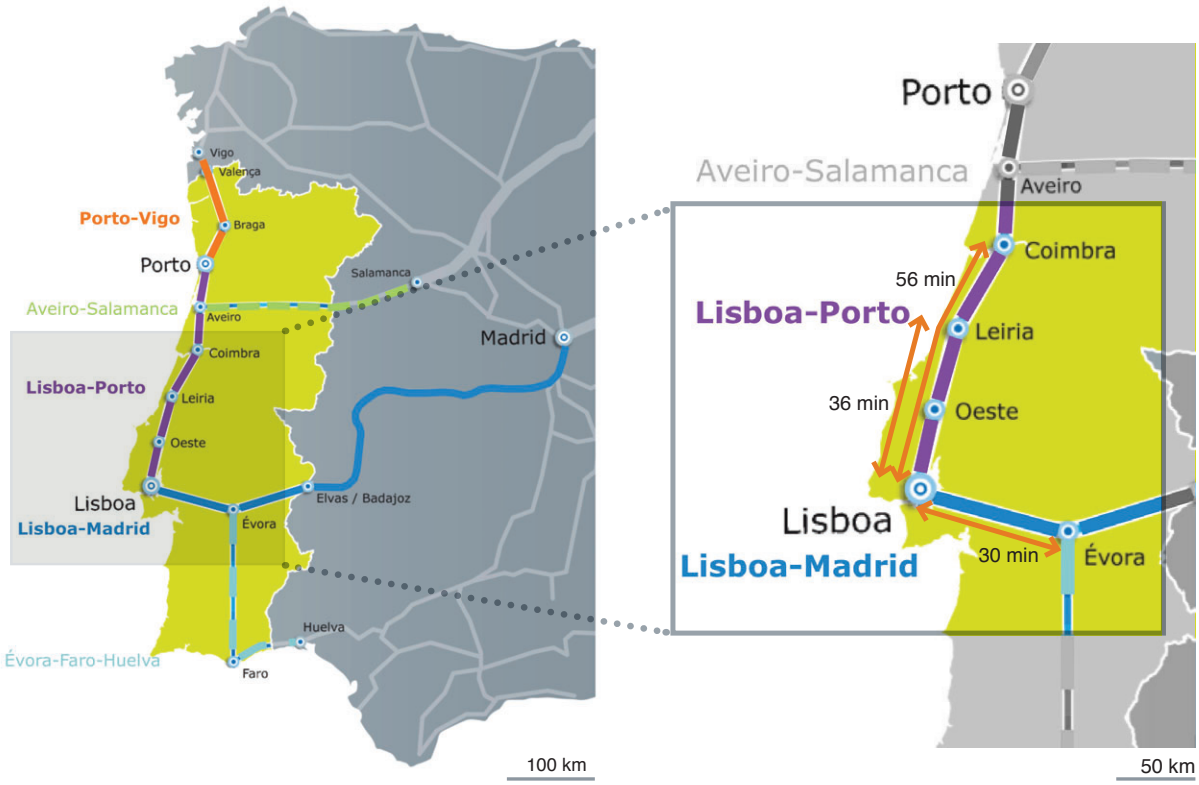

Figure 3-2 Proposed HSR network (Adapted from RAVE[4])

3.2 Project history and current status of the Portuguese HSR project

The Portuguese HSR project has been under formal development for a little over a decade. RAVE (Rede Ferroviária de Alta Velocidade), the public entity charged with planning and managing the HSR implementation process in Portugal, was created in 2000 under the management of REFER, the national rail infrastructure manager. Feasibility studies for HSR began in 2001 and by 2008 and early 2009 the first two tendering processes for public-private-partnerships had begun.[5] Not long thereafter, the global financial crisis began to severely affect sovereign debt in Europe.

Beginning in the spring of 2010, Portugal was hit by the debt crisis that started in Greece and spread through Europe. Three rounds of austerity measures were enacted to counteract rising interest rates on Portuguese debt. After failing to push though a 4th round of spending cuts and tax increases, Prime Minister Sócrates of the Socialist Party (who had vowed not to seek a

[4] *The Portuguese High Speed Rail Project* (Presented, Moscow: Rede Ferroviária de Alta Velocidade (RAVE),[2004]).

[5] "Portuguese High Speed Rail Project: General Overview and Status of the Project."

bailout) resigned.[6] Labor protests, in particular, made pushing through austerity quite difficult. In April 2011 Portugal became the third European country to seek financial bailout from the EU and the International Monetary Fund (IMF), following Greece and Ireland, in the amount of €78 billion ($111 billion). Elections in June 2011 saw Sócrates' Socialist part soundly defeated by the Social Democrats. Sócrates and his party had remained staunch supporters of the high-speed rail projects, even after the financial crisis hit in 2009.[7]

In March of 2012 the Portuguese government officially stopped all HSR work, including on the Lisbon-Madrid axis (which had higher EU priority) in order to deal with its austerity measures and the economic crisis.[8] At that point the EU withdrew funding on the basis that Portugal had defaulted on the project. Then in February 2013, the Finance Ministry announced that it successfully renegotiated funding for the project, with a higher percentage to come from the EU than before (a change from 25 to 40 percent). Construction was expected to begin on the Lisbon-Madrid axis no earlier than 2015. This announcement was quickly followed by a retraction by the Secretary of State for Transport indicating the project had been suspended indefinitely and that the national priority was now freight rather than passenger connections, with the primary aim of connecting Portuguese ports to the rest of Europe.[9] There has been some discussion of taking a more incremental approach to freight connections across the border into Spain but the future of HSR in Portugal remains uncertain. Nevertheless, researchers in Portugal, including those involved with the MIT Portugal Program,[10] continue to build a body of knowledge in relation to the project. Public sector planning continues to some extent within REFER, the parent agency of RAVE. RAVE was gradually reabsorbed into REFER during 2011 and formally dissolved in November 2012.[11]

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[6] "Portugal PM Jose Socrates Resigns After Budget Rejected." BBC News Europe, http://www.bbc.co.uk/news/world-europe-12841492 (accessed May 15, 2013).

[7] "High Speed Rail U-Turn." *The Portugal News Online*, sec. General, February 7, 2013.

[8] "TGV Plans Officially Shelved." *The Portugal News Online*, sec. General, March 31, 2012b.

[9] "High Speed Rail U-Turn."

[10] Which funds the research project for which this thesis work was done

[11] *Management Report Notes to the Financial Statements, 2012* (Lisboa: REFER,[2012a]).

3.3 Ongoing social and environmental trends

Portugal has experienced significant socioeconomic restructuring since its entrance into the EU in 1986. In particular Lisbon, Portugal's capitol and dominant metropolitan region, is now part of the globalized service economy: by 1991 seventy percent of total employment in the Lisbon region was in the tertiary (service) sector.[12] Economic change is accompanied in turn by spatial and governance changes:

> There has been a shift from what was still a single centre city in the late 1960s, to a poly-nuclear metropolitan area by the beginning of the twenty-first century. The reality of an increasingly complex, diverse and rapidly developing city strongly interrelated with its broader city-region has brought increased recognition of the limitations of current governance systems and spawned the emergence, in a largely fragmented and evolutionary manner, of a range of new governance arrangements.[13]

An interview methodology is used in Chapter 4 to investigate HSR's potential to extend this process from the more traditional metropolitan scale to the scale and form of new *discontinuous regions*—single labor and commercial markets that spans large distances but do not include all intermediate areas.

Portugal's economic growth was, as is so often the case, accompanied by more sprawling development pattern. The 2010 *State and Outlook* report released by the European Environment Agency (EEA), an agency of the EU, cites concerns over Portugal's "Disorderly urban expansion causing fragmentation and degradation of surrounding areas (affecting quality, ecology, production and landscape potential and contributing to the depopulation and deterioration of other areas)."[14] This degradation, the report points out, is compounded by "Insufficient transport intermodality, too much dependency on private vehicles and insufficient development of other transport modes such as rail."[15]

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[12] C. N. Silva and S. Syrett, "Governing Lisbon: Evolving Forms of City Governance," *International Journal of Urban and Regional Research* 39, no. 1 (2006), 98-199.

[13] Ibid.

[14] "Land use (Portugal).*SOER 2010: The European Environment – State and Outlook 2010*." European Environment Agency, http://www.eea.europa.eu/soer/countries/pt/soertopic_view?topic=land (accessed July 6, 2012).

[15] Ibid.

As can be seen, the general trends identified in Chapter 2—a globalizing economy with increased attention paid in parallel to local urban quality and sustainability—also manifest themselves specifically in Portugal and thus form the backdrop for HSR implementation at the national scale.

3.4 Institutional background

As discussed in Chapters 1 and 2, the success of a HSR project depends in part on the degree to which HSR service is integrated into other local transport and land use systems. This in turn is dependent, partially, on the institutional context within which HSR is implemented. Here we focus on the systems in place for planning and regulation of land and of mass transit. Ideal HSR planning would include provisions for encouraging station-area development as well as modifications to existing transit (in either routes or scheduling) to provide good accessibility to a station. Therefore, for each category we are interested in both who has the power to make a given set of decisions and in the degree to which those decisions can be successfully coordinated across government jurisdictions. For station-area planning, national-local relationships may be of the greatest importance. For public transit, coordination is likely to be necessary across local jurisdictional boundaries, given that the catchment area for a HSR station is broader geographically than a single municipality.

In Portugal there are four legally defined levels of spatial organization: sub-municipal or freguesia, municipal, regional, and national. In reality the vast majority of power is concentrated at the municipal level and national level. Regional governance encompasses a patchwork of entities beholden for power and resources either to national or local governments (see Figure 3-3).[16] Some formalized regional governance exists. In 1991, metropolitan governments were established for the metropolises of Lisbon and Porto. Appointed municipal representatives serve to coordinate planning activity. In 2003 this concept was expanded to enable a variety of municipal coalitions, with criteria based on population size and level of urbanization.[17] The scope of potential local action has also increased in recent years. Under the principle of 'general competence,' local government may undertake any action for the wellbeing of its residents.

[16] Lisa Rayle and Christopher Zegras, "The Emergence of Inter-Municipal Collaboration: Evidence from Metropolitan Planning in Portugal," *European Planning Studies* (09/26; 2013/03, 2012), 1-23.

[17] J. S. Nelson, "The Portuguese Surface Transportation Policy and Finance System: Current Status." *MIT Portugal Program Working Paper Series* (2008).

Greater financial resources do not necessarily accompany this freedom but it has played a role in the diversification of public service delivery modes across municipalities in Portugal.[18]

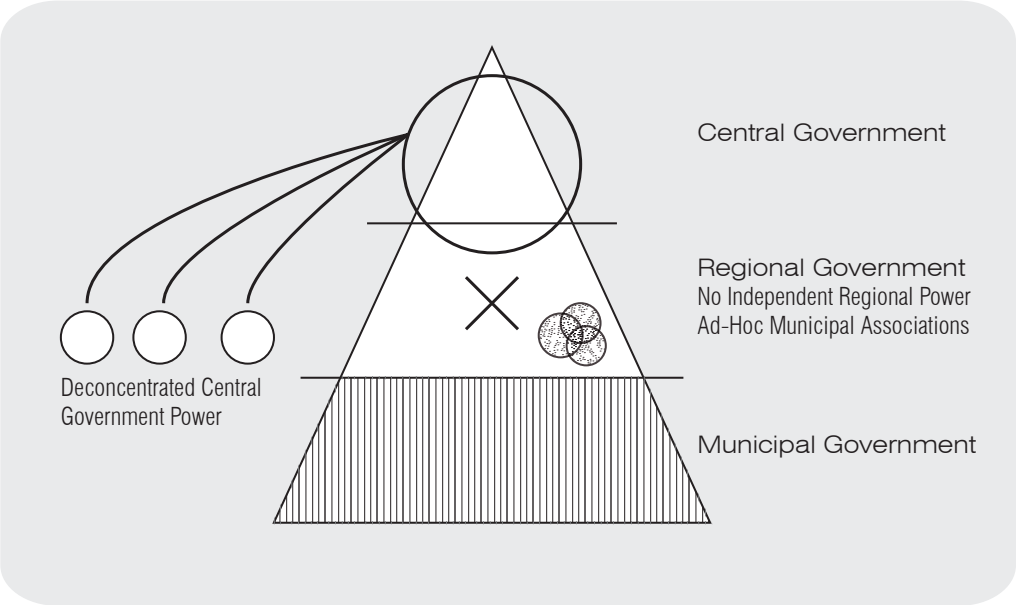

Figure 3-3 The institutional structure in Portugal essentially limits regional governance to voluntary cooperation (Source: Author)

3.4.1 Provision of mass transit in Portugal

Except in the Lisbon and Porto metropolitan areas, municipalities are solely responsible for land use planning and for managing a broad spectrum of local services including public transportation.[19] Given the importance of access and egress to HSR stations, the structure for local provision of transit is of particular interest. Porto and Lisbon have their own metropolitan-level funding structure and relationship to the central government. Elsewhere municipal governments are responsible for funding local transportation within their borders. Central government funding applies to capital project grants but not operations for municipally owned transportation services. Operating subsidies from the central government are distributed exclusively to state-owned enterprises, such as the *Metro do Porto*, not to municipalities. EU Structural Funds can be applied to specific projects at a local level. These funds are, however, administered by the central government.[20]

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[18] Silva and Syrett, *Governing Lisbon: Evolving Forms of City Governance*, 98-199

[19] Nelson, *The Portuguese Surface Transportation Policy and Finance System: Current Status.*

[20] Ibid.

Bus and other transportation that crosses municipal boundaries is becoming an increasingly important part of the Portuguese transport system, given that labor markets are expanding their reach (see Section 3.5.2). Inter-city bus routes are operated by private companies and licensed by IMTT, the national transportation regulator, with minimal oversight involved in actually defining service. Only ad-hoc coordination exists between public municipal and private regional operators (Interview, SMTUC, unpublished data).[21]

3.4.2 Spatial planning and land regulation

While lacking the power to create a regionally coordinated network of public transport services, municipalities do bear the greatest responsibility for shaping development and land use. Apart from national protection of environmentally sensitive areas (wetlands, coastal regions, etc.), responsibility for land use regulation lies entirely with municipal governments. The single most important document is the PDM (Plano Director Municipal), a zoning document that categorizes the entire area of the municipality according to allowed uses. Every municipality has at least one such document because it was mandated by the central government in order for a municipality to gain access to EU funds. While the municipality has the legal right to regulate a whole range of development characteristics (land use, density, volume, setbacks, parcel size, etc.), in practice most PDMs only have the spatial resolution to regulate allowed uses and possibly some form of density (Interview, Professor Baptista e Silva, unpublished data).[22]

There are two additional more detailed regulatory documents that can be used by municipalities to gain greater control over development. The Planos de Urbanização (PU) have the resolution needed to influence urban design. They are labor-intensive to produce, however, and according to Baptista e Silva, the required institutional capacity to produce a PU varies widely among municipalities. Motivation within a municipality to invest considerable resources in preparing detailed zoning comes from expectations of growth or dramatic change in the urban environment. Even more detailed is the PP (Plano de Pormenor), which most closely approximates overlay-zoning districts in the United States. A PP is appropriate for brownfield site redevelopment and possibly for station-area planning. Even though the tools exist for

[21] Interview, Luis Santos and Ricardo Grade, SMTUC. Coimbra, November 2, 2012.

[22] Interview, Jorge Baptista e Silva, Departmento de Engenharia Civil, IST. Lisbon, October 31, 2012

transport-oriented land use planning, there are no formal process mechanisms in place to ensure land use and public transportation service decisions are made in a coordinated manner. According to planners at Coimbra's municipal transit operator, service planning is subsequent to rather than concurrent with the municipal land-use planning process. (Interview, SMTUC, unpublished data).[23]

3.5 Cities of interest – prospective HSR implementation

The following two chapters are based on detailed case study material (Figure 3-4). Chapter 4 builds on our theme of *relationships*; it uses interviews with local officials to examine perceptions and expectations regarding prospective HSR implementation and its bearing on inter-governmental cooperation. Chapter 5 takes a *space*-based approach, looking at cities with current rail commuting patterns to Lisbon. Material from field visits is used to document the relationship between rail characteristics and the urban form of two cities with current rail commuting to Lisbon, Cascais and Santarém.

Our first comparative study focuses on three cities located on the planned Portuguese alignments: Évora, Leiria, and Coimbra. Each would be brought within potentially feasible commuting times (less than one hour) of Lisbon, Portugal's dominant metropolitan area (see Figure 3-2). They are therefore appropriate locations to examine stakeholder views regarding the influence of HSR implementation on development, commuting patterns, metropolitan boundaries, and regional structure. Évora is located on the Lisbon-Madrid axis, approximately 135 road kilometers (84 miles) from Lisbon. This city of 50,000 would be brought within a thirty-minute trip (station-to-station) of downtown Lisbon by HSR. Both Leiria and Coimbra are located along the north-south HSR axis. Coimbra is the third major city in Portugal, located 200 road kilometers (124 miles) north of Lisbon. Leiria is located 70 kilometers (43 miles) south of Coimbra. HSR would bring Leiria and Coimbra within 36 and 56 minutes of Lisbon, respectively, although time to connect actual origins and destinations would of course be greater.

[23] Interview, Luis Santos and Ricardo Grade, SMTUC.

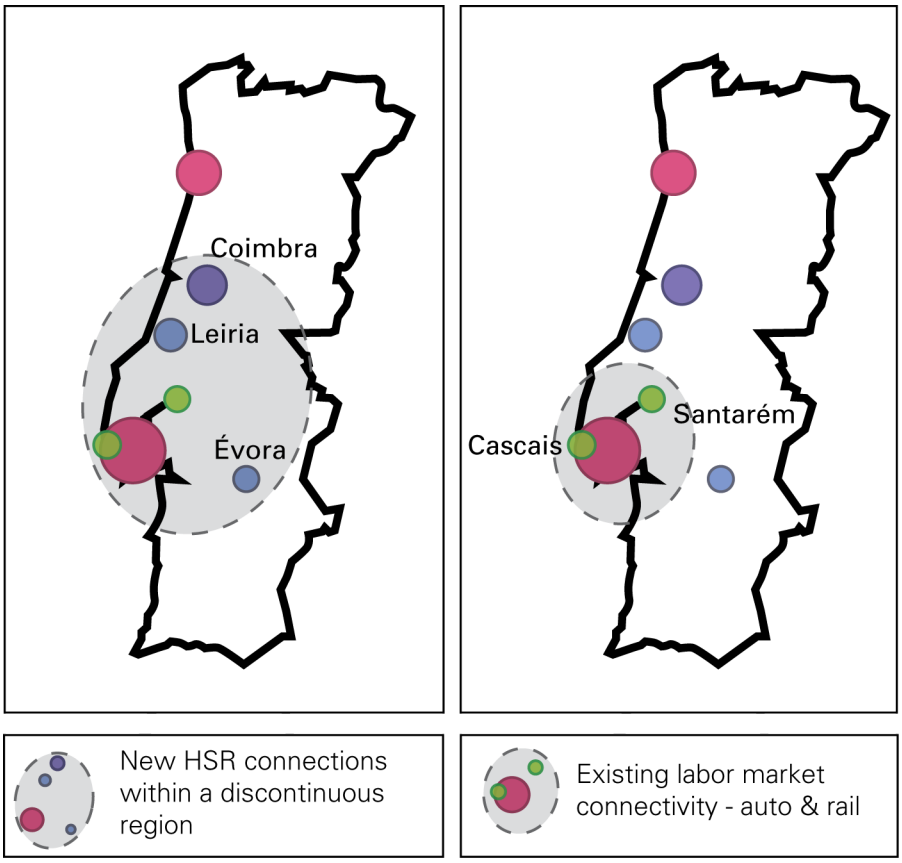

Figure 3-4 Two sets of cities examined to gain both a prospective and retrospective understanding of intercity rail commuting, at two different scales

3.5.1 Existing and proposed rail service

As introduced in Chapter 2, the level of impact expected by each municipality is partially determined by the increment in accessibility resulting from planned HSR. Évora is at present served by only four trains per weekday in each direction with a travel time of 1 hour and 58 minutes to Lisbon.[24] The planned frequency for HSR would be 12 trains per day and 30-minute travel times (Interview, Lopes, unpublished data).[25] Leiria also has relatively low rail accessibility. The primary conventional rail Norte line does not serve the city. With five trains per day from Lisbon, only two of which do not require transfers, and all of which are slowed by the frequency of intermediate stops, rail is not currently a competitive alternative. Bus and private automobile are the primary means of access to Lisbon from Leiria.

[24] "CP Timetables." Comboios de Portugal, http://www.cp.pt/ (accessed February 9, 2012).

[25] Interview, Isabel Mendes Lopes, REFER. January 10, 2012.

Coimbra, as one of Portugal's major cities, important for both its educational institutions and cultural history, is currently served quite well by the rail system. With more than hourly frequency between Lisbon and Coimbra for most of the day, along with the higher speed "Alfa Pendular" tilting-train service, rail is already a competitive option for travel between Coimbra and Lisbon, although as in all of Portugal the competition from the private automobile has increased in recent years. The proposed HSR would reduce travel times from 2h05 for intercity service (Intercidades) or 1h51 for the Alfa Pendular[26] to just under an hour, pushing service under the threshold for reasonable daily commuting times.

3.5.2 Mobility and commuting trends

Two other ongoing trends, beyond globalization and sprawling growth, are of importance to the Portuguese case: increased connections between cities and towns within Portugal's regions and, as in so many other parts of the world, increased motorization (Table 3-1).

One indicator of the level of connectivity between municipalities is network density: the ratio between all commuting flows that are not internal to their respective municipality and total employment in a region.[27] Conceptually, this indicator measures the ratio between actual and potential inter-municipal commuter connections within a region. A network density of 1 would mean that every single commuting trip crosses a municipal boundary. Conversely a value of 0 would mean everyone lives and works within their home municipality. Taking the Centro Region (Figure 3-5) of Portugal as an example because it includes both Coimbra and Leiria and because it is the most polycentric and interconnected region of Portugal, we use commuting data to calculate the network density changes between 1991 and 2001. Thus measured, network density increased somewhat in the Centro region from 1991 to 2001.[28] Interviews with local transportation officials confirm that the region has become increasingly interconnected in recent decades.[29]

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[26] Ibid.

[27] Martijn Burger and Evert Meijers, "Form Follows Function? Linking Morphological and Functional Polycentricity," *Urban Studies* 49, no. 5 (Apr 2012, 2012), 1127.

[28] From 0.136 to 0.174

[29] Interview, Luis Santos and Ricardo Grade, SMTUC.

Table 3-1 Change in auto mode share and within-municipal commuting, 1991-2001[30]

	1991		2001	
Residents of:	Auto mode share*	Internal commuting	Auto mode share	Internal commuting
Coimbra	33%	93%	58%	90%
Leiria	34%	88%	61%	87%
Évora	36%	95%	63%	94%

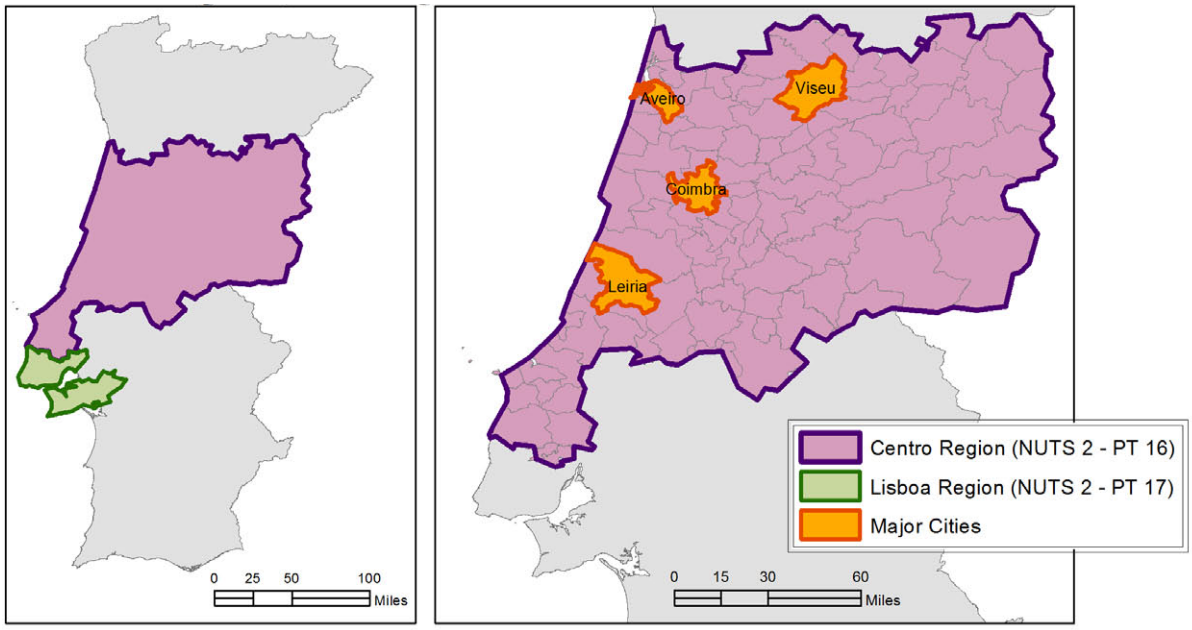

Figure 3-5 Centro region, Portugal and major cities (Source: Author)

There are some notable differences between each of the three cities in terms of their daily commuting patterns. Évora is the most isolated while Leiria and Coimbra are part of the same polycentric and interconnected region. In 2001, ninety-four percent of all commuting trips originating in Évora were also destined for the municipality (Figure 3-6); the high degree of internal commuting has remained relatively constant since the previous census in 1991. Looking at the small slice of outward commuting trips to other municipalities, there has been increased dispersion of destinations, although Lisbon remains the dominant attractor. While the top 76% of external commuting trips were destined to 11 other municipalities in 1991, that number expanded

[30] Data source: Census 1991, 2001(Instituto Nacional de Estatística, INE - http://www.ine.pt/); *Commuting trips as either a driver or a passenger

by 2001, with the top 77% now destined to 18 other local jurisdictions (see Figure 3-7 and Figure 3-8). Comparing the two graphs also demonstrates the increasing dominance of the automobile as a mode of travel.

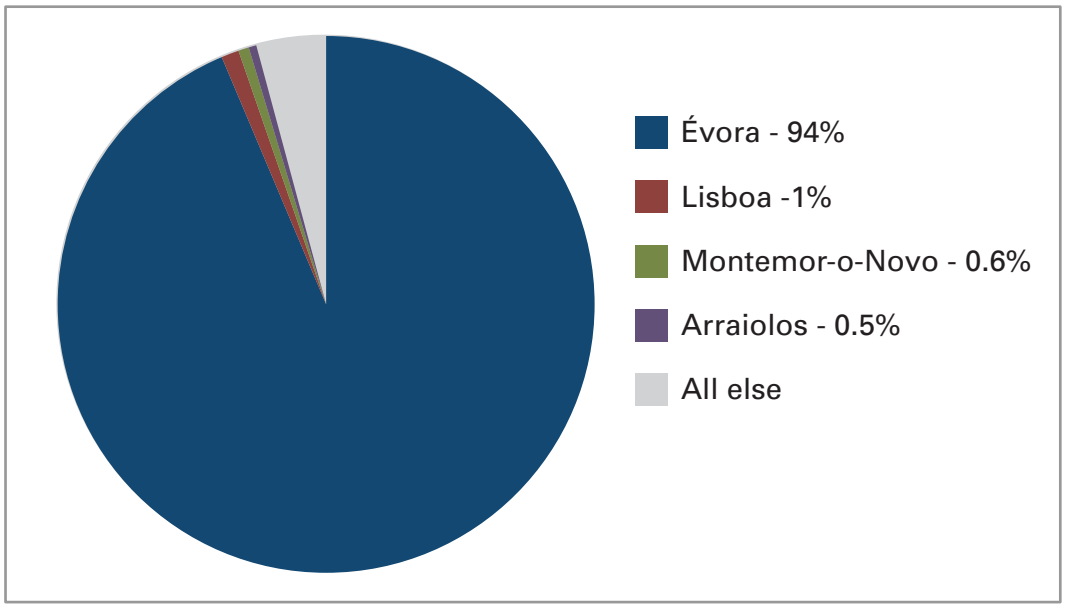

Figure 3-6 Total Commuting from Évora by municipal destination (Source: Author, data from 2001 Census, INE)

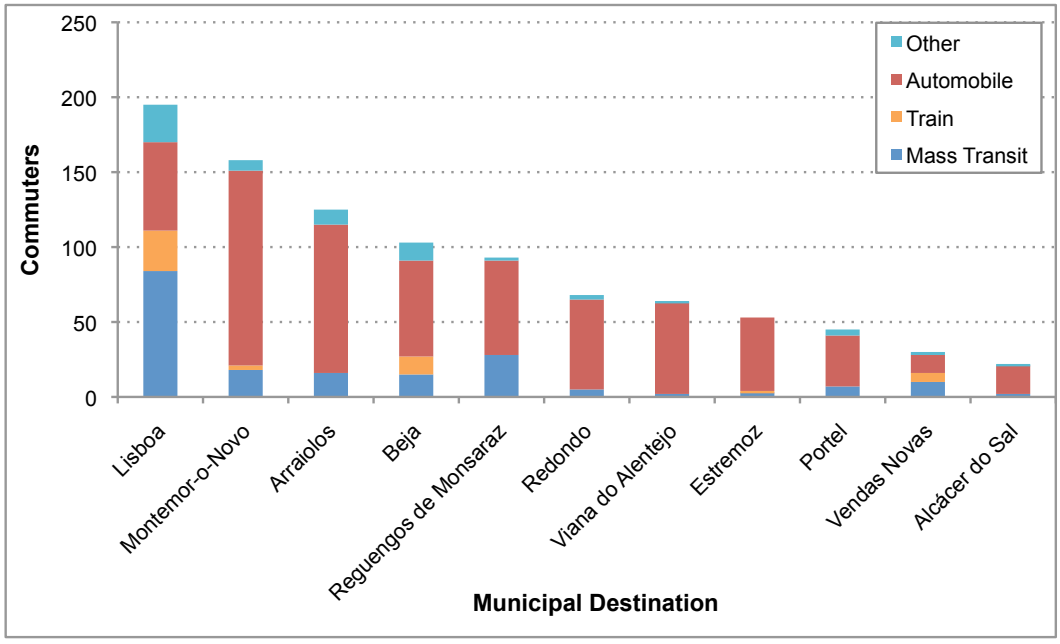

Figure 3-7 Destinations and mode split for the top 76.2% of external commuting trips from Évora in 1991 (Source: Author, data from 1991 Census, INE)

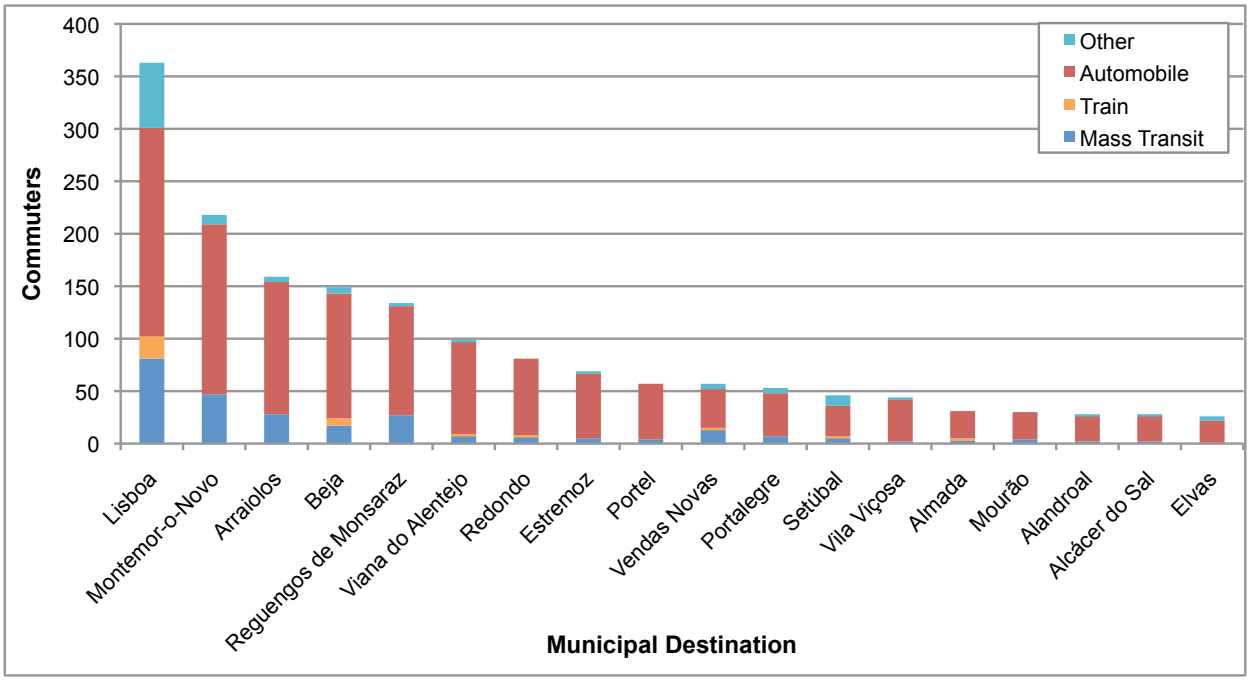

Figure 3-8 Destinations and mode split for the top 76.9% of external commuting trips from Évora in 2001 (Source: Author, data from 2001 Census, INE)[31]

Leiria and Coimbra both have more commuting trips bound for external destinations than Évora and both demonstrate some minor reduction in the percentage of internal commuting between 1991 and 2001. Eighty-seven percent of Leiria's commuting trips were internal in 2001, a 1% reduction from 1991 (Figure 3-9). Ninety percent of Coimbra's commuter trips were internal in 2001, down from ninety-three percent in 1991 (Figure 3-12), a modest change. Moreover, if one performs the same analysis as above of dominant external attractors, dispersion is again discernable, although the change is somewhat greater for Leiria (Figure 3-10 and Figure 3-11) than for Coimbra (Figure 3-13 and Figure 3-14). In 1991, Leiria's external commuting traffic was highly localized to five adjacent municipalities, the most prominent of which is Marinha Grande. By 2001, Lisbon and Coimbra both become more significant attractors for Leiria residents.

[31] Note: there is some ambiguity in the definition of "Nenhum" or 'None', which is include in the aggregated category of "Other." Given that walking is an infeasible access mode for commuting to Lisbon but "Nenhum" is nevertheless a mode choice for trips there, this category may be capturing telecommuting or other non-standard commuting patterns not adequately addressed in the Census.

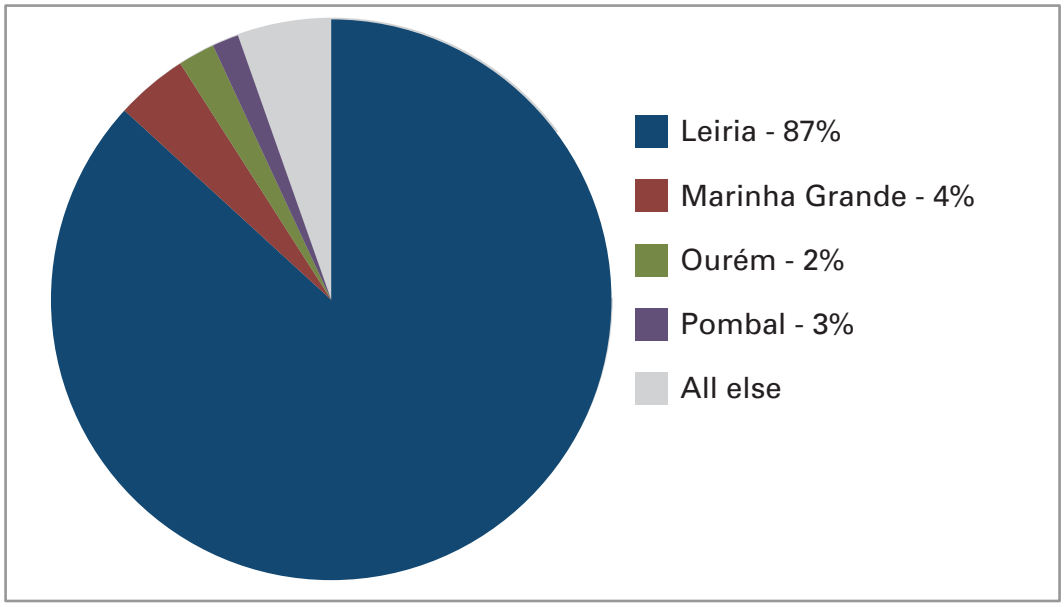

Figure 3-9 Total Commuting from Leiria by municipal destination (Source: Author, data from 2001 Census, INE)

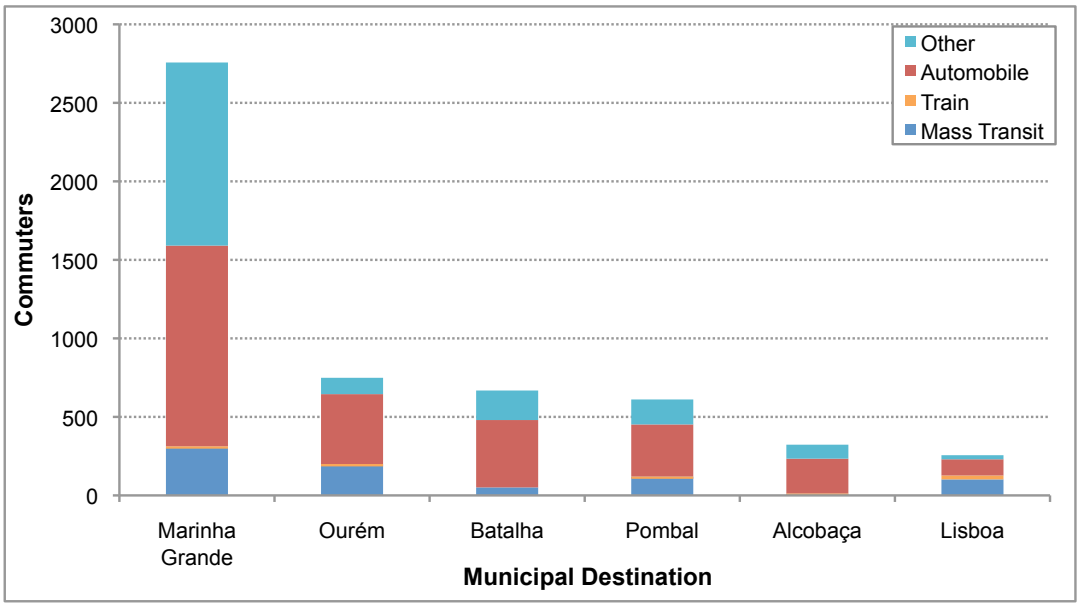

Figure 3-10 Destinations and mode split for the top 84.8% of external commuting trips from Leiria in 1991 (Source: Author, data from 1991 Census, INE)

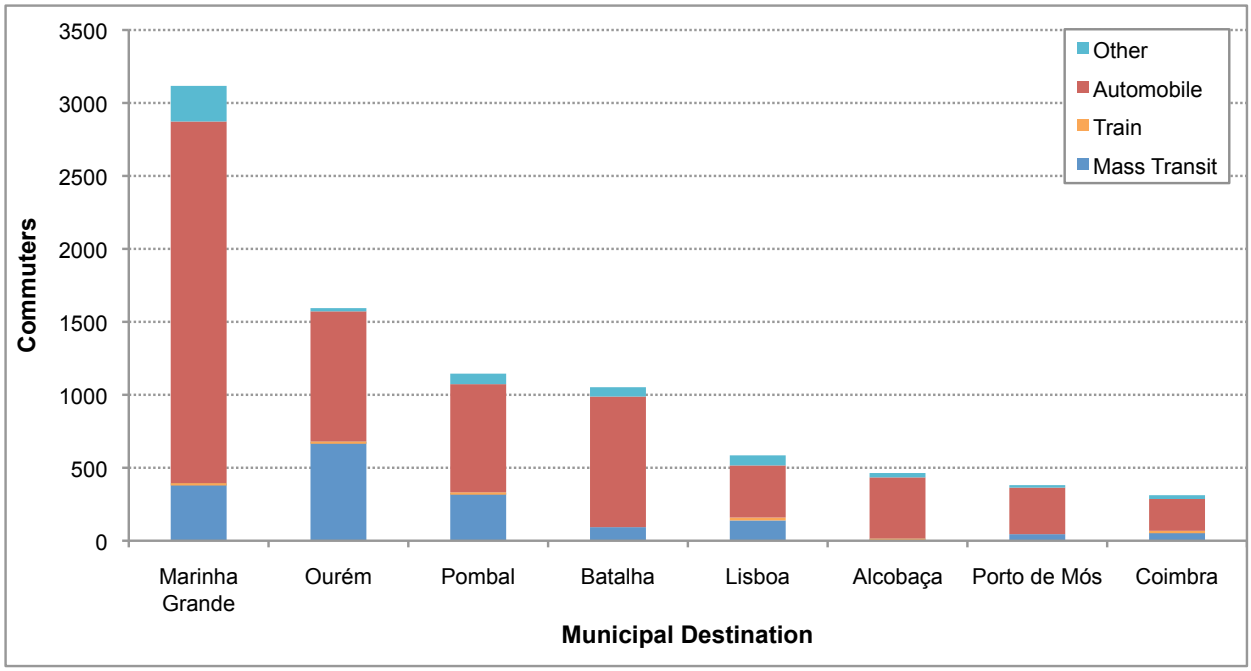

Figure 3-11 Destinations and mode split for the top 87.2% of external commuting trips from Leiria in 2001 (Source: Author, data from 2001 Census, INE)

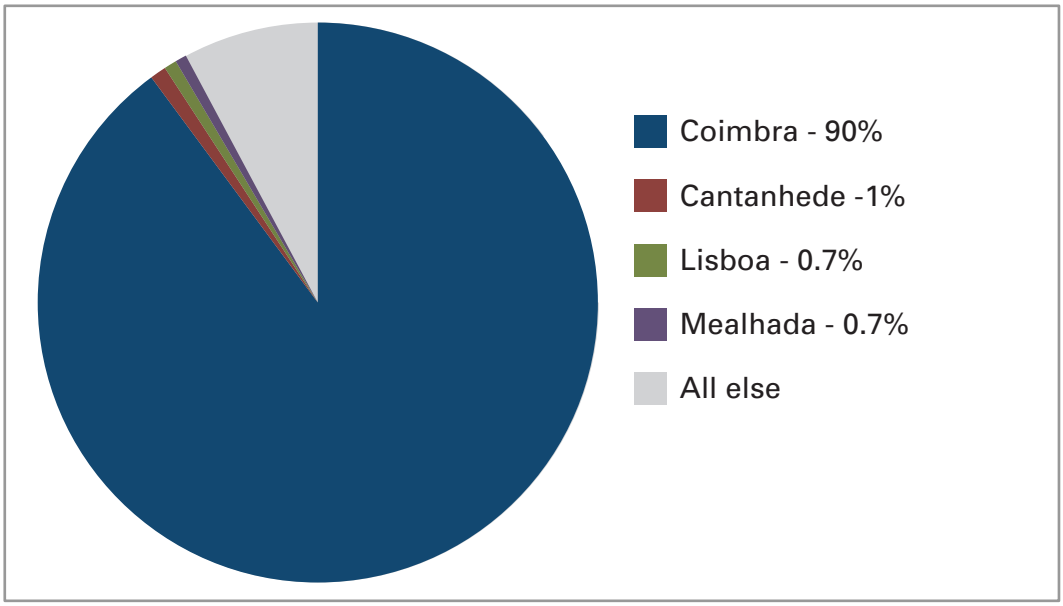

Figure 3-12 Total Commuting from Coimbra by municipal destination: (Source: Author, data from 2001 Census, INE)

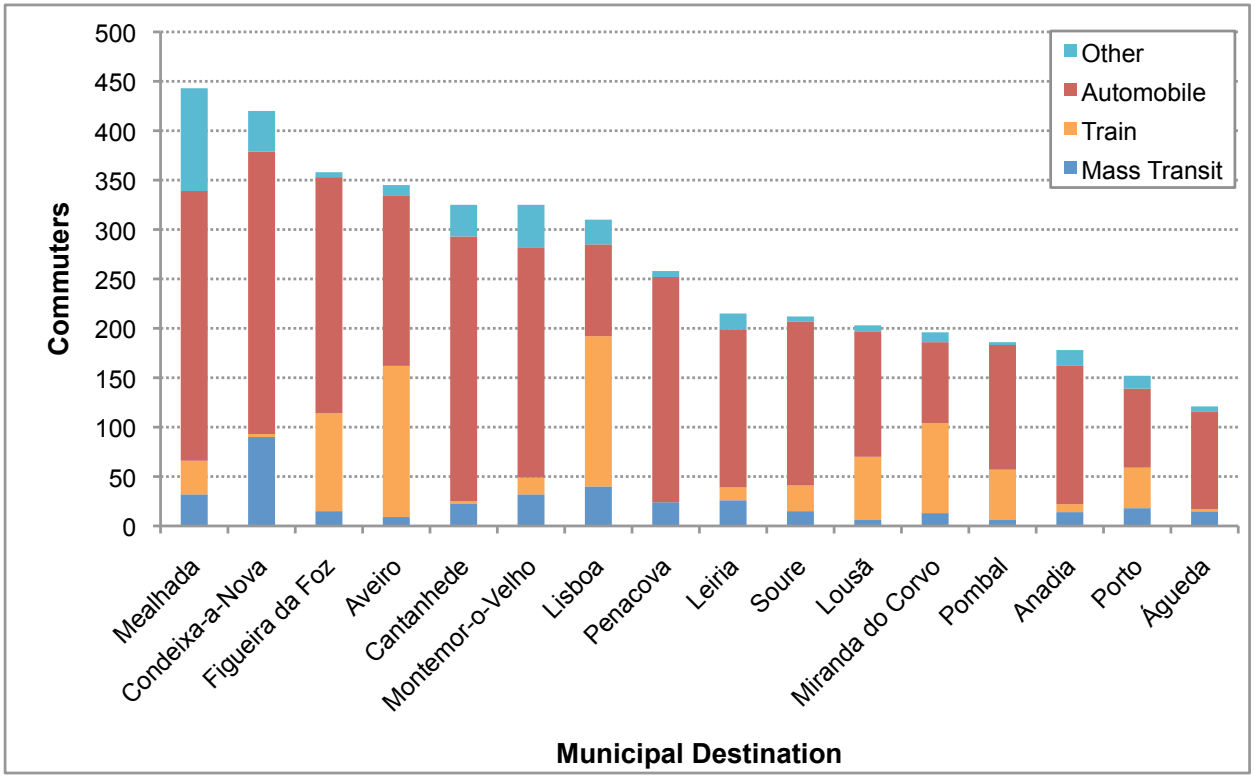

Figure 3-13 Destinations and mode split for the top 76.8% of external commuting trips from Coimbra in 1991 (Source: Author, data from 1991 Census, INE)

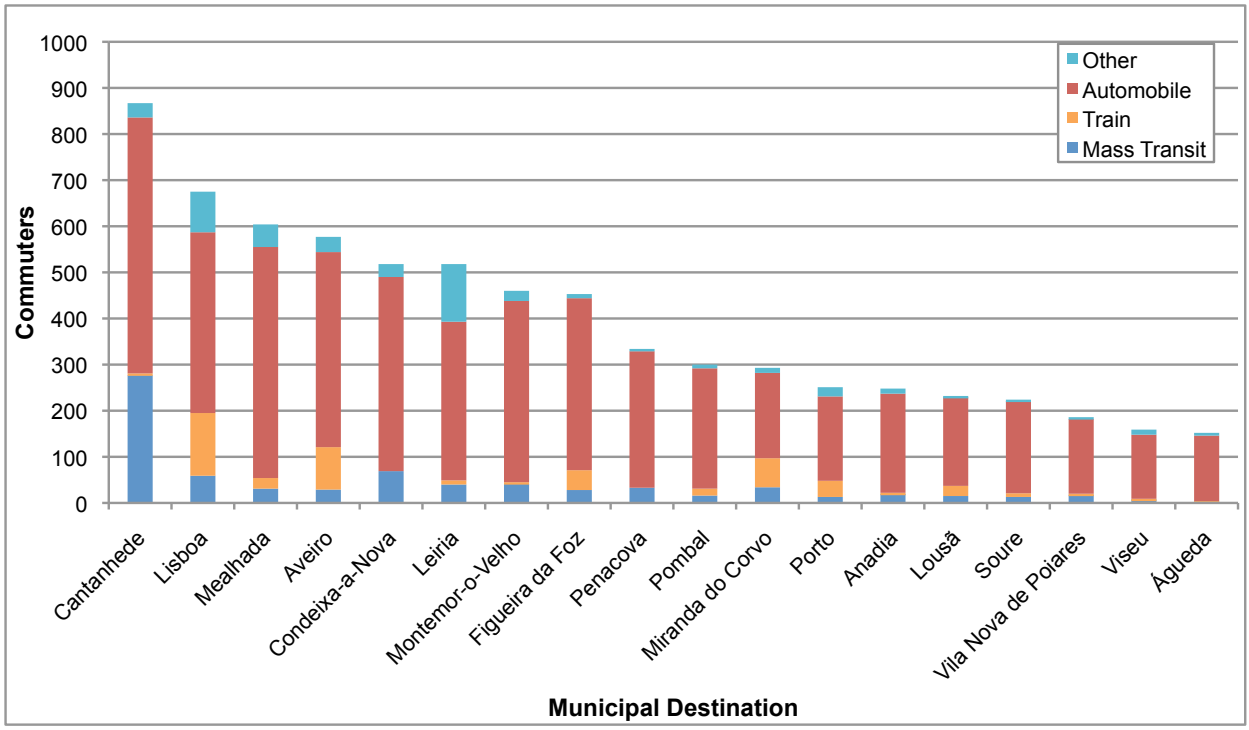

Figure 3-14 Destinations and mode split for the top 75.2% of external commuting trips from Coimbra in 2001 (Source: Author, data from 2001 Census, INE)

Figure A-1 through A-3 in the Appendix visualize the spatial patterning of commute trips for each of the municipalities, in 1991 and 2001. Overall, the analysis of mobility trends demonstrates that all three cities experienced an increased dispersion of outgoing commuter trips and increased motorization of journey-to-work trips from 1991 to 2001. In comparison to Évora, Leiria and Coimbra participate in a more polycentric labor market. Because Évora is more isolated, regional mobility issues are less likely to be of interest to the city.

3.6 Conclusions

This chapter presented specifics of the proposed Portuguese HSR system, along with a number of observations regarding the physical environment and institutional sphere within which the proposed system will operate. Consistent with global trends, Portugal has experienced significant economic restructuring that increased the role of the service sector of the economy. As a result, Lisbon—Portugal's capitol—underwent metropolitan level restructuring and a corresponding reconsideration of fragmented local governance. A similar process might be expected, should HSR expand Lisbon's area of influence to include cities like Évora, Leiria, and Coimbra.

The institutional structure in Portugal (outside of Lisbon and Porto) essentially limits regional governance to voluntary cooperation. Land use regulation is controlled by municipalities, as is municipal public transport. Inter-city bus service is provided by private operators with minimal national government oversight. The limited mechanisms available for coordinating land use and transport policy across municipal boundaries will be a challenge to the implementation of HSR in Portugal.

Finally, this chapter describes ongoing land use and mobility changes in Portugal. Past trends in Évora, Leiria, and Coimbra demonstrate that the country is becoming more connected, with expanding commuter sheds and increasing inter-municipal commuting. That change, however, is unfortunately accompanied by increased motorization and sprawling land use patterns. High-speed rail offers the opportunity to support a different model of growth, while still providing for increased social and economic connectivity within the country.

We now go on in Chapter 4 to examine prospective attitudes towards HSR in Évora, Leiria, and Coimbra. Interviews with local and national officials in Portugal offer a window into stakeholder priorities and motivations regarding HSR.

4 Intermediate HSR Cities in Portugal

The decision to invest in HSR is a mostly top-down decision from upper levels of government (at the both national and EU scale) predicated on the belief that HSR will enable economic integration without environmental degradation. However, whether or not the intended regional restructuring materializes depends to some extent on local government policy, which is in turn a function of local expectations and perceptions of likely benefit, and the resulting incentives for inter-governmental coordination.

The following study of three cities in Portugal, Évora, Leiria, and Coimbra, is based primarily on information collected during interviews with national and local officials in January 2012. Based on perspectives from the interviews, as well as a set of ideas about the effect of HSR on forms of spatial organization and governance, we come to conclusions about the ways in which HSR planning is changing attitudes towards regional identity and urban governance. These include the integration of national entities into local planning processes, the potential for new models of commuting, and the role of HSR as an exogenous motivator for regional cooperation.

The study reveals how HSR can serve as a catalyst for governments to rethink regional identity, intergovernmental relationships, and competitive positioning. The prospect of HSR implementation raises the profile of potential intra-regional complementarity and highlights the importance of inter-governmental relationships for guiding HSR-supportive policies.

4.1 HSR, altered geography, and the hypothesis of discontinuous regions

4.1.1 Patterns of access and a changing geography

R.M. Hurd, considered by some to be the father of modern urban land economics[1], was already grappling in 1903 with various complexities of the relationship between accessibility and development patterns, including: the difference between direct proximity and transport-enable accessibility, the various morphologies of access (axial v. nodal or center-oriented), and the importance of daily lived experience in shaping the unstable equilibrium of city growth.

[1] H. W. Richardson, *The New Urban Economics: And Alternatives* (London: Pion, 1977).

> Value by proximity responds to central growth, *diminishing in proportion to distance from various centres, while values from accessibility responds to axial growth, diminishing in proportion to absence of transportation facilities*. Change occurs not only at the circumference but throughout the whole area of the city, outward growth being due both to pressure from the centre and to aggregation at the edges. All buildings within a city react upon each other, superior and inferior utilities displacing each other in turn. Whatever the size or shape of a city and however great the complexity of its utilities, the order of dependence of one upon another is based on simple principles*, all residences seeking attractive surroundings and all businesses seeking its customers***.**
>
> While the outward glacial movement of a city continues, *the daily currents of travel within alter its internal structure.* The fluidity of daily traffic shifts utilities, creates plastic conditions in cities and keeps values in a state of unstable equilibrium.[2]

These issues are magnified in the case of the drastic change in accessibility caused by HSR. While HSR infrastructure may be linear in form, the patterns of access created by it are more center-oriented, as entry to the system limited to stations located at considerable distances from one another. Nevertheless, the speed of HSR means a possible integration of daily lived-experience across those considerable distances.

Plassard coined the term 'tunnel effect' to describe the consequences of the new high-speed transport modes of air, highways, and high-speed rail. The effect is so called because it induces activity concentrations at access points to a high-speed network while reducing the relative importance of the intermediate areas through which the transport infrastructure 'tunnels' but does not stop.[3] While the concept is similar across all three modes, HSR has a unique capacity to influence territorial organization, above and beyond air or highway infrastructure. Ureña et al. refer to "increased metropolitan processes" caused by HSR in which a metropolitan area undergoes a "discontinuous expansion" to include small cities up to one hour away by HSR, without the surrounding areas necessarily being integrated as well.[4] It is this phenomenon on which we will focus our attention.

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[2] Richard M. Hurd, *Principles of City Land Values*, Second ed. (New York: The Record and Guide, 1905), 146-148. (Emphasis added)

[3] José M. Ureña et al., "Territorial Implications at National and Regional Scales of High-Speed Rail," in *Territorial Implications of High Speed Rail: A Spanish Perspective*, ed. José Maria de Ureña (Farnham, Surrey ; Burlington, VT: Ashgate, 2012), 129.

[4] Ibid.

4.1.2 Discontinuous regions – exploring an expanded field of metropolitan influence

According to standard bid-rent theory, an increase in travel speeds can change the slope of the urban rent gradient, thus extending the feasible commute shed of a metropolitan area. In a monocentric model, increased land value at the periphery results in new development on previously undeveloped land. Historically this process is what guided the expansion of metropolitan areas.[5] HSR, however, operates at a greater scale, blurring the boundaries of inter-city and intra-city travel. HSR is not implemented on a tabula rasa. Rather, it connects already existing urban settlements, and therefore will build on prior social and economic networks (and on other transport networks).

HSR experience to date has shown that it can integrate previously independent urban areas into the commute-shed of a larger metropolitan area.[6] As philosopher Michel Serres put it when addressing SNCF (France's national rail operator), HSR can compress travel times to the extent that all of a sudden "it seemed that cities somehow crashed into one another and merged."[7] When centers are integrated by high-speed transport the urban environment reemerges as a focal point of experience and potential intervention. Here our attention is directed in particular at smaller cities that would be brought within the realm of influence of Lisbon.

This investigation posits a new form of regionalism based on long-distance commuting between cities that are far enough apart so as not to be adequately integrated by auto travel or conventional rail. We hypothesize the formation of a *discontinuous regions*—a single labor and commercial market that spans large distances but does not include all intermediate areas—and then ask: If HSR can contribute to the spatial reorganization of functional relationships, what does that mean for the newly integrated cities, for rational mobility and land use planning within this *discontinuous region*, and for the sustainability impacts of HSR? Figure 4-1 depicts this posited new form of region. Évora, Leiria, and Coimbra were selected for interviews based on their potential to become part of a discontinuous region centered on Lisbon.

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[5] Peter O. Muller, "Transportation and Urban Form: Stages in the Spatial Evolution of the American Metropolis," in *The Geography of Urban Transportation*, ed. S. Hanson, 3rd ed. (New York: Guildford Press, 2004), 59-85.

[6] Ureña et al., *Territorial Implications at National and Regional Scales of High-Speed Rail*, 129

[7] Michel Serres, "The Expert: I Live in Palylobru," *SNCF Connections,* 2012, 22-25.

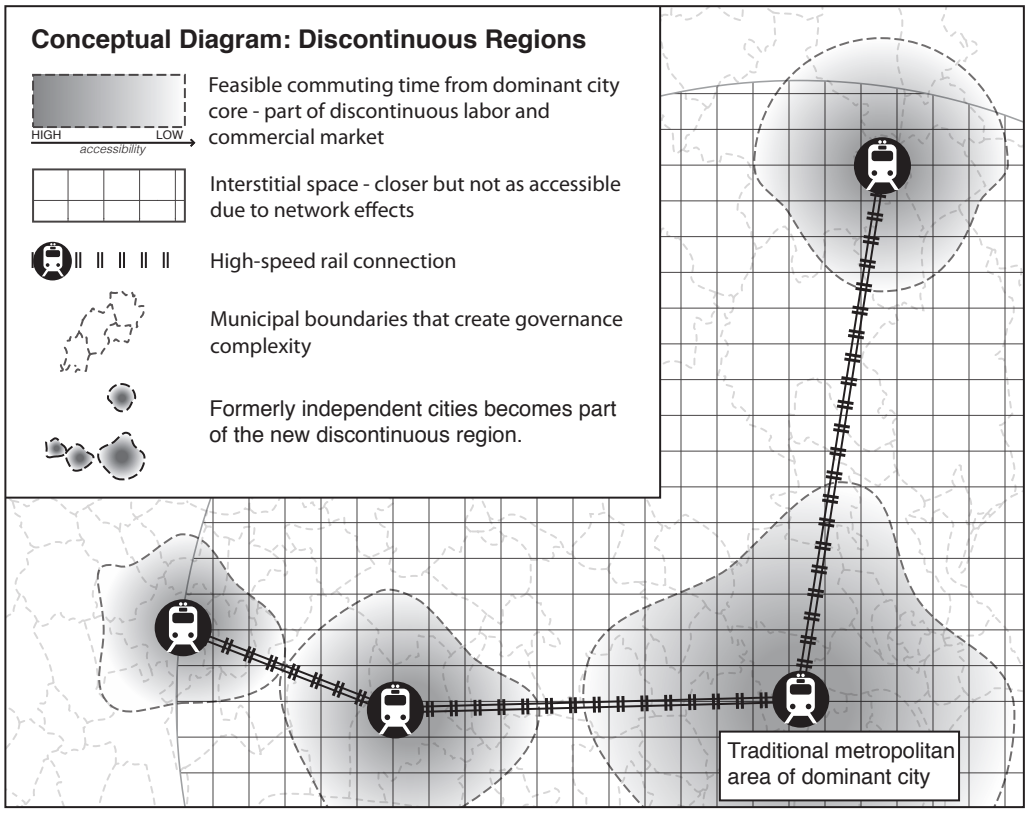

Figure 4-1 Conceptual Framework: Discontinuous Regions Linked by High-Speed Rail

4.2 The regionalism argument – seeking to match form and governance

To understand the implications of new forms of spatial organization requires that we also understand the bidirectional relationship between form and governance. Several decades ago in *What Time is this Place?* Kevin Lynch asked one of the oldest and most difficult to answer questions within urban studies: "What…is the relationship between environmental change and social change?" He goes on to enumerate various examples of this "loosely coupled" relationship.[8] The simplest case is when a society wishes to alter its physical environment in a specific way—housing construction, irrigation, etc.—and so creates or alters organizations to accomplish the task:

> Should we want to cause a major environmental change, it is usually necessary or expedient to make some selected social changes as well, particularly in the nature of institutions...These institutional innovations may in time have secondary effects elsewhere in the social fabric.[9]

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[8] K. Lynch, *What Time is this Place?* (London: The MIT Press, 1972), 215-223.

[9] Ibid.

In the terminology of the CLIOS process (discussed further in Chapter 8), the need to consider institutional change in order to achieve an alteration within the physical environment results from "nested complexity"—the fact that the physical system is embedded within and interacts with an institutional sphere.[10] There is a relationship between the physical form of an experienced environment and the formal and informal governance relationships that influence that environment. In the case of HSR, reconceptualizations of space and reorganized relationships between cities can affect the behavior of decision-makers within local governments and therefore the realized outcomes of HSR implementation.

4.2.1 Demands for larger-scale decision making

It is often claimed that as metropolitan areas grow to span multiple jurisdictions, so too should scales of "urban" analysis, intervention, and according to some,[11] governance. One argument for decision-making at a larger geographic scale is as follows: Fragmentation of land use and transport policy leave each municipality to act in its own self-interest, pursuing policies that will maximize local property values and minimize the burden of demand for local public services.[12] At this disaggregate level, competition dominates. Each local government does its best to attract residents and revenue-generating businesses while attempting to avoid undesirable land uses and lower-income populations. Beyond the troubling social equity issues and the tendency towards less efficient uses of land, organization at this disaggregate level also cannot cope with the needs of larger systems. For example, effective watershed management, minimization of land consumption, congestion mitigation, and larger-scale energy policies all require levels of organization at a broader geographic scale.

Transportation, as a network phenomenon, presents a particular challenge at the disaggregate level. Well before the advent of the automobile era, labor markets began to span multi-jurisdictional regions. Despite more recent attempts at using land use planning to shorten

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[10] Joseph M. Sussman et al., *The "CLIOS Process": A User's Guide* (Cambridge: Massachusetts Institute of Technology,[2009]).

[11] C. L. Ross and M. Woo, "Megaregions and Mobility," *The Bridge on Urban Sustainability* 4, no. 1 (2011).

[12] W. C. Wheaton and D. DiPasquale, "Local Governments, Property Taxes, and Real Estate Markets," in *Urban Economics and Real Estate Markets* (Englewood Cliffs, NJ: Prentice Hall, 1996), 319-337.

trip distances[13] daily commutes seem ever more likely to cross jurisdictional boundaries.[14] Moreover, spatially dispersed networks of clients and service providers have increased the demand for regional business travel.[15]

Governmental change in the past has been associated with changes in spatial structure. In the United States, Metropolitan Planning Organizations (MPOs) exist to tackle mobility planning (or at the very least, federal funding distribution) at a scale larger than a single municipality—precisely because metropolitan regions extend beyond a single jurisdiction. In some places this legislatively mandated form of governance has attracted other regional duties. San Diego's MPO, for example, has since the 1970s gradually accumulated responsibilities such as housing needs determination and spending of revenue from a dedicated transportation state sales tax.[16] Other forms of regional transport-related governance include "special-purpose governments"[17] such as transit agencies and the more recent federally mandated Intelligent Transportation System (ITS) Architectures, which ensure consistency of ITS projects thereby de-facto creating inter-governmental and inter-agency cooperation to establish and manage the "architecture."[18] Moving up to the scale of mega-regions, the current HSR-planning process in the Northeast Corridor of the United States is being managed by the Federal Railroad Administration (FRA) in cooperation with multiple states. To meet these larger-scale concerns, the FRA is making a transition from its prior regulatory role towards more strategic thinking.

Consideration of the relationship between transport and metropolitan structure is expanding to encompass larger and larger geographies. In the European Union (EU), spatial policy is explicitly linked to transport policy, and backed by structural cohesion and European Investment Bank funds. When issues span larger geographic scales, policy becomes less about the give-and-take of government officials trading benefits for local constituencies. Instead, in a

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[13] J. Cortright, *Driven Apart: How Sprawl is Lengthening our Commutes and Why Misleading Mobility Measures and Making Things Worse* (Washington, DC: CEOs for Cities,[2010]). http://documents.scribd.com.s3.amazonaws.com/docs/3mea0rxg001huf45.pdf?t=1333050406.

[14] D. J. Forkenbrock, "Transportation Investments and Urban Form," *Transportation Research Record: Journal of the Transportation Research Board* 1805 (2003), 153.

[15] P. Hall and K. Pain, *The Polycentric Metropolis: Learning from Mega-City Regions in Europe* (London: Earthscan, 2006).

[16] Gabriel Metcalf, "Regional Planning without Regional Government," *SPUR Newsletter* (July 2004).

[17] Ibid.

[18] "National ITS Architecture." http://www.iteris.com/itsarch/ (accessed July 23, 2012).

globalized urbanizing economy, the success of one area depends in a more immediate way than previously on the success of a project in another often not spatially contiguous area. While conventional rail already operates in Portugal, it is hoped the substantial increment in accessibility provided by HSR will support unprecedented regional integration. HSR is a paradigmatic example of a network phenomenon that demands reconsideration of cooperation and control across scales and space.

4.2.2 Cooperative governance and incentives

The theoretical arguments for regionalism satisfy an intuitive sense that a problem should be matched in scale and form by the tools used to address it. The mirroring of networked society by networked governance is conceptually attractive; nevertheless, the actual development of regional cooperation is by no means straightforward. Not all governance changes are formal or mandated from the top-down as in the case of MPOs in the United States. Far more elusive and subtle are the forms of cooperative governance that have been proposed to deal with a wide range of inter-jurisdictional issues in environmental, land use, and transportation planning. True regional government is less common that more voluntary intergovernmental relationships:

> Since at least the 1990s, a general conceptual and practical shift has emerged, away from a "classical," territory-based, hierarchical structure (i.e., "government") and towards more fluid, de-territorialised, network-based, multi-actor structures (i.e., "governance").[19]

Given the voluntary nature of these management structures, incentives for and expected benefits of collaboration must outweigh transaction costs and overcome institutional barriers to cooperation. As Rayle and Zegras discovered in a study of inter-municipal collaboration in Portuguese metropolitan areas, the emergence of collaboration depends on many factors including the legal and institutional environment, prior existence of intergovernmental networks of interaction, and—most relevantly for the case of HSR—on an external trigger "that prompts potential partners to reevaluate their situation and consider collaboration".[20]

Rayle and Zegras also discuss the importance of inter-municipal competition as a constraint on cooperation and postulate the role of higher levels of government in incentivizing

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[19] Lisa Rayle and Christopher Zegras, "The Emergence of Inter-Municipal Collaboration: Evidence from Metropolitan Planning in Portugal," *European Planning Studies* (09/26; 2013/03, 2012), 1-23.

[20] Ibid.

cooperative action. They recommend that the central government disburse funds at the metropolitan level in order to provide a significant enough incentive to overcome the competitive "zero-sum context of metropolitan planning".[21]

The local perspectives reported in the latter part of this chapter reveal a twist on the competition effect: the expected changes in accessibility (and therefore in the competitive landscape) within Portugal may actually motivate cooperation between municipalities. The threat of losing out to Lisbon is beginning to alter expected outcomes of municipal collaboration within the central region of Portugal. In the same way that at the national level Lisbon is seeking to network with its surrounding cities and so become more competitive at an international scale, Leiria and particularly Coimbra are interested in networking at the more regional scale so as to not lose out within the national (and to a more limited degree, international) arena.

4.2.3 Collaborative adaptive management

Parallel to the literature detailing institutional collaboration is a body of work dealing with the benefits and challenges of stakeholder involvement in decision-making processes. "Stakeholder" refers not only to members of the public but to "any group or individual who can affect or is affected by the achievement of the organization's objectives".[22] Recently, ideas of *collaborative adaptive management* have moved stakeholder approaches away from one-time consultation to provisions for ongoing management. The nature of rapidly changing, unstable and "increasingly networked societies," demands a conversion of planning into ongoing cycles of implementation and learning aimed not only at approaching the public interest now, but also capable of evolving to fit changes and provide management into the future.[23] The land-use/transport sector is characterized by long timelines for project development and realization of impacts. Thus, ongoing collaborative management is a particularly salient approach to the involvement of multiple levels of government. Coimbra's urbanization plan is one case of a national entity engaging with local government as an ongoing management partner critical to the

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[21] Ibid.

[22] R. K. Mitchell, B. R. Agle and D. J. Wood, "Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of Who and what really Counts," *The Academy of Management Review* 22, no. 4 (1997), 854.

[23] J. Innes and D. Booher, "Consensus Building and Complex Adaptive Systems – A Framework for Evaluating Collaborative Planning," *APA Journal* 65, no. 4 (1999), 412-423.

success of a much larger endeavor. Chapter 8 considers additional approaches to ongoing management in an inter-jurisdictional planning environment.

4.3 National and local perspectives

The previous section established an analytical framework based primarily on two concepts: *discontinuous regions and cooperative governance*. Given the relationship between transportation and metropolitan form, we wish to understand the implications HSR implementation in Portugal might have for:

- Independent cities brought within viable commuting time of Lisbon, and
- Governance relationships between newly connected cities.

The following study uses stakeholder interviews as its methodology. While undeniably speculative, the perceptions and expectations of decision-makers will guide future decisions related to HSR implementation, and thus the realized benefits (or costs) of a HSR system. Moreover, local knowledge is necessary for properly applying general theory to the specific case of Portuguese HSR. The next section examines national-local interactions and in particular the process for determining station location. Thereafter, sections 4.3.2 and 4.3.3 focus primarily on lessons learned from interviews with local officials in Évora, Leiria, and Coimbra.

4.3.1 National-local interactions and locating the station

Prior to visiting each of the three municipalities, an initial interview was conducted at the Lisbon offices of REFER, the national rail agency charged with planning HSR. Of primary interest here was to ascertain the degree of national-local interaction in the HSR planning process. As part of the formal environmental impact assessment (EIA), municipalities were provided with alternatives for comment. A primary issue at this stage is station location. Not only does a station's proximity to a city's activity center affect the degree of connectivity into the local urban economy, it also—because of expectations about the level of impact—affects the degree to which municipalities feel they should engage in the national HSR planning process.

The national government (REFER) presented Évora with only one possible station location in the EIA, with various alignment differences considered (Figure 4-2). For Leiria, sites to the east and the west of the city were analyzed, with the western site ultimately selected (Figure 4-3). In Coimbra, by contrast, the initial pre-EIA proposals located the station

significantly outside the city. Political pressure altered the proposed location to a site north of the city's two conventional rail stations, in a currently underdeveloped area (Figure 4-4). According to the Menéndez et al. typology presented in Chapter 2, the site would be categorized as an edge location—still accessible for multiple transport modes but with ample development potential.[24,25] In all cases, national policy priorities dictated that stations should have some connection to the conventional rail system.

Figure 4-2 Évora HSR Environmental Impact Study – a single station option and multiple alignments (Source: RAVE[26])

[24] J. M. Menéndez, B. Guiorao and J. M. Coronado, "New High-Speed Rail Lines and Small Cities: Locating the Station," in *The Sustainable City II : Urban Regeneration and Sustainability*, eds. C. A. Brebbia, J. F. Martin-Duque and L. C. Wadhwa, Segovia, Spain ed. (Southampton, UK ; Boston: WIT Press, 2002).

[25] José M. Menéndez, Ana Rivas and Inmaculada Gallego, "Mobility Characteristics of Medium-Distance High-Speed Rail Services," in *Territorial Implication of High Speed Rail: A Spanish Perspective*, ed. José Maria de Ureña (Farnham, Surrey ; Burlington, VT: Ashgate, 2012), 105.

[26] *Ligação Ferroviária De Alta Velocidade Entre Lisboa E Madrid Lote 3B Troço Montemor - Évora: Resumo Não Técnico* (Lisbon: RAVE,[2007b]).

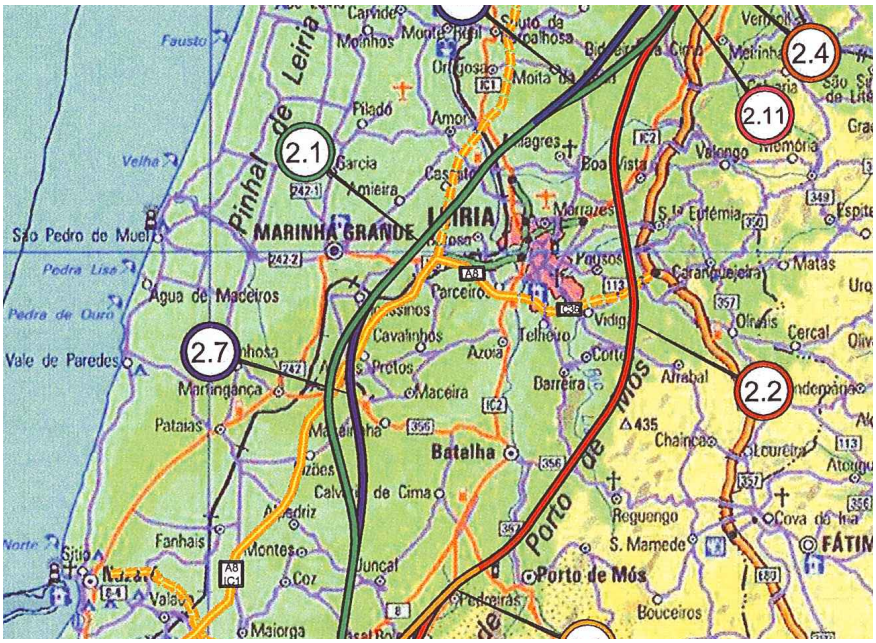

Figure 4-3 Leiria HSR Environmental Impact Study – station options to the east and west (Adapted from RAVE[27])

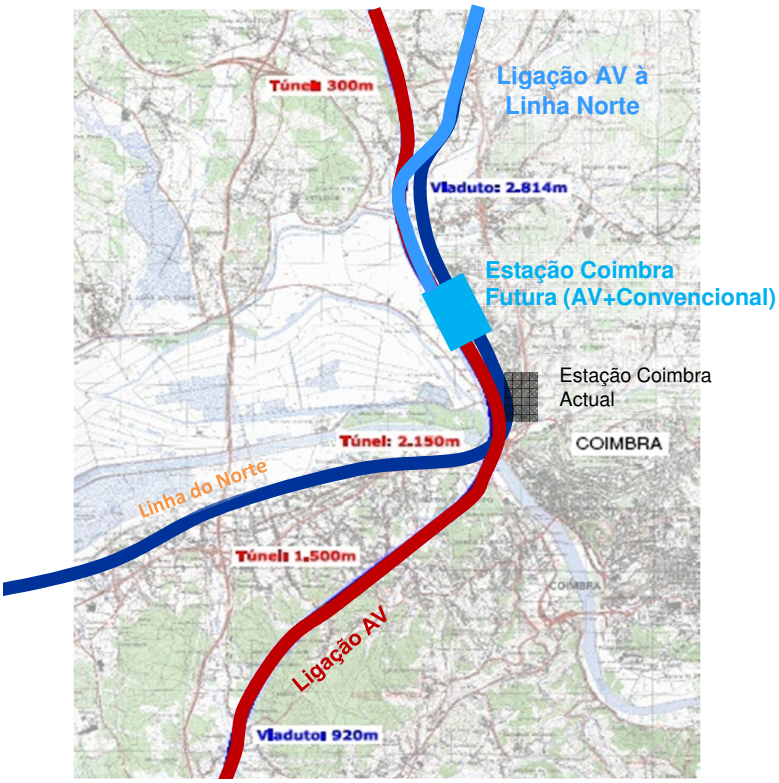

Figure 4-4 Station location in Coimbra, north of existing rail stations (AV=Alta Velocidade or high speed)– relocated in response to local pressure regarding an initial external siting (Source: Lopes[28])

[27] *Fig. 1 Planta De Localizaçao, Resumo Tecnico Estudo Impacte Ambiental: LC1- Leiria*, Vol. 1:500000 (Lisbon: RAVE, 2007a).

Comparing the process across the three cities demonstrates the degree to which smaller cities can be at a disadvantage in terms of advocacy power. Coimbra, as a larger and historically more influential city, was able to pressure the national government for a more central station. Officials in Évora and Leiria, on the other hand, are more inclined towards a 'wait-and-see' planning approach, given their lesser leverage. Still, even with these differences, the three sets of interviews in Évora, Leira, and Coimbra revealed important shared conceptions of how HSR can change regional identities and the demands placed on urban governance. These are discussed in detail below.

4.3.2 HSR commuting and social impacts

Beginning with the effects of HSR on the urban experience, city officials in both Évora and Coimbra independently mentioned new modes of commuting that might emerge or be augmented by the provision of HSR service. In Évora, teaching faculty and senior management professionals were proposed as demographics that might live in Évora and commute to Lisbon for part of the week (or vice versa). According to Arq. Pereira, it is not uncommon for faculty to teach at multiple institutions and therefore have multi-destination commutes (Interview, unpublished data).[29] Similarly, senior management professionals with multiple business locations and/or the flexibility to work from home might use HSR to commute part-time. The planning officials in Évora emphasized the city's quality of life as an asset that might attract people who wish to live in the city and commute into Lisbon.

Interestingly, in the case of Ciudad Real, Spain, "reverse" commuting from Madrid to the smaller city became a relevant phenomenon, especially for education professionals drawn by the research university in Ciudad Real. One third of the commuting via HSR between Madrid and Ciudad Real is towards Ciudad Real. Moreover, as of 2000, a greater percentage of those commuting from Madrid to Ciudad Real had a university degree than did those commuting in the opposite direction.[30] Évora also has a university[31] and so might see similar behavioral responses.

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[28] Isabel Mendes Lopes, "2012-01-09 HSR Project Presentation for Naomi Stein" (Presentation, REFER, 2012).

[29] Interview, Arq. José Manuel Pereira, Director of Land Use Planning and Management and Dr. Nuno Camelo. City of Évora, January 10, 2012.

[30] Ureña et al., *Territorial Implications at National and Regional Scales of High-Speed Rail*, 145

Évora is located in what could be characterized as an idyllic agricultural setting and is famous for its historic city center (Figure 4-5). Its city planners, while excited about HSR, are apprehensive about the social effects of potentially dramatic population change. The city feels strongly about maintaining the strength of its core and for this reason has already turned down one proposal for a new service-industry development in the vicinity of the station, nine kilometers from the city center (Figure 4-6). The project as they saw it would have become an independent entity and thus deliver primarily external benefits. This choice illustrates the development challenges of a non-central station in concrete terms.

Figure 4-5 (a) Évora's residential neighborhoods surrounded by open agricultural land (b) Historic city-center

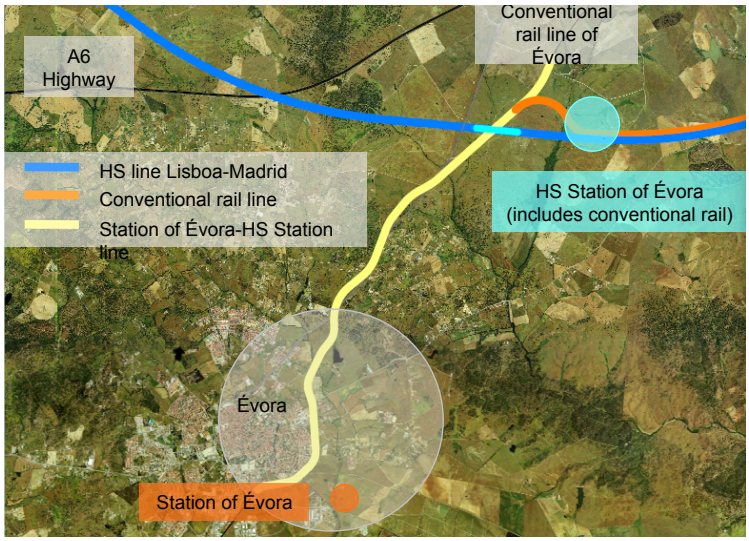

Figure 4-6 Évora's planned external HSR station with conventional rail connection to the city center (Source: RAVE[32])

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[31] "The University of Evora." Innovation Europe: Innovation EU Vol 2-1, http://www.innovationeu.org/news/innovation-eu-vol2-1/0240-the-university-of-evora.html (accessed March 20, 2013).

[32] *The Portuguese High Speed Rail Project* (Presented, Moscow: Rede Ferroviária de Alta Velocidade (RAVE),[2004]).

The perspective on commuting was similar in Coimbra: Because of the university and various health institutions, the city boasts considerable intellectual capital. Unfortunately, much of that knowledge base is lost once students complete their education. Coimbra's greatest expectation with respect to the HSR project and the associated urbanization plan (discussed in 4.3.3) is to retain its knowledge base. At present, many graduates relocate to Lisbon or Porto to find jobs. The city officials want to increase housing supply and develop Coimbra as a residential base for commuting outward. One desirable model would be to have people live in Coimbra and then work a few days a week elsewhere and a few days in the city. This model is most applicable to a specific socioeconomic class (academic, health) that lends itself to part-time commuting. The reasoning, according to city officials, is that Coimbra can provide a more relaxed residential environment (than Lisbon or Porto) while still maintaining easy access by train to the cultural and social aspects of the bigger cities (Interview, Coimbra, unpublished data).[33]

The idea of commuting for part of the week or to multiple destinations is consistent with other research: A recent report cites the fact that "many workers are not required to appear in one office five days a week" as one of the major drivers of increases in super-commuting.[34] Similarly, the POLYNET study, published in 2006 and aimed at defining more closely the concept of polycentricity, revealed the importance of intraregional mobility to the extent that for some professionals, "the nature of their work may make a regular daily commuting pattern impossible."[35]

There is a difference between "super-commuting," or even longer distance business travel by other modes, and regional HSR: HSR commuting would no longer necessarily refer to the tail-end of the distribution of willingness to travel, but rather (assuming adequate station accessibility, a significant assumption) to a set of travel times within the normal range of commuting behavior, even *if* distances are in the range of "super-commuting". It is therefore important when thinking about HSR and its effects on labor-market definition to consider the potential for associated social change. Not all people are equally likely to commute via HSR or

[33] Interview, José Vilela, Director; António José Cardoso, Municipal Director for the Land Use Management; Helena Terêncio, and Fernando Rebelo. City of Coimbra, January 13, 2012.

[34] M. L. Moss and C. Qing, *The Emergence of the "Super-Commuter"* (New York: Rudin Center for Transportation, New York University Wagner School of Public Service,[2012]).

[35] Hall and Pain, *The Polycentric Metropolis: Learning from Mega-City Regions in Europe*

to relocate to smaller connected cities. Demand studies are important not only to predict the use of the transport service, but also to understand the much broader socioeconomic changes that might come with an altered metropolitan region.[36]

Any rearrangement of spatial and economic relationships within a region, while influenced by contemporary forces of globalization and supported by new infrastructure like HSR, nevertheless does not begin with a blank slate. New functional networks are overlaid onto an existing urban landscape.[37] As a result, cities may develop dual identities, simultaneously existing in relative self-sufficiency, with a given labor market structure and socioeconomic base, and as networked entities within a new "discontinuous region." The idea that a city can concurrently perform multiple functions within an urban hierarchy will be further explored in Chapter 6.

Again returning to the much-studied example of Ciudad Real in Spain: the city now combines the characteristics of an isolated small city and of a suburban district. Located 112 miles from Madrid and linked via a 51 minute HSR trip as of 1992, this relatively small city (population 65,703 in 2003) has some of the best-documented small-city-to-large-metropolis commuting via high-speed rail.[38] More notable than the existence of commuting itself is the social differentiation of the "Avelinos," as they are called—from AVE, Alta Velocidad Española. A survey conducted by Garmendia et al. found that households that choose to locate close to the Ciudad Real HSR station tend to be owners rather than renters and are more likely to have children than the city average. The authors attribute this to expanded metropolitan-level location choices; people interested in the Madrid labor market but in less permanent family situations would be more likely to rent and therefore could be accommodated within the contiguous metropolitan area. Families, on the other hand, chose to relocate so that they can afford more space. The survey also revealed that 39% of daily commuters to Madrid were born

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[36] Maddi Garmendia et al., "Urban Residential Development in Isolated Small Cities that are Partially Integrated in Metropolitan Areas by High Speed Train," *European Urban and Regional Studies* 15 (2008), 249-264.

[37] R. C. Kloosterman and S. Musterd, "The Polycentric Urban Region: Towards a Research Agenda," *Urban Studies* 38, no. 4 (2001), 623-633.

[38] Garmendia et al., *Urban Residential Development in Isolated Small Cities that are Partially Integrated in Metropolitan Areas by High Speed Train*, 249-264

outside the province of Ciudad Real.[39] "Avelinos," the new class of HSR commuters, possess partially distinct socio-demographics from the population that predates the introduction of HSR.

In the longer-run, these kinds of changes may have implications for social relations and for the demand profile for public services imposed on a local government. Prior to deployment, the HSR planning process should incorporate awareness of possible social implications and raise questions at the local level about whom the HSR investment is intended to serve. Is it most important to consider convenience factors (e.g. multimodal coordination) that cater to multi-destination business travel? Or perhaps, as officials in Évora and Coimbra hinted at, the points of influence are those that address "residential environment" choice to cater to more diverse and mobile households.[40] In reality, the market for all large-scale infrastructure can (and should) reach across groups. Nevertheless, asking user-oriented questions can guide decisions at the municipal scale and begin to address what it means, in terms of local decisions and everyday experience, to be integrated into a discontinuous region.

4.3.3 Governance and coordination

Next, the municipal interviews in Coimbra and Leiria, along with interviews at REFER, revealed changing views of intergovernmental relationships and the need for coordination. Évora, because of its external proposed station location and relative isolation from neighboring population centers, has less inducement to consider cooperative governance in response to HSR. Coimbra provides an example case in which a national agency (REFER) views a local entity as an indispensible partner in the development of a large-scale system. As discussed earlier, the economic benefits of HSR depend very much on local development. Moreover, land use planning requires a long timeline and ongoing management. For this reason, REFER and the municipality of Coimbra have entered into a formal cooperative protocol. Together they are managing a 100-hectare (247-acre) urbanization plan to develop the HSR station area into a new city gateway.

Under this plan, HSR is but one piece of a multimodal hub and new urbanization area that will serve both the city and the region. Coimbra's new hub would integrate conventional rail, a planned new tram system (also currently suspended), taxis, and buses. The Coimbra

[39] Ibid.

[40] Kloosterman and Musterd, *The Polycentric Urban Region: Towards a Research Agenda*, 623-633

housing market is high-priced; the presence of high-income professions (doctors, nurses, teachers, engineers, upper-level state employees) along with a sizeable student population—the majority of whom are from outside the city—pushes prices up for the existing supply of housing and thus contributes to the development potential of the station area (Interview, REFER, unpublished data).[41] Involvement of REFER in local planning was actually a way to reduce transaction costs: the overall project will still need to get approval from all involved parties but REFER offers extra management and financial resources to speed up the overall planning process (Interview, Azevado, unpublished data).[42]

The most interesting aspect of this national-local cooperation is that it shows signs of creating spillover effects beyond the single-issue of HSR. Under the current financial situation, there are three possible scenarios for the urban plan and station in Coimbra:

1) A national HSR public-private partnership (PPP) goes forward as initially planned by REFER with the Coimbra station plan embedded in it.

2) An HSR PPP goes forward but the station is not included and is instead built as a separate project under REFER's full control. This approach would make detailed collaboration between REFER and Coimbra easier.

3) No HSR PPP materializes. Planning of the station and development of the urban plan continues until funding can be procured. The HSR aspects are left out of the intermodal station (tracks, escalators, etc.) but without precluding their future addition.

Although the HSR project in Portugal has been suspended, the urbanization plan in Coimbra is ongoing and considered important enough to continue (at least in planning) regardless of the HSR situation. The joint process established ensures some level of bi-directional 'future-proofing.' The national HSR plans are designed so as to incorporate local plans and objectives. At the same time shorter-term station planning in Coimbra is coordinated with long-term HSR plans so as to ensure decisions aren't made that would block HSR implementation later on (or make it significantly more expensive). Nevertheless, there are constraints associated with planning processes that span multiple scales of governance. In this case, local action must wait

[41] Interview, Isabel Lopes, Eduardo Pires, and Daniel Ferreira, REFER. Lisbon. January 10, 2012.
[42] Interview, Rafael António Robalo Ribeiro de Azevado, REFER. Lisbon. January 13, 2012.

for the realization of national policy. Many years of anticipation of a new station for Coimbra have preempted more incremental improvements to the existing rail stations, with the result that the current stations are not consistent with Coimbra's position as Portugal's third-largest city. Coordination between national and local entities regarding HSR planning will be further considered in Chapter 8, using the UK as a comparative case.

In addition to the entry of a national agency into a local planning process that extends beyond the single issue of HSR, representatives from both Leiria and Coimbra cited HSR as a reason to reconsider institutional relationships within the central region of Portugal. In both cases the double-edged sword of increased accessibility via HSR is motivating changing attitudes. While shorter travel times from Lisbon mean that Coimbra and Leiria might attract more visitors, the compressed trip time also runs the risk of eliminating overnight stays. City officials in Coimbra and Leiria recognize that their cities' competitiveness within the tourism and business tourism industry depends in part on their ability to be part of multi-day multi-destination trips. Otherwise, business and leisure travelers based in Lisbon may choose to take advantage of reduced travel times and make only day trips to Coimbra.

In Leiria the opening of a new highway connecting to nearby Fatimah, a major pilgrimage site, and the possibility of HSR connectivity are reasons, according to city planners, that Leiria might rethink its currently competitive relationship with Fatimah. Similarly Coimbra is considering a shift away from regional competition to a more cooperative approach. A regional association of tourism was previously established but Coimbra chose not to become a member. The organization was set up by the central government and from Coimbra's point of view was too large, had unsuitable sub-regions, and did not pay adequate attention to Coimbra. Objecting to the headquarters' location in Aveiro, the city refused to participate and created its own authority. Now, while there are still two authorities, the relationship between them is more relaxed because of changed attitudes towards regional cooperation. The municipal government understands that collaboration is needed and that they have to be able to market the whole region, not just the city, in order to compete (Interviews, Coimbra and Leiria 2012).[43,44]

[43] Interview, José Vilela, Director; António José Cardoso, Municipal Director for the Land Use Management; Helena Terêncio, and Fernando Rebelo. City of Coimbra.

[44] Interview, Dra. Sandra Cadima, head of the Planning, Management and Land Strategy Division; Maria João C.G. Neto de Vasconcelos, Técnica Superior, DPGU, DIPOET. City of Leiria, January 13, 2012.

Coimbra and Leiria are additionally reconsidering regional mobility planning in response to the external catalyst of HSR. Leiria and the adjacent community of Marinha Grande are 10-12 minutes apart by car and interact extensively, effectively sharing their labor markets. The municipalities have for many years discussed an inter-municipal transportation plan. Planning staff in Leiria think that HSR could increase expected benefits from joint planning enough to overcome the transaction costs of inter-municipal cooperation. HSR could be the catalyst that finally pushes the two municipalities to join in long-considered cooperative efforts. Similarly, Coimbra is eager to have a regional transport authority to define rules and coordinate both public and private transport operators. Current trends of suburbanization and increased inter-city commuting within the region around Coimbra mean that the city is already struggling with inadequate regional mobility planning (Interview, SMTUC, unpublished data).[45] Because the catchment area of a HSR station would be larger than the municipality, the introduction of HSR service would magnify this existing regional gap. A proposal for a regional transport authority is included in the city's formal strategic plan document, as the creation of such a body would depend on the central government for definition and authorization.

Chapters 7 and 8 continue this discussion by comparing the institutional contexts and mechanisms available for inter-jurisdictional planning in Coimbra and Birmingham, UK.

4.4 Conclusions

4.4.1 Altered local expectations

There is much yet to study in the relationship between HSR, discontinuous regions, and governance at various levels. The interview-based findings presented here reveal three primary ways in which HSR can alter local expectations and perceptions:

First, inter-scalar collaborative planning: The simultaneously local and national/global relevance of HSR creates conditions in which local and national planning entities choose to partner in ongoing planning efforts (i.e. the Coimbra Urbanization Plan).

Second, new models of commuting: Because of cost, the higher levels of intercity accessibility offered by HSR are not expected by local officials to be uniformly relevant to all their citizens. Rather, HSR commuting is more likely to cater to a few particular demographics,

[45] Interview, Luis Santos and Ricardo Grade, SMTUC.

namely skilled business, education, and health professionals. Public officials within both Évora and Coimbra anticipate new models of commuting in which HSR enables multi-destination commuting or work patterns that only require commuting a few times per week.

Third and most interestingly for considerations of a possible new discontinuous region, HSR may provide the incentive to rethink inter-municipal regional cooperation (Figure 4-7): Increased accessibility from HSR can be a double-edged sword. Both Leiria and Coimbra officials cited the risk of losing overnight tourism and business stays because of shorter travel times to Lisbon. The changing competitive landscape may, according these officials, incentivize a shift from competitive inter-municipal relationships to more cooperative planning within the Centro Region of Portugal.

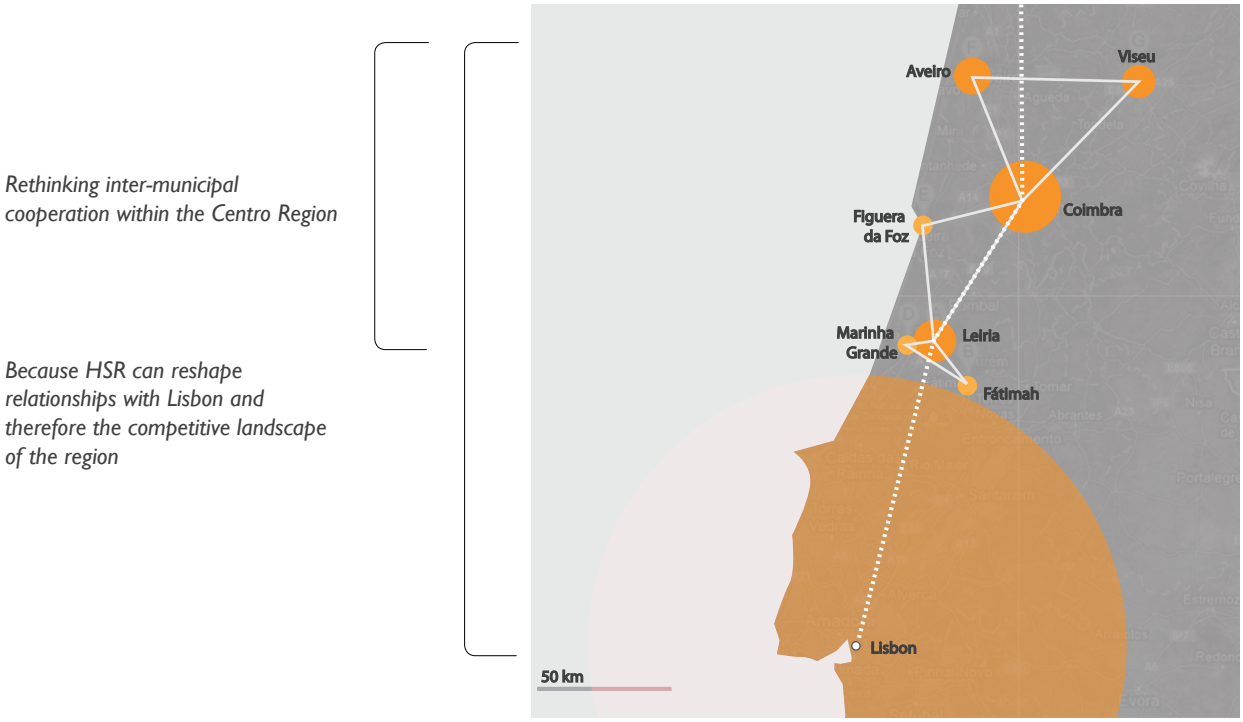


Figure 4-7 Rethinking inter-municipal relationships within the smaller Centro region, because of connectivity to Lisbon (circles are approximately to scale by city employment). Source: author.

At first blush this shift seems to direct our planning attention towards a regional scale smaller than that of the posited discontinuous region. Still, there may be tools or approaches that can be shared by smaller HSR cities across a discontinuous region, by virtue of the common condition of receiving new HSR service. Such approaches are examined in the UK case study in

Chapter 8, where we consider formal mechanisms for integrating local concerns into the national transportation planning process.

4.4.2 The need for clarified objectives and expectations

HSR can serve as a catalyst for governments to rethink regional identity, intergovernmental relationships, and competitive positioning. From an intentional policy perspective, however, our understanding must develop beyond the descriptive relationship posited thus far: transport changes regional form and form can change attitudes towards governance, which can in turn continue to redefine the spatial and functional organization of a region. For these reorganizations to happen in any intentional manner, it is necessary to clarify at the outset what might be considered reasonable in terms of expectations. This need will guide our analysis in the remainder of this thesis.

If new relationships between cities result from HSR investment, these will necessarily be overlaid on existing spatial, governmental, and economic configurations of cities and towns. Local context and therefore local knowledge are important to the "design process" of HSR. The global importance of information-based network economies makes it tempting to focus on purely functional definitions of regions, as defined by flows of people and information. A governance perspective, however, reminds us that space matters because it is the unit of control. Functional relationships that define economic networks or labor markets are inherently fluid and semi-de-territorialized; one cannot simply define a higher level of government to make closer to "optimal decisions" (even assuming there are clear definitions of optimality) because the scale and boundaries of the functional economic unit are not fixed. Moreover, economic networks are layered and differentiated across sectors and across scales. One city may simultaneously exist within regional and international networks and each role may possess a degree of mutual independence.[46] Thus, *governance* and the creation of relationships between units and levels of *government* remains a necessity. In order for cooperation to emerge, each government entity needs to more fully understand their expected outcomes and those of their prospective partners so that they may seek common ground.

[46] Hall and Pain, *The Polycentric Metropolis: Learning from Mega-City Regions in Europe*

In some ways HSR is unique: it enables a continuity of daily lived-experience across geographic distances which are greater than those that could be integrated by the automobile or conventional rail, in effect creating social and economic relationships within discontinuous regions. This discontinuity could enable intentional preservation of the ecologically valuable interstitial spaces between urbanized areas. Moreover, HSR can create a higher degree of interdependence between the areas it serves and thus may provide the impetus for more cooperative action. With the stakes set high enough, national-local and local-local cooperation emerge as promising tools for guiding HSR-supportive policies.

In other ways, the magnitude of HSR as an environmental change simply highlights existing trends (sprawling land use patterns, increased inter-city commuting) and magnifies already relevant gaps in the Portuguese planning process: the challenges of coordinating inter-city transport with intra-city service or the inadequate connections between spatial and mobility planning. Next, in chapter 5, we delve more deeply into current conditions, seeking knowledge for the future by learning from Portugal's present and past.

To clarify goals and expected outcomes for HSR at each level of government will also require further development and refinement of theory: What is the nature of relationships between cities within a region connected by HSR, along the spectrum from hierarchy to equality? The results of the POLYNET study state unequivocally that dominant cities still matter and have a unique role to play as gateways into the global economy.[47] If that is so, what does it mean for how secondary cities like Évora, Leiria, and Coimbra establish goals for HSR or define their relationship to Lisbon? What differences might be expected for a dominant regional city such as Coimbra relative to the others?

Chapter 6 will investigate the underlying logic behind "polycentricity" as a contemporary spatial phenomenon in order clarify a framework for HSR's spatial objectives, across multiple geographic scales. Before returning to more generalized theory, however, Chapter 5 will take a field-study based approach to examining the specific situation of rail commuting in Portugal. The chapter will detail variables that are relevant to the experience of rail commuting and will highlight the risks of failing to achieve proper inter-jurisdictional relationships in the course of HSR planning and implementation.

[47] Ibid.

5 Current Rail Commuter Cities in Portugal

Chapter 4 focused on perceptions and expectations related to the future implementation of HSR in Portugal. It took for granted to some extent the need for inter-jurisdictional planning, without examining in detail what and who needs to be coordinated, and why. This chapter takes a step back to look more retrospectively at cities already connected to Lisbon by rail lines that are currently used for daily commuting. Changing the scope of analysis from the prior regional or even megaregional perspective, we now examine the urban form and human experience aspects of two rail commuter cities, Cascais and Santarém.

While much can be learned from the attitudes of local officials regarding the *planned* HSR system in Portugal, it is also important to learn from current and past rail-oriented urban development in Portugal, as a benchmark for future expectations. Opinions of public officials engaged in active project planning can have a positive expectation bias and therefore are not guaranteed to be the best way of uncovering potential shortcomings in the HSR plans.

This section therefore is based on site visits to two cities with current rail commuting to Lisbon. The cities were selected intentionally to demonstrate a degree of contrast: Cascais is part of the contiguous Lisbon metropolitan area and served by the "Urbano" commuter rail (Figure 5-1). Santarém, on the other hand, is served by conventional rail and is not part of the contiguous urbanized area of the Lisbon metropolitan area (Figure 5-2). The degree to which each city is integrated into the Lisbon labor market is also, unsurprisingly, quite different but we need to more deeply understand this difference (Figure 5-3).

5.1 Rail service characteristics and alternate competitive modes for Lisbon commuting

While the two cities have similar rail travel times to Lisbon, the level of service according to other relevant service variables previously identified in the literature review (Section 2.1) is significantly different (Table 5-1). Cascais benefits from frequent and regular service that uses the same electronic payment system as the Lisbon metro system, the Viva Pass. Fares are upwards of three times less expensive for the suburban service to Cascais than the conventional train service to Santarém. Trip planning is made simple by the combined effect of integrated ticketing, regular headways, and high frequencies of the Urbano service between

Cascais and Lisbon. Not only is it easy to select a specific schedule trip, it is also easy to alter one's plans without consulting complex timetables. In contrast, Santarém is served by three different conventional rail services with uneven headways; in order of increasing speed, they are the Regional, Intercidades(IC), and Alfa Pendular(AP) services, each with their own fare structure.

In each city the most competitive alternate mode for travel to Lisbon is the automobile. Driving from Cascais to Lisbon takes between twenty-five and thirty minutes plus, depending on traffic. Driving from Santarém is closer to fifty minutes or an hour.[1] Despite that, the mode split for commuting to Lisbon by car in 2001 was essentially the same in the two cities (51.1% for Cascais and 51.9% for Santarém).[2]

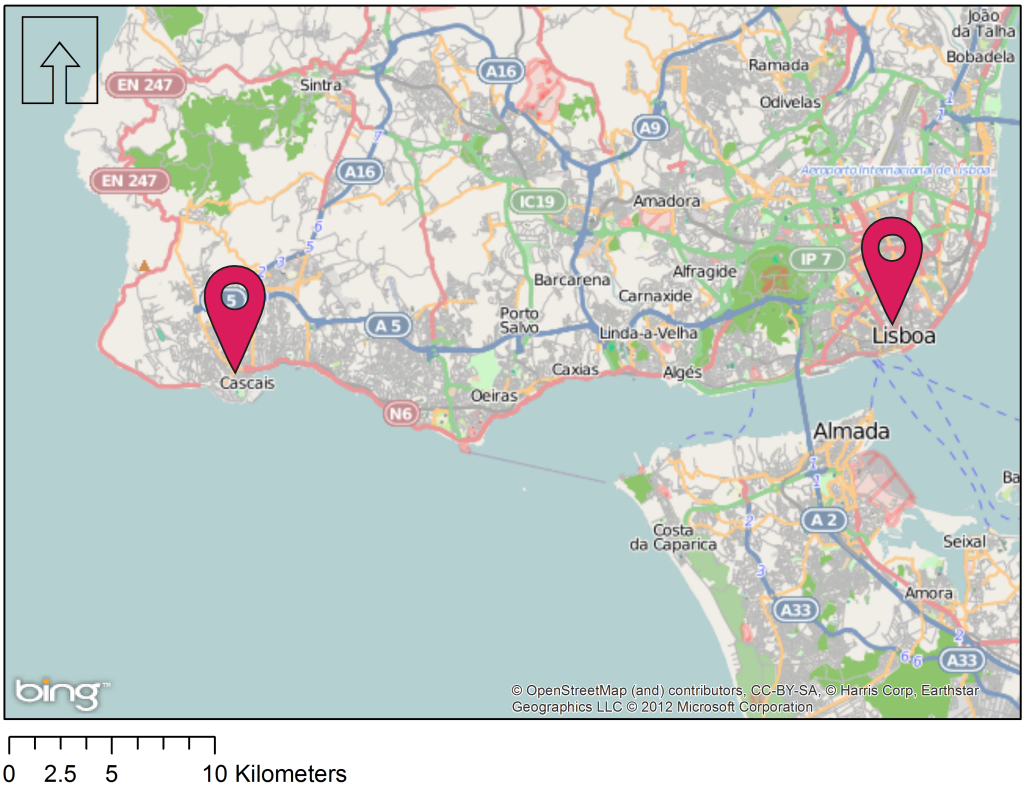


Figure 5-1 Lisbon and Cascais (Source: Author, base map from Bing[3])

[1] Calculated with Google Maps Directions. https://maps.google.com/ (accessed March 21, 2013).

[2] Data source: Census 2001(Instituto Nacional de Estatística, INE - http://www.ine.pt/); vehicular travel includes both 'Car – Driver' and 'Car – Passenger.'

[3] "Bing Maps Road." Accessed via ESRI ArcGIS.

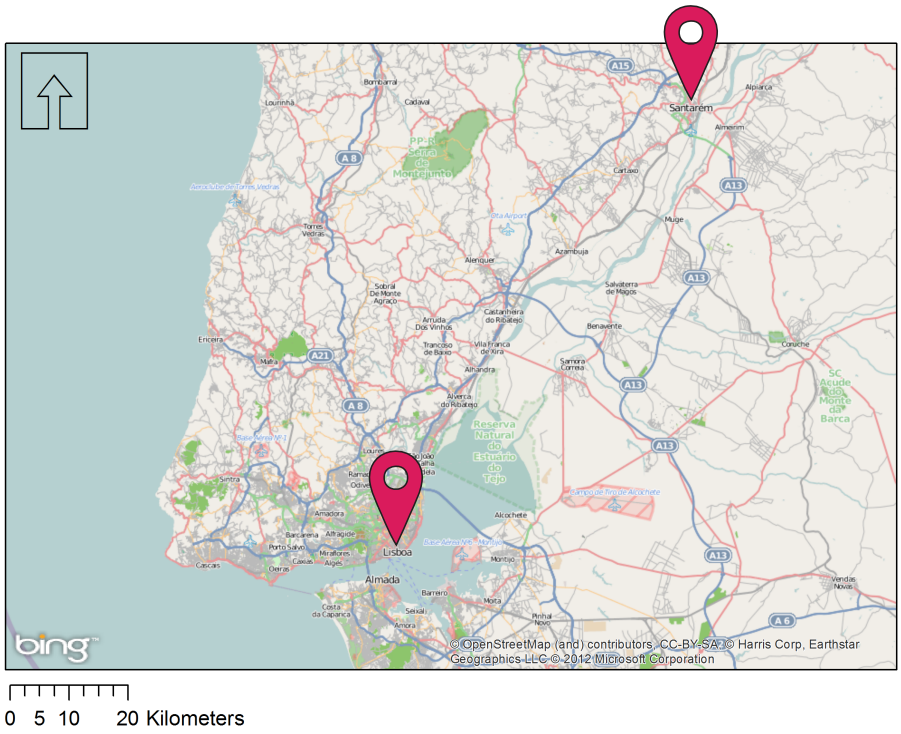


Figure 5-2 Lisbon and Santarém (Source: Author, base map from Bing[4])

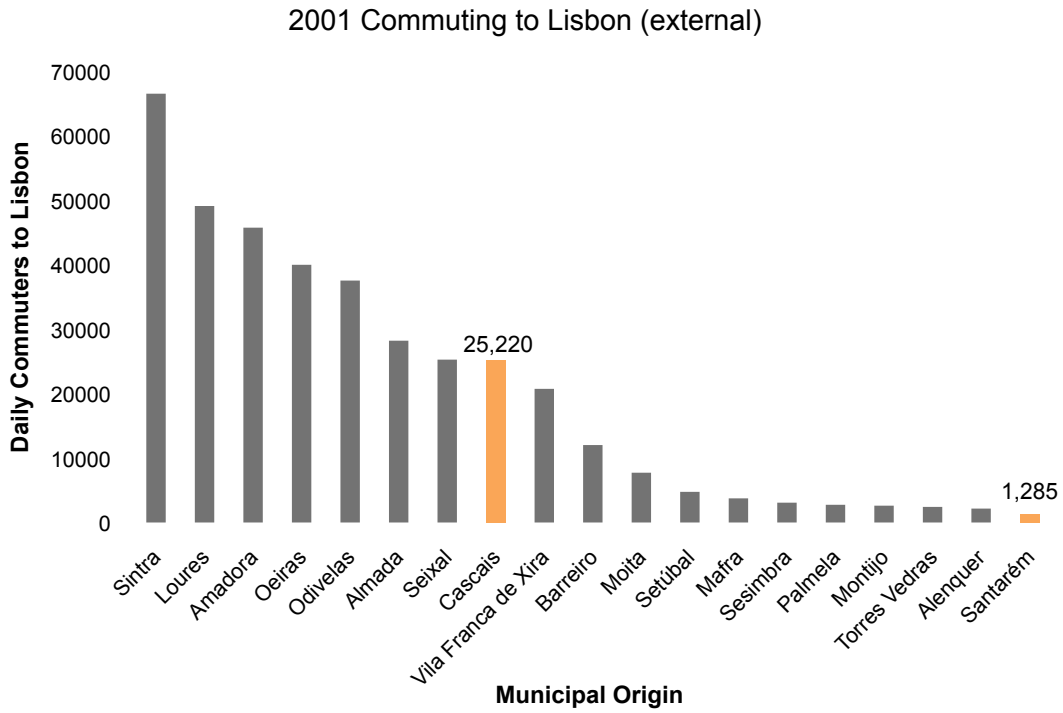


Figure 5-3 Commuting to Lisbon from outside (Source: Author, data from 2001 Census, INE)

[4] "Bing Maps Road." Accessed via ESRI ArcGIS.

Table 5-1 Rail Commuting Cities: Cascais and Santarém (Source: Author, data from 2001 Census, INE and from CP timetables[5])

	Cascais	Santarém
Demographics and Lisbon Commuting		
Distance from Lisbon	30 km	90 km
Number of daily commuters to Lisbon	25,220 (15% of 2001 population)	1,285 (2% of 2001 population)
Mode Split to Lisbon (Vehicular/Bus/Rail)	51.1% / 2.8% / 44.3%	51.9% / 11.2% / 32.3%
Percent of Lisbon Employment	3.7%	0.2%
Population (2011)	198,262	60,720
Population growth since 2001	20%	-3%
Commuter Service		
Rail Service Description	CP Urbano: Linha de Cascais from Cais do Sodré (Linha Verde, Metro Lisboa)	Regional, Intercidades (IC), and Alfa Pendular (AP)
Trains per day	69 Inbound (to Libson)	34 Inbound (only 2 Alfa Pendular)
Regular headways?	YES	NO
Travel Time by Rail	40 minutes	30-60 minutes, depending
Cost one-way	€ 1.80 on viva pass	€6,00 regional; € 11,50 IC; €16,50 AP
Fare integration	Viva Pass (integrated with Lisbon)	None
Commuter rates	Zone 3: € 45.10 (30-day)	15% discounts available to businesses with a minimum annual usage for IC and AP services[6]

5.2 Station location and intermodal connectivity

Site visits conducted in October 2012[7] reveal a number of striking differences between these cities in their relationship to their respective rail stations (summarized in Table 5-2). Cascais has a city-center station with easy access by modes other than the personal automobile, including walking, free city bicycles, taxis, and both tourist and local buses with regular ten to

[5] "Comboios De Portugal." CP, http://cp.pt/ (accessed May 3, 2013).

[6] "CP/Empresas." Comboios de Portugal, http://cp.pt/cp/displayPage.do?vgnextoid=5b4a9821a95aa110VgnVCM1000007b01a8c0RCRD (accessed May 6, 2013).

[7] Figure 5-4-Figure 5-7 show the GPS tracked paths of my site visits and corresponding annotated photo documentation. Certain photos are keyed to numbered points along the GPS paths.

fifteen-minute headways. Adjacent commercial development (the Cascais Villa Shopping Center) is advertised within the station and both tourist and commuting information is easily accessible in passenger arrival areas. The station parking lot advertises discounted commuter rates for those also using the train. The historic center of the city surrounds the rail station (Figure 5-4). Santarém, on the other hand, has an external rail station located 1.6 km (straight-line distance) from the city's central bus station downtown. Access by bus requires a 3.8 km bus path up a mountain. The Santarém station is completely divorced from the primary urban areas of the city (Figure 5-6); a single strip of older development stands across the street from the station and access by walking or biking to the city center is not practical. There is bus service into town with average headways of 20 minutes but the scheduled headways are irregular due to overlapping service from multiple bus routes, making the system less user-friendly.

The external location of Santarém's rail station severely limits its influence on both the location of new development and on the city's symbolic identity. In Cascais, high-quality housing is located within a kilometer of the rail station, and even the newest wave of development is located in an area with ample transit access to the station (Figure 5-5). Santarém, on the other hand, shows symptoms of city-center disinvestment and suburban sprawl (Figure 5-7). The rail station in Cascais serves as a gateway to the city; tourist signs are located immediately adjacent to the station (Figure 5-5). In contrast, Santarém's central bus station—not the rail station—is located in the city center, close to city hall and a large new park constructed over a municipal parking garage. The bus station serves as a hub for regional mobility, with both local and longer-distance buses arriving and departing frequently. Even more telling is the location of a new monument dedicated in 2006 to commemorate Santarém's role in the Carnation Revolution[8]: It is located adjacent to an (also new) entry arch, not near the external and minimally relevant rail station, but at the top of a hill on the road coming from a major highway interchange (Figure 5-7). Tellingly, the symbolic entrance of the city is auto-oriented. Additionally, a mixed-use development was recently constructed in the same area thus signaling that new development is attracted to the side of the city closer to the highway entrance.

[8] The Carnation Revolution on April 25, 1974 marked the end of the Salazar dictatorship.

Table 5-2 Rail commuting cities – summary of station connectivity and station-area development

	Cascais	Santarém
Station Connectivity		
Transit at station	Tourist (10-15 min headway) and municipal buses	Bus from train station into town (20 minute average headway but no consistency)
Parking - availability and cost	Yes: Parking only clients - 4 €/day or 55.95 €/month; Train clients - 3 €/day or 33 €/month (subject to waiting list)	€ 2.50 /day. For monthly-differentiated prices, consult with attendant.
Other visible access modes	Taxi stand, information about free bike rentals	None
Availability of Information	Ticket office, signage, digital signs with train departure times	Minimal - ticket office
Station Area Development		
Distance from City Center	None (0.6 km from City Hall)	1.6 km straight-line to Central Bus Station; 3.8 km bus path up mountain
Street Frontage/Continuity of Urban Form	Across the street from city center	Single strip of development across from station
Adjacent Commercial/Retail	Cacais Villa Shopping Center	None
Station Amenities	Ticket office, parking, snack bar/food with sit-down area, ATM Machine, restrooms	Ticket office, parking, snack bar, restrooms
Pedestrian/Bike Access	Good - urban center	None to city center

CITY-CENTER BUS STATION (002)

TRAIN STATION WITH EASILY ACCESSIBLE INFORMATION

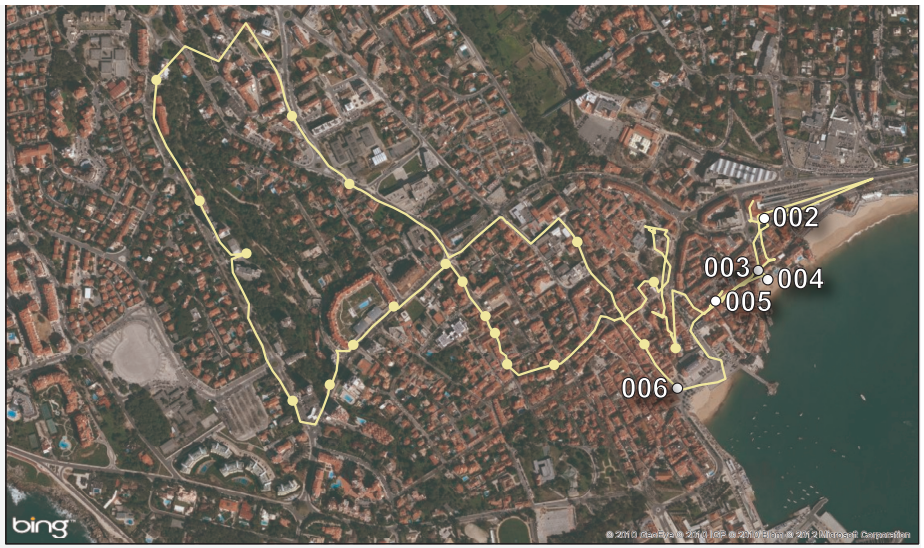
DIRECT CONNECTIONS TO URBAN LIFE

TRANSIT CONNECTIVITY IMMEDIATELY OUTSIDE STATION

ADJACENT TO THE HISTORIC CITY CENTER

TOURIST SIGNS LOCATED ADJACENT TO STATION

Cascais, Portugal - Observations (Oct 29, 2012)



HISTORIC CITY CENTER (003-006)

CITY HALL SQUARE AND DISTINCTIVE PAVERS

Figure 5-4 Observations – Cascais, Portugal. Number labels refer to numbered points along the GPS path (Source: Author).

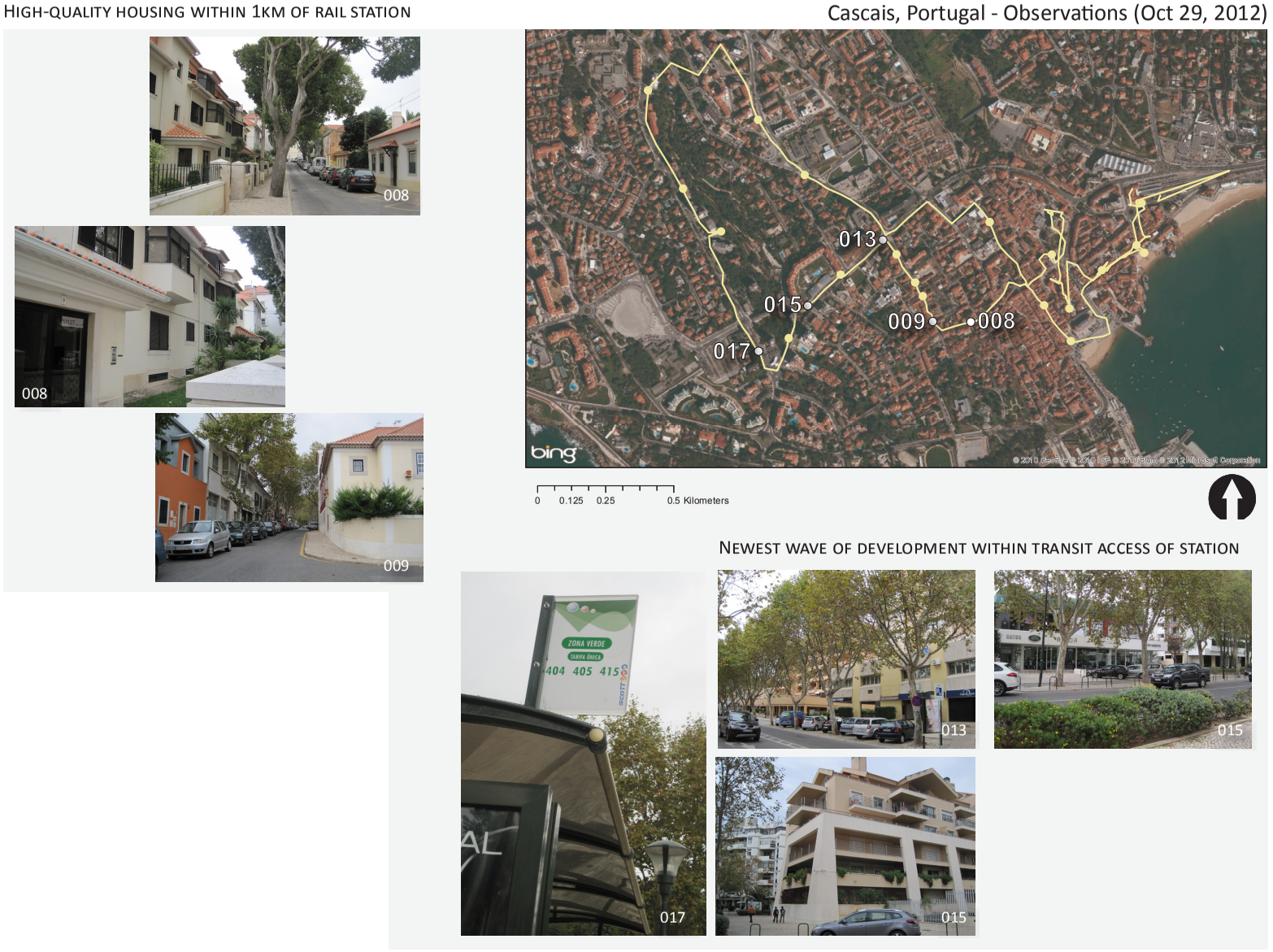


Figure 5-5 Observations – Cascais, Portugal (continued). Number labels refer to numbered points along the GPS path (Source: Author).

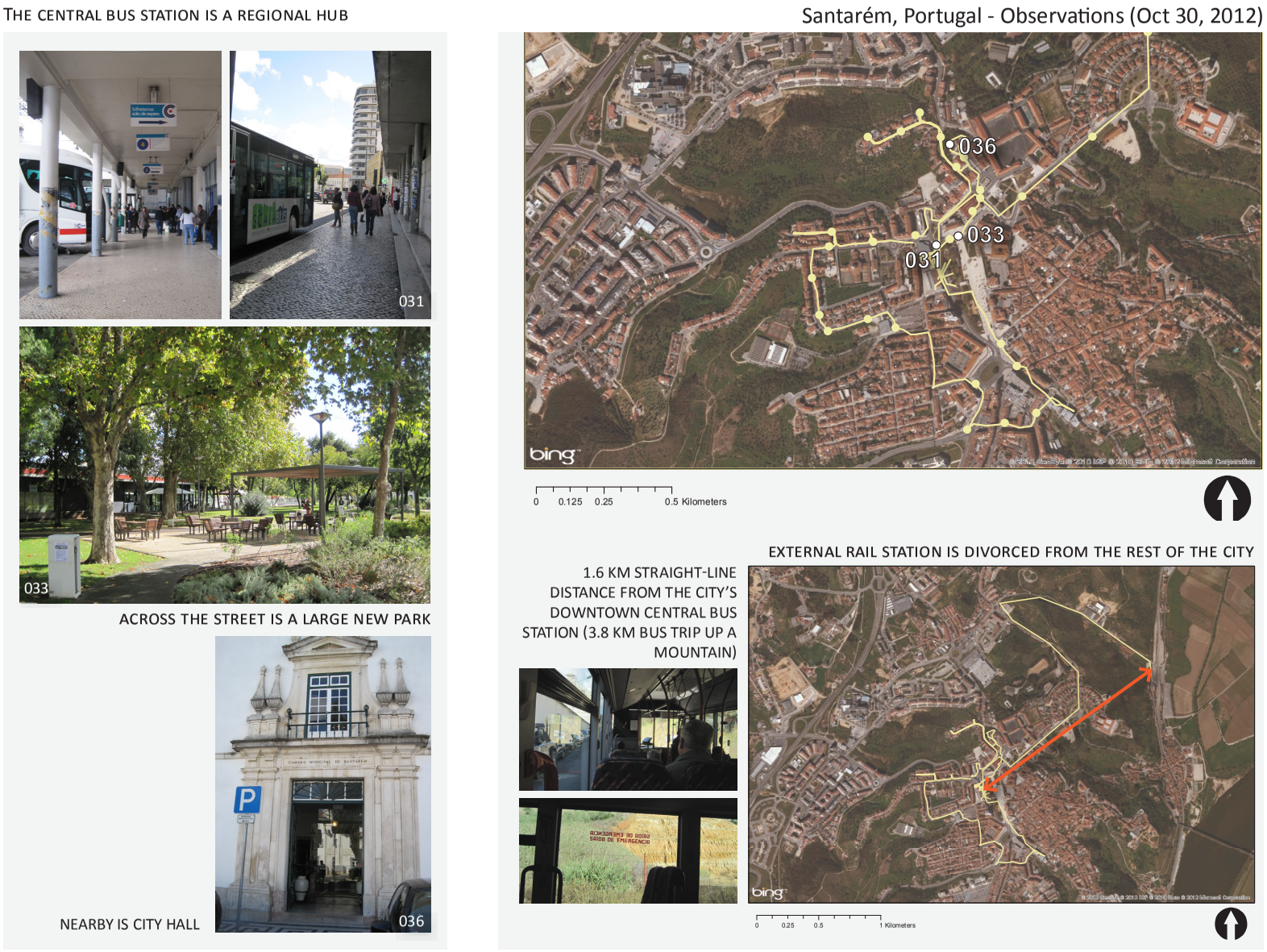


Figure 5-6 Observations – Santarém, Portugal. Number labels refer to numbered points along the GPS path (Source: Author).

CITY-CENTER DISINVESTMENT AND SUBURBAN SPRAWL

CENTRAL DISINVESTMENT IS JUXTAPOSED WITH SPRAWLING NEW DEVELOPMENT IN THE VALLEY BELOW

Santarém, Portugal - Observations (Oct 30, 2012)

NEW DEVELOPMENT AND THE CITY'S SYMBOLIC GATEWAY ARE ORIENTED TOWARDS THE ENTRANCE FROM THE HIGHWAY AND NOT TOWARDS THE RAIL STATION

Figure 5-7 Observations – Santarém, Portugal (continued). Number labels refer to numbered points along the GPS path (Source: Author).

5.3 General observations and resulting expectation for HSR in Portugal

The comparative study of Cascais and Santarém reveal a number of insights into patterns of urban development in rail-commuter cities. These cases should provide some guidance for what to expect or be concerned with at the urban level in the implementation of Portuguese HSR.

We begin with a few comments addressing the context of growth in these two cities: First, history matters. The Santarém city-region developed in the auto-era while Cascais experienced an earlier wave of growth in the beginning of the 19th century when the Portuguese royalty chose it as a vacation location.[9] Second, the possible impact of HSR on development needs to be understood within the context of general trends in sprawl and increased interconnectivity in city-regions. Greenfield development is almost always easier and therefore more attractive to private developers. In the same way that external stations are attractive because they avoid costs associated with construction in an already built-up area, general development is also often easier (in the short term) on undeveloped land. Operation costs over the lifetime of expanded infrastructure do make the total costs of greenfield growth much greater. These costs, however, are born by the public sector and the citizens and is not perceived as immediately relevant by private investors or public officials interested in revenue from new construction.[10]

Because it is easier to expand than to reinvest, and because entirely new development in most cases brings revenue to a small number of landholders (as opposed to the aggregate benefit gained by many small owners from urban infill or reinvestment) thereby creating powerful political advocates, city-center locations need other qualities to be competitive with more suburban locations. In big metropolitan areas like Lisbon the benefits of agglomeration economies—clustering of important firms, labor pooling, and high quality local transportation and urban quality—can be enough to tip the balance in favor of more urban locations. For smaller cities, these forces alone may not be enough.

The contrast between Santarém and Cascais suggests that a central rail station can help overcome obstacles to infill development in central locations. Santarém's external rail station

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[9] "Cascais History." Cascais Villa, http://cascaisvilla.net/cascais-2/cascais-history/ (accessed December 19, 2012).

[10] *Curbside Chat: A Candid Talk about the Future of America's Cities, Towns and Neighborhoods* (Brainerd: StrongTowns.org,[2011]).

adds no more value to the historic center of the city, which is currently experiencing disinvestment, than to other parts of the municipality. Investment seems oriented towards areas more accessible by automobile travel. The municipality of Cascais on the other hand clearly sees investment in the historic center as a good return on investment. For example they have installed distinctive pavers (Figure 5-4), tourist information kiosks, and parking meters. This decision to invest in the core is supported by the high level of accessibility provided by the central rail station.

Admittedly, there are many other factors at work. Cascais is one of the wealthiest municipalities in the country and so has generally high property investment. Still, absent severely constrained land markets driving growth in entirely new urban areas, it is unlikely an external rail station can be used to support compact urban growth.

This leads us to what might be called "The Paradox of Sustainability" embedded in certain planning decisions in Portugal: Environmental regulations (limiting noise, etc.) drive away infill development and centrally located rail stations.[11] This in turn negatively impacts global sustainability goals that try to limit energy consumption from access modes (i.e. walking to the station rather than driving) and the built environment (more compact development as opposed to sprawl). Based on the cases of Cascais and Santarém, and on other HSR literature,[12,13,14] it can be concluded that station centrality really does matter. This means that the plans for external stations in Leiria and Évora are worrisome and likely to hinder the ability of HSR to achieve its intended agenda of encouraging more sustainable development patterns. As discussed in Chapter 4, Évora has already faced proposals for greenfield development around the planned external HSR station. Whether a municipality looking for revenue from new development can continue to resist greenfield construction is a standing question. The

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11 Credit for this phrase goes to João de Abreu e Silva, Professor, Instituto Superior Técnico, Lisbon.

12 Paul Lewis, "Planning for a Regional Rail System: Analysis of High Speed and High Quality Rail in the Basque Region" (S.M. in Transportation, Massachusetts Institute of Technology. Dept. of Civil and Environmental Engineering.), 2011.

13 Matt Nichols, *Policy Brief - Planning High Speed Rail Stations for Sustainable Urban Development: European Case Studies* (Washington, DC: Comparative Domestic Policy Program, The German Marshall Fund of the United States,[2011]).

14 J. M. Menéndez, B. Guiorao and J. M. Coronado, "New High-Speed Rail Lines and Small Cities: Locating the Station," in *The Sustainable City II : Urban Regeneration and Sustainability*, eds. C. A. Brebbia, J. F. Martin-Duque and L. C. Wadhwa, Segovia, Spain ed. (Southampton, UK ; Boston: WIT Press, 2002).

challenging realities of an external station will, in all likelihood, act in contradiction to policy goals of improving on current patterns of Portuguese development.

5.4 HSR, the user experience, and the importance of station-areas

Were environmental sustainability to be deemphasized, there are still strong economic development and regional equity arguments for more central station locations. A city is most likely to benefit from new HSR if it its connectivity enables two-way interactions with other cities—particularly with a major metropolis located less than one hour away. Based on evidence from China, Zheng and Kahn argue that secondary cities stand to gain much from participation in a two-fold improved matching process: first, a matching between residential locations in less expensive and less congested cities and jobs in larger metropolis labor markets and second, a matching between various firm functions and the different forms of accessibility and proximity offered across a region integrated by HSR. HSR, they claim, can "encourage firm fragmentation and firm sorting depending on their idiosyncratic demand for megacity access."[15] For example, a company may maintain its headquarters in a major city while other activities are allowed to disperse to cheaper locations.[16]

Cascais and Santarém were initially selected for analysis because of the existence of inbound rail commuter traffic to Lisbon. Both cities, however, are also clearly interested in being accessible *from* Lisbon, most visibly for tourism but likely for business and social reasons as well. Similarly, the expectations of local officials discussed in Chapter 4 highlight the potential for tourism and business tourism trips to secondary cities in addition to daily or part-of-the-week commuting in both directions. Station-area plans in Coimbra, Portugal and Birmingham, UK (the latter discussed further in Chapters 7 and 8) incorporate plans for new service industry clusters. Therefore, it is relevant at this point to broaden our perspective beyond the single purpose of daily commuting. Instead, a useful lens is one that distinguishes between the experiences of "origin" and "destination" users.

The transition between consideration of current rail and future HSR in Portugal also requires acknowledgment of a number of aspects that are particular to transport-enabled

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[15] Siqi Zheng and Matthew E. Kahn, "China's Bullet Trains Facilitate Market Integration and Mitigate the Cost of Megacity Growth," *PNAS Early Edition* (2013), 1-6.

[16] Ibid.

integration within a *discontinuous region*. While in the case of Cascais and Santarém, conventional rail is simply another mode in competition with the completely feasible use of a personal automobile, in the case of a hypothetical discontinuous region the increment between conventional rail or the automobile and HSR is much more dramatic. This difference makes the HSR station-area even more important. The car is still part of what philosopher Michel Serres calls "the old network, the old form of traffic," "that's still moving objects from one place to another."[17] HSR on the other hand can compress formerly significant travel times to the extent that all of a sudden station-areas become focal points of access within regions that are otherwise not integrated. That is, the widened scope of HSR network connectivity actually makes the highly local even more important than in a system of car-dominated networks.

HSR can offer multiple kinds of connections within a region:

- Between businesses connecting to each other through increasingly frequent and multi-destination business trips;
- Between employees connecting to employers through longer-distance (but not longer time) commutes;
- Between people taking advantage of more diverse residential environment choices while maintaining access to cultural amenities within a larger metropolitan area;
- And between visitors using HSR for access to tourist destinations or conferences from major cities or airports.

To facilitate these interactions requires a focus on the HSR experience, namely: the level of access between origins, destinations, and stations; the activity mix and design of the station-area; the transfer experience connecting with local transit (or other access modes) and HSR; and the multi-dimensional quality of the trip itself. In his thesis on the potential for rail-supported economic cohesion in the Basque region of Spain, Paul Lewis urges a user-oriented perspective broken down into two basic groups: the *origin user* who is familiar with local transit or is likely to have personal mobility options and the *destination user* who has more limited mobility options for egress from the HSR system but also is likely to have more targeted destinations (i.e. centers

[17] Michel Serres, "The Expert: I Live in Palylobru," *SNCF Connections,* 2012, 22-25.

of business or cultural activity).[18] Planning for true door-to-door integration of cities and for successful competition with the automobile must account, Lewis argues, for the needs of both these groups.[19] He also highlights the differential needs of frequent and infrequent users in terms of system familiarity.

Failing to consider the needs of both origin and destination users can lead to a decision-making process for station placement that gives disproportionate weight to current rather than targeted future conditions and therefore selects an external station site. A station might be placed outside a city to a) reduce HSR travel times between dominant O-D pairs and b) provide easy auto access to a region as a whole. What such a decision does not acknowledge is the longer-term growth impacts of HSR service (as opposed to the demands coming from existing categories of users). Central stations have been shown to be better for destination users and in Spain have also proven better for building up business in smaller cities[20]. It is easier to attract new businesses to areas that already have some critical mass of activity, because developers see this as less risky. As that prior concentration tends to be in more central locations, a centrally located HSR station has more to build on to attract investment than the accessibility increment from HSR alone. While entirely new developments are not impossible, they depend to a much more significant degree on securing anchor tenants that inspire enough confidence for other developers to invest. Therefore, while more short-term objectives can be met with an external station placement, longer-term land use and growth objectives point towards choosing a more central location.

5.5 The need for inter-jurisdictional and interdisciplinary planning

Not only do the detailed site-visit investigations in this chapter highlight key physical characteristics of rail systems, they also provide a more concrete basis for the claim that successful HSR implementation requires inter-jurisdictional planning. In Chapter 4, national-local and local-local cooperation were identified as promising tools for guiding HSR-supportive

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[18] Paul Lewis, "Planning for a Regional Rail System: Analysis of High Speed and High Quality Rail in the Basque Region" (S.M. in Transportation, Massachusetts Institute of Technology. Dept. of Civil and Environmental Engineering.), 2011.

[19] Ibid.

[20] José M. Ureña et al., "Territorial Implications at National and Regional Scales of High-Speed Rail," in *Territorial Implications of High Speed Rail: A Spanish Perspective*, ed. José Maria de Ureña (Farnham, Surrey ; Burlington, VT: Ashgate, 2012), 129.

policies. Apart from crossing governance boundaries, those interactions also involve the integration of multiple forms of expertise. For example, within Portugal, REFER is the entity with the most knowledge and background on how to deliver a rail system, complete with functional and accessible rail stations. They even have some prior experience with creating stations that serve as hubs within areas of urban development—the Oriente station in Libon being the most obvious example. What a national infrastructure agency may not be as well equipped to do is ensure that the station integrates well with the local urban context or is consistent with existing or planned mobility systems. Provision of information about local destinations, the use of way-finding mechanisms such as signage and distinct paving outside the station, and the creation of visible and easy to use transfer points to other modes (buses, taxis) may be generalizable ideas but require site-specific knowledge and implementation.

Moreover, there is the matter of getting priorities in line across scales of government. Because of concerns for local economic growth, smaller intermediate cities may have an interest in frequent-user discounts over and above what the infrastructure manager or national operator would want from a pure cost-recovering or profit maximization perspective. Similarly, the issue of station location, highlighted here as a matter of considerable importance, is determined early on in a project's lifecycle and depends on the initial assessment methodologies used. If the scope for a cost-benefit analysis is drawn too narrowly, longer term economic and development impacts in station-areas may be neglected. On the other hand, if the scope is too broad, the national planning agency will be faced with intractable uncertainties in predicting land use changes and resulting value added. For example, the central-city disinvestment in Santarém is neither surprising *nor* easy to predict in anything more than general terms, a priori. Over and above that, the role the external rail station played in the city's more sprawling development, while hard to deny conceptually is decidedly hard to prove econometrically. Chapter 8 considers project assessment methodologies in the UK planning system and details some of the challenges making it difficult to include local interests and land use impacts into calculations of benefit.

Finally, there is the issue of local resources and interests in supporting station-area planning. One might assume that local governments would both want to and be able to change land use regulations to support a new rail station—by increasing allowable densities, encouraging a mix of uses, and enacting form controls that support a pedestrian-friendly environment. However, Chapter 4 demonstrated that station location is a determining factor in

the level of attention a municipality is willing to give a station-area. External stations are less likely to receive in-depth consideration and even if they are addressed, determining appropriate development objectives for an external station-area is not an easy process. In Portugal, the land use regulatory system only gives clear grounds for a city to reject a private sector development proposal if it does not comply with *existing* regulatory documents prepared by the municipality. The process for approval is as follows: a private developer interested in creating a new greenfield development drafts a plan which proposes new parcelization for an existing piece of property and also designates space to be allocated to utilities. If the municipality approves the plan, the developer is then required to build the necessary infrastructure (roads, water, sewer), subject to oversight by the municipal engineer. Once the municipal engineer approves the new infrastructure as being consistent with the plan and with city standards, the developer receives a certificate and can register the new parcels individually as new urban parcels (Interview, Professor Baptista e Silva, unpublished data).[21] In practice, this has led to relatively unregulated expansion of urbanized areas in Portugal. A city may not necessarily have zoning documents developed to any level of detail within a newly urbanizing area, due to constrained planning resources. If that is the case, there is no mechanism for applying new conditions in response to a proposal.

Therefore, if intentional station-area development is a national objective of HSR, as we argue it should be, involvement in or support for local land-use planning by the national government is merited. In the case of the Coimbra urbanization plan, participation by REFER was cited as being beneficial to the local government as it brought additional experience and management expertise. In general, the national government might consider offering resources or even developing policy guidelines to support adequate planning and regulation for station-areas (see Chapter 8).

5.6 Conclusions

The detailed investigations of two commuter rail cities in Portugal presented in this chapter offer insight into the future of HSR in Portugal. In particular, evidence from site visits to Cascais and Satarém demonstrate the criticality of station location in both functional and

[21] Interview, Jorge Baptista e Silva, Departmento de Engenharia Civil, IST. Lisbon, October 31, 2012

symbolic terms. All else being equal, greenfield development tends to be more attractive. In order to achieve more compact patterns of growth, *something* is needed to overcome the costs of urban reinvestment; a rail station can play that catalytic role. Given the spatially defined environmental and economic goals of HSR, the system should be designed to reintroduce incentives for centralized and contained development. The planned external siting of stations in Évora and Leiria, therefore, is cause for worry and may limit the opportunities and achievements of Portuguese HSR.

This chapter also highlights other service and access variables that should be taken into account when developing HSR-supportive policies. Some were already introduced in the literature review and are simply reemphasized here, namely: travel time, frequency of rail service, pricing, and the availability of commuter rates. A few new aspects were additionally revealed by the analysis, including the user-friendliness of scheduled service, as defined by the regularity of headways, and fare integration with urban transit systems. In terms of accessibility, the analysis in Cascais and Santarém demonstrates how instrumental station location can be in enabling or discouraging level of integration into the urban environment. Still, it is worth reiterating the "softer" variables that define the user experience when getting off a train, even in a central location. These include: the availability of information about local destinations, visibility of and ease of transferring to other modes, street frontage and/or continuity with surrounding urban form, pedestrian and bicycle accessibility, proximity to commercial or retail activity, and the level of amenity provided within the station. Intelligent transportation systems can also aid in improving the transfer experience and availability of passenger information.

Finally, by focusing on the local variables relevant to HSR development, this chapter highlights the risks of failing to achieve proper inter-jurisdictional relationships and points toward the potentially conflicting objectives and interests that may arise across jurisdictions in the course of HSR planning and implementation. The next chapter returns to a more theory-based approach to regional spatial dynamics with the aim of better defining a framework within which differing stakeholder priorities may be debated and evaluated. After an introduction to the UK HSR project and planning context in Chapter 7, Chapter 8 will consider two phases of HSR implementation: 1) project evaluation and 2) ongoing management. A comparative investigation of Portugal and the UK further elucidates the mechanisms available for inter-jurisdictional HSR planning.

6 Contemporary Spatial Processes and HSR's Spatial Objectives

The research presented in Chapters 4 and 5 focuses principally on the motivation and need for inter-jurisdictional planning, as viewed from a set of specific local perspectives. However, to truly influence policy and implementation strategies requires consideration of objectives across geographic scales, with a blended top-down and bottom-up approach. This chapter returns to the theoretical discussion begun in the literature review, using a lens that is both broader and more generic than in the previous chapter. We connect the local point of view—what is necessary or desirable at the urban level to capture the most benefit from a HSR station—with the possible economic and distributional benefits of HSR at the regional or national level. This includes consideration of areas without HSR service and requires a more nuanced understanding of contemporary spatial processes that influence HSR and its "success." To guide our search for clarity, we turn to the field of economic geography. By reexamining the definitions of and logic behind "polycentricity" as a spatial phenomenon, this chapter offers a refined understanding of HSR's spatial objectives.

6.1 In search of performance objectives for HSR-enabled regional restructuring

Economic geography as a discipline is concerned less with the narrow question asked by cities of, "how does our community get the most benefit out of this situation (i.e. a new HSR network)?" and more in the broader question: what is the most efficient and beneficial way of architecting our urban system, and how can transport infrastructure support or enable the preferred architecture? Moving up from local to regional or national scales forces an expansion of boundaries within which costs and benefits are counted. Moreover, when attempting to balance interests across communities, decision-makers are necessarily confronted with tension between tallying aggregate benefits and grappling with the existence of "winners and losers."[1] The research for this thesis was done as part of the EXPRESS project within the MIT Portugal Program—a collaboration between IST, the University of Coimbra and MIT; one stated objective of the project is to "develop integrated policy recommendations for Portugal that

[1] Sevara Melibaeva, "Development Impacts of High-Speed Rail: Megalopolis Formation and Implications for Portugal's Lisbon-Porto High-Speed Rail Link" (S.M. in Transportation, Massachusetts Institute of Technology. Dept. of Civil and Environmental Engineering.), 189.

minimize the negative effects of HSR on small and isolated urban areas and maximize the regional economic gains of the megalopolis."[2] We will begin in this chapter with a birds-eye view, examining what regional economic theory says about the relative advantages and disadvantages of various patterns of human activity across geographic space. From there we transition in Chapter 7 and Chapter 8 to a more realistic world-view that acknowledges the political system, as well as the need to grapple with evaluative complexity (the fact that "different stakeholders value different aspects of system performance in different ways"[3]) and the equity implications of redistributed economic activity.

HSR has been in existence worldwide since the 1960s (in Japan) and in Europe since the 1980s.[4] Strategies for deployment of new systems—in Portugal, the UK, or elsewhere—should be able to benefit from experiences to date. In a recently published retrospective on the Spanish HSR experience, Ureña urges, "High-speed rail infrastructure should not be considered the end objective, but rather the initiation of a *long process* of developing actions and strategies to enhance its effects" (emphasis added).[5] Adding a taste of skepticism from the European HSR experience, Vickerman concludes that "in most cases (of HSR appraisal) objectives are obscure, optimism bias is common"[6]. To guide a project from initial appraisal through to its long-term impacts requires as much clarity in objectives and corresponding performance measures as possible. Moreover, the challenge of evaluative complexity becomes even more difficult when goals, such as "polycentricity," are characterized by a high degree of functional ambiguity. Phrases like 'mega-regional integration' or 'polycentric development' are useful shorthand for the distributional and growth impacts at which HSR is aimed. All too often, however, the planning process seems to lose sight of performance-oriented questions such as: how does a

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2 Travis Dunn and Joseph M. Sussman, "EXPRESS – Work Packages" (Memo, MIT Portugal Program, Cambridge, MA, 2010).

3 Joseph M. Sussman et al., *The "CLIOS Process": A User's Guide* (Cambridge: Massachusetts Institute of Technology,[2009]).

4 Melibaeva, *Development Impacts of High-Speed Rail: Megalopolis Formation and Implications for Portugal's Lisbon-Porto High-Speed Rail Link*, 35

5 José Maria de Ureña, "Preface," in *Territorial Implications of High Speed Rail: A Spanish Perspective*, ed. José Maria de Ureña (Farnham, Surrey ; Burlington, VT: Ashgate, 2012), xix.

6 Roger Vickerman, "High-Speed Rail - the European Experience," in *Territorial Implications of High Speed Rail: A Spanish Perspective*, ed. José Maria de Ureña (Farnham, Surrey ; Burlington, VT: Ashgate, 2012), 17.

polycentric mega-city region behave? What are its defining characteristics and how do these relate to overarching goals of social, environmental, and economic sustainability?

Looking ahead, the analysis in Chapter 8 is guided by the idea from the CLIOS process that bundles of institutional and technical strategic alternatives should be joined together in order to be successful.[7] The approach suggests the following question to guide implementation: "Under the current institutional structure, can organizations manage the system to achieve target levels of performance?"[8] To answer that, one must first define target levels of performance, and thus also the spectra along which different aspects of performance can be measured. This chapter looks at ways of describing and measuring regional spatial structure and seeks insight into the goals that can be defined for regional restructuring. Our goal is to more precisely link measures with appropriate overarching goals for regional restructuring.

6.2 Defining spatial and functional characteristics of regional structure

HSR technology is seen as a way to further enable metropolitan areas to be integrated into polycentric mega-city regions.[9] Polycentricity comes from 'pol-', meaning many, and '-centric', the property of having a center.[10] The simple etymology yields a seemingly simple definition: the quality of having several or many centers. Yet, the academic literature identifies a number of spectra and definitional distinctions that together produce a much more nuanced understanding of the term: the difference between morphological and functional polycentricity, the distinction between network density and balanced relationships, the existence of layered hierarchies and a multiplicity of roles for cities within polycentric systems, and the parallel but not identical consideration of dispersion versus centralization in terms of urban form.

The concept of polycentric development has received a significant amount of attention particularly in Europe because of its inclusion in European spatial policy, specifically the European Spatial Development Perspective agreed upon in 1999:

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[7] Sussman et al., *The "CLIOS Process": A User's Guide*

[8] Ibid.

[9] C. L. Ross and M. Woo, "The Identification and Assessment of Potential High-Speed Rail (HSR) Routes from a Megaregion Perspective," *Transportation Research Record: Journal of the Transportation Research Board, Transportation Planning* (2012).

[10] Oxford English Dictionary Online, s.v. "Polycentric," accessed March 27, 2013, http://www.oed.com.libproxy.mit.edu/view/Entry/147080#eid29541831.

> The concept of polycentric development has to be pursued, to ensure regionally balanced development, because the EU is becoming fully integrated in the global economy. Pursuit of this concept will help to avoid further excessive economic and demographic concentration in the core area of the EU. The economic potential of all regions of the EU can only be utilised through the further development of a more polycentric European settlement structure. The greater competitiveness of the EU on a global scale demands a stronger integration of the European regions into the global economy.[11]

Notably the policy focuses on *balanced* development and the avoidance of excessive concentrations of economic activity and population. All the same, the European Union's proposed method for achieving balanced growth also includes an implicit acknowledgment of hierarchy:

> The creation of several dynamic zones of global economic integration, well distributed throughout the EU territory and comprising a network of internationally accessible metropolitan regions and their linked hinterland (towns, cities and rural areas of varying sizes), will play a key role in improving spatial balance in Europe.[12]

"Internationally accessible metropolitan regions" are to be linked in a network with their surrounding hinterland, thus presumably offering *better* access to the nevertheless still 'hinter' (meaning behind in German) or less connected communities in the broader region.

Some of the theoretical challenges of defining polycentricity can be described by means of two seeming dichotomies. The first concerns the vary nature of the phenomenon itself: should it primarily be considered in *morphological* (meaning related to form) or *functional* (meaning related to patterns of activity) terms? Discussion of the second dichotomy, *balance* versus *hierarchy*, occurs in both descriptive and prescriptive discourse concerning polycentricity. Many consider balance to be essential to polycentricity—balance being the very reason for pursuing this particular architecture of space. At the same time, researchers are confronted by apparently conflicting empirical observations: that (a) morphological hierarchy is becoming a *less* dominant feature of urbanized space[13] and (b) the hierarchical importance of dominant cities within the

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[11] The Committee on Spatial Development, *ESDP - European Spatial Development Perspective: Towards Balanced and Sustainable Development of the Territory of the European Union* (Potsdam: The European Commission,[1999]).

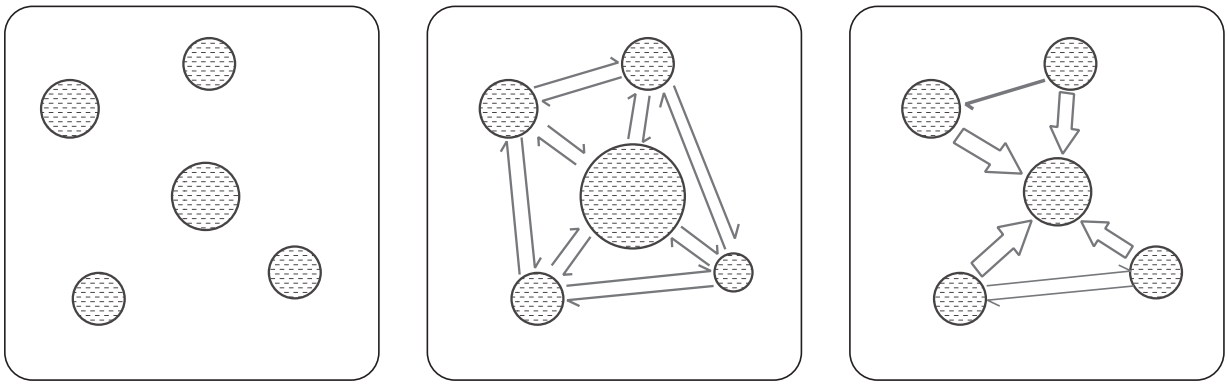
[12] Ibid.

[13] Martijn Burger and Evert Meijers, "Form Follows Function? Linking Morphological and Functional Polycentricity," *Urban Studies* 49, no. 5 (Apr 2012, 2012), 1130.

global economic network has *increased*. Note that the distinction between morphology and functional networks plays a role in this contradiction. As we examine the literature, other characteristics of spatial organization will be highlighted which help to resolve some of the ambiguity that surrounds the concept of polycentricity.

6.2.1 Measuring polycentricity – form, function, connectivity, and balance

Given the importance of networked economies, conversations about polycentricity have evolved to include and even demand the consideration of functional relationships. The claim is that regardless of the distribution of size and location of urban centers, an area cannot be considered truly polycentric unless it is somehow linked functionally—with commuting, freight movements, or informational flows (Figure 6-1, arrows represent flows). The emphasis is placed not only on distributing demographic and economic mass more evenly across space but also (and perhaps even more so) on creating relationships between centers, in either a reciprocal or otherwise defined mutually beneficial manner.



This configuration is morphologically polycentric, with a balance in size of the region's localities.

This configuration is morphologically more monocentric than the previous but displays balanced functional relationships.

This configuration is morphologically polycentric but functionally monocentric, with more flows into the cental locality than into others.

Figure 6-1 Morphological versus functional polycentricity according the Burger and Meijers framework[14] (Source: Author).

[14] Ibid.

Recent work by Burger and Meijers from 2012 demonstrates one attempt to differentiate morphological and functional polycentricity. The approach is in some ways distinctly a-spatial in that it does not account for the built form of urban space.[15] The authors choose balance in the directionality of flows as the defining characteristic of functional polycentricity. Network density, which quantifies the degree of network formation between centers, is designated as a *separate*, if equally important, phenomenon (Figure 6-2). Burger and Meijers connect polycentricity with the concepts of nodality and centrality. Nodality represents the absolute importance of a center while centrality is its relative or "surplus" importance. Both measures require a selection of flows to characterize the urban network. Burger and Meijers use both commuting and shopping trips, thus measuring polycentricity at the scale of the daily activity zone. Centrality and nodality are not inherently scale dependent but do depend critically on boundary definitions, as will be demonstrated in Section 6.3. The paper also divides centrality into two components, the within-system component C_{ci} and the outside-system component C_{ce} such that:

$$C_{ci} = N_C - C_{ce} - L_c$$

where N_C is the nodality of a center (for commuter flows, the total employment within the center) and L_c is the local importance of a center (e.g. commuters that both live and work within the defined boundaries of the center).

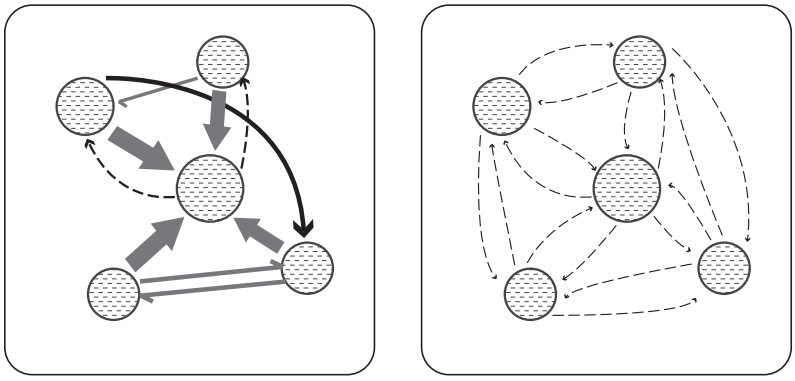
The separate concept of network density, measuring interdependence, can be as assessed as the ratio between actual and potential connections:

$\frac{\sum C_{ci}}{\sum N_c}$, the ratio of the sum of internal centrality scores to the sum of nodalities within a region. A low ratio means low network density.

Burger and Meijers apply these measures in the Netherlands using boundaries from the legally defined cooperative governance structure of the Intermunicipal Statutory Regulations Act. Because local knowledge has defined these as areas within which inter-municipal issues should be addressed, the regions are taken as a proxy for functionally coherent regions.

[15] Ibid.

The focus on surplus importance ties back to early work on central place theory.[16] Urban hierarchies were understood in terms of relative dependence: lower-order places were dependent on higher order places for more advanced goods and services. This dependency also included labor markets: smaller centers had excess labor supply while dominant centers had excess demand. Investigating polycentricity means investigating the breakdown of such straightforward hierarchy, as exchanges become more frequent and cities play a multiplicity of roles within a layered and globalizing network. As the availability of data on functional connections improves, so too does our ability to study functional connections, in addition to the easier-to-measure nodality of centers. More traditional survey data on commuter and shopping trip flows is used in this example, but opportunity exists for using newer distributed data sources such as cell phones to track both mobility and information exchanges.



This configuration has high network density (with greater flows represented by the thicker arrows) while still being functionally monocentric. A traditional city-suburb system with mostly inward commuting would be of this type.

This configuration is composed of relatively independent centers (smaller flows are drawn as thinner dashed arrows) with low but balanced connectivity amongst them.

Figure 6-2 Network density versus balanced relationships (Source: Author).

Given that balance is the key characteristic of polycentricity in this framework, translating the measures of centrality and nodality for each center within a region to a single measure of regional polycentricity requires assessment of balance within the system. The slope of the regression line through a rank-size distribution (size expressed as either nodality or centrality plotted against rank on a log-log plot) of the largest centers in a region is used to

[16] The beginning of Central Place Theory is attributed to Walter Christaller's "Die Zentralen Orte in Süddeutschland" (The Central Places in Southern Germany), published in 1933 (cited in Burger and Meijers 2012).

measure morphological and functional polycentricity, respectively. The steeper the slope, the more hierarchical a region is (see Figure 6-3). The results of the analysis demonstrate that functional polycentricity and network density should not be confused; in the Netherlands cases, network density is shown not to be related to directional balance of commuting flows. Burger and Meijers find a correlation between network density and functional polycentricity of only 0.10 for employment and -0.01 for shopping. That is: increasing connectivity does not necessarily result in reciprocal relationships, and thus network density and functional reciprocity should be considered independently when assessing objectives.

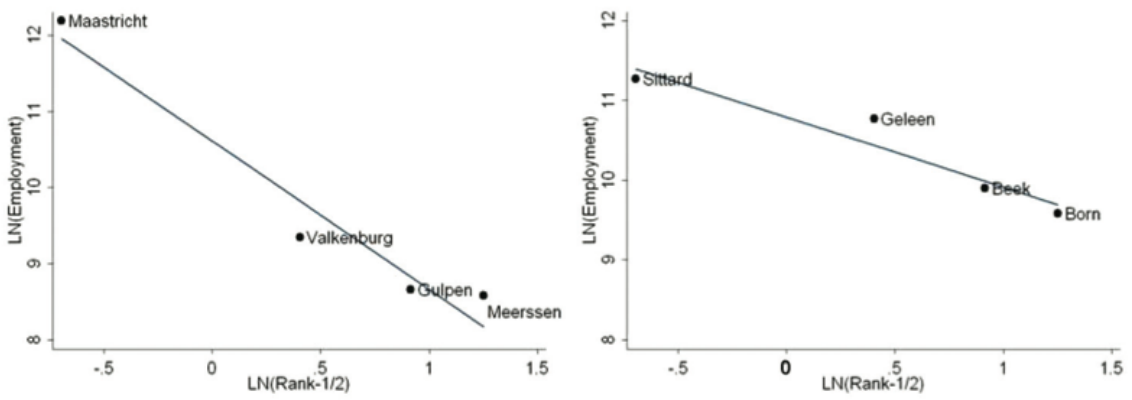


Figure 6-3 Rank-size distributions to measure mono/polycentricity (Source: Burger and Meijers[17])

6.2.2 Layered hierarchies and a multiplicity of urban roles

Rather than considering balance and hierarchy in a dichotomous relationship, it is in some ways more worthwhile to look at the urban system as a layered architecture of different kinds of networks, such that a city can simultaneously perform multiple roles at once. The POLYNET study, from 2006, focuses in one of its analyses on multi-locational firms as a proxy for connectivity. The analysis yields important observations about the scale-dependence of hierarchy.

Funded by the European Commission, Hall and Pain led a team of researchers in a broad and rather ambitious effort to define and understand the phenomenon of polycentricity across eight regions in Europe: Southeast England, the Randstad in Holland, Northern Switzerland, the Paris Region, Greater Dublin, Rhine-Main (in central Germany, centered on Frankfurt),

[17] Ibid.

RhineRuhr (named after two rivers in western Germany), and Central Belgium. The POLYNET hypothesis at the outset was that "regions…are becoming more so [polycentric] over time….as other smaller cities and towns become increasingly networked with each other, exchanging information which bypasses the large central city altogether."[18] This hypothesis rests on two points: first, a prior condition of a hierarchy in urban systems and second, that currently the system is in the process of becoming more balanced. The definition in that sense aligns with that in Burger and Meijers' view.[19]

The POLYNET study went through multiple iterations to define "the polycentric mega-city region," or MCR. Boundary definitions are influential: in order to investigate a phenomenon, one must select its spatial boundaries and then characterize that pre-defined entity. However, boundaries by definition influence the resulting characterization. POLYNET began with a definition that combines morphological and functional aspects. From there, further investigations—mostly into functional relationships—were used to refine understanding of polycentricity, as currently observed in Western Europe:

Like the US census equivalent of Metropolitan Statistical Areas (MSA's), POLYNET's Functional Urban Regions (FURs) are defined to "encompass all the areas that have regular daily relationships with a core city." A core is any single or contiguous set of municipalities[20] with more than seven workers per hectare and a minimum employment size of 20,000. The surrounding ring area, also in the FUR, includes any municipality for which more than 10% of residents commute daily to the core. Moving up the geographic scale, MCRs are groupings of *contiguous* FURs. Contiguity, a morphological attribute, is the only criteria for aggregation. Functional relationships do not necessarily exist between adjacent FURs. Moreover, the existence of balance was not a precondition to the designation of an MCR.

Having established the geographic boundaries of eight MCRs, Hall and his team made successive attempts at characterization, ranging from the more traditional approaches of rank-size and commuter flow analyses to more difficult but in some ways more telling investigations

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[18] P. Hall and K. Pain, *The Polycentric Metropolis: Learning from Mega-City Regions in Europe* (London: Earthscan, 2006), 3.

[19] Burger and Meijers, *Form Follows Function? Linking Morphological and Functional Polycentricity*, 1127

[20] Defined by the then NUTS 5 EU designation, now called the Local Area Unit (LAU) 2.

into information exchanges between MCRs. Information exchange within the APS sector was of particular interest given its role within globalized information economies.

The study uses firms that span multiple locations as indicators of economic integration. The analysis was performed for networks at four scales: regional, national, European, and global, with groups of cities selected at each level. For each scale, a matrix was created with APS firms along one axis and selected cities on the other. A scoring from zero to three indicates the presence of the firm in the city, ranging from zero for no presence to three for a headquarters. Based on the ranked importance, Hall et al. then calculated network connectivities for all cities based on *assumed* intra-firm relationships; these numbers represent the potential connections between a city and all others at that scale, with the assumption that headquarters forge more connections than back offices of a firm.[21]

The results point to systematic differences in polycentricity by scale. Specifically, hierarchy is much more prominent at the global scale. The analysis looks at "connectivity gradients": Take the top six cities in each region and rank them by connectivity on a normalized scale so that the most connected city has a score of 100 and each subsequent city has a percentage of that level of connectivity. The gradient is defined as the sum of scores for the five next-most-connected cities. If the region were perfectly polycentric, the gradient would be 500 (all 5 cities are just as connected as the "first" city). A perfectly monocentric region would yield a score of zero. Looking across scales from regional to global, there is a notable drop-off in the gradients. Within Southeast England, for example, the gradient for connections between firms in regional cities is 205, while at the global scale the score is only 78.

> Smaller cities have relatively more connections at lower scales of service provision – so that in all regions, gradients are shallowest at the intra-regional scale and get steeper up through the scales, so that the global scale has the steepest gradient (because…at this scale smaller cities provide least service provision).[22]

In contrast to smaller cities, London, the dominant city within the Southeast England MCR, plays a unique role at the global scale. Moreover, interviews with executives within the APS sector reveal that whether or not a MCR even exists is to some degree a matter of perspective.

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[21] Hall and Pain, *The Polycentric Metropolis: Learning from Mega-City Regions in Europe*

[22] Ibid.

> For secondary urban centers, the mega-city region exists, as Paris hub city region is the business horizon for most of them. On the contrary, for Paris firms, there is no such thing as a mega-city region (Hall 2006, 118).[23]

This difference likely stems from the fact that firms within cities may be participating in different networks, despite being part of the same geographic regions: some are specialized geographically, offering regional services, while others specialize in particular kinds of tasks more targeted at the global market.

The Burger and Meijers study also finds that scale matters to polycentricity.[24] Intraregional commuting flows tend to follow a more balanced distribution (i.e. to be more functionally polycentric) than the distribution of external centrality. Dominant cities play a special role in relation to external relationships. Similarly, regions that have large principal centers in absolute terms also tend to be more functionally polycentric than morphologically polycentric. Bigger cities (in absolute terms) are less likely to have similar sized cities in their regions. More interestingly, relational hierarchy shows some signs of influence over and above the influence of size alone. The region of which Groningen (in the Netherlands) is the dominant city is distinctly more functionally than morphologically polycentric. "External centrality, however, has a slightly more skewed distribution than morphological polycentricity" meaning that Groningen has more connections to outside than might be expected given its relative size compared to the other major cities in the region (see Figure 6-5).[25] This single observation is corroborated by more general POLYNET findings that dominant cities within regions tend to play privileged gateway roles to the global economy.[26] The persistent (or perhaps even augmented) importance of hierarchy in the global economy leads naturally to questions about the directionality and nature of support roles between primary and secondary cities.

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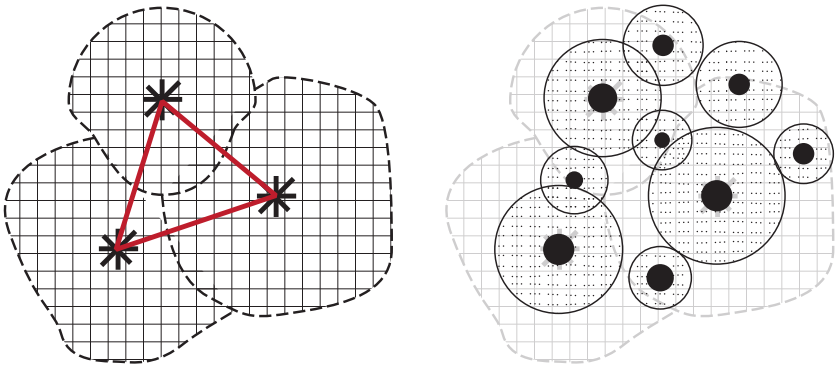
[23] Ibid.

[24] Burger and Meijers, *Form Follows Function? Linking Morphological and Functional Polycentricity*, 1127

[25] Ibid.

[26] Hall and Pain, *The Polycentric Metropolis: Learning from Mega-City Regions in Europe*, 116



"First cities" (* above) perform a hub function for mega-city regions, acting as knowledge gateways to the global economy.

These same cities can also perform regional functions at a smaller scale, along with other secondary cities in the MCR.

Figure 6-4 Layered hierarchies and a multiplicity of urban roles (Source: Author).

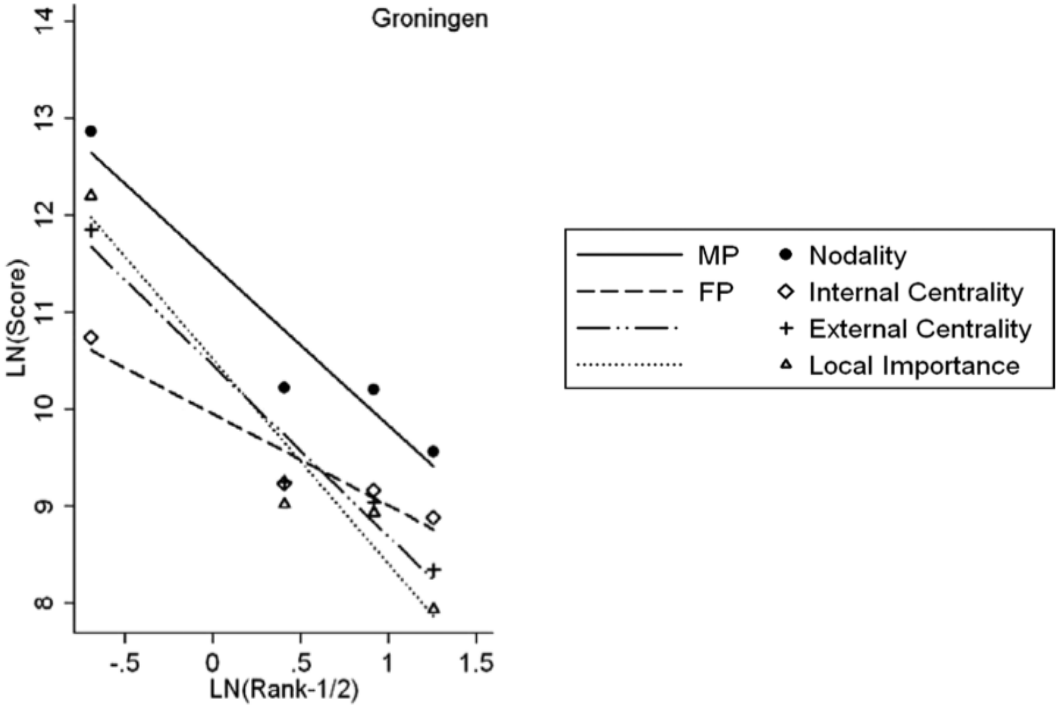


Figure 6-5 Example region - Groningen (Burger and Meijers[27])

[27] Burger and Meijers, *Form Follows Function? Linking Morphological and Functional Polycentricity*

6.2.3 Urban form: dispersion versus centralization

Morphological polycentricity, under Burger and Meijer's construct, does *not* include *any* consideration of the relative continuity or discontinuity of urbanized areas, the proportion of undeveloped land, or the level of spatial concentration of population and jobs.[28] The Hall et al. approach does use contiguity of development as a criterion for uniting FURs into MCRs. They are, however, skeptical of the relationship between polycentricity and environmental sustainability: "polycentricity…does not have a direct or axiomatic relevance for [environmentally] sustainable development".[29] Lack of clarity stems from ambiguity about the types of functional connections between centers:

> Focus groups[30] saw morphological polycentricity as something essentially unsustainable, producing a residential driven 'commuting polycentricity' which should be restricted; but functional polycentricity, constituting a market-driven 'clustering polycentricity', was beneficial to regional development and should be promoted. These policy implications required further consideration.[31]

Here "commuting polycentricity" is assumed to be negative in environmental terms, presumably because it is cross-cutting and therefore supported by the automobile rather than by older radial systems of public transportation. The case to be made for environmental sustainability is likely different for polycentric regions *in general* and for the specific case of HSR-enabled polycentricity. In fact, spatial discontinuity (between urban centers) may only come into its own as a matter of environmental significance with the longer-distance connections enabled by HSR. What HSR brings to the discussion is the potential to create commuting connections within polycentric systems that are disassociated from the negative environmental impacts of the automobile. This is also, to some degree, a matter of scale: HSR creates *inter*-urban commuter flows while automobile commuting is more often associated with *intra*-urban polycentricity.

The above quote highlights the importance of market-driven 'clustering' and pushes us once more to consider the relationship between activity density and the economic forces behind

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[28] Ibid.

[29] Hall and Pain, *The Polycentric Metropolis: Learning from Mega-City Regions in Europe*203

[30] Focus groups were used in the study to understand stakeholder attitudes towards polycentricity.

[31] Ibid.

clustering and agglomeration. An earlier paper from Meijers and Burger provides additional evidence on the contribution of a region's spatial organization to productivity.[32]

The paper sought to evaluate the effect on labor productivity of urban spatial structure defined along two spectra: centralization-dispersion and monocentric-polycentric (Figure 6-6). As in other studies, rank-size analysis (using population size) was used to characterize the degree of polycentricity of US Metropolitan-Statistical-Areas (MSAs) and Combined Statistical Areas (CSAs). Dispersion, on-the-other-hand, was measured by the share of population not located in urban centers of at least 25,000. This approach explicitly acknowledges that sprawling development patterns can exist in both monocentric and polycentric systems. Proximity and the efficient use of space, which accounts for many of the benefits of urban agglomeration, are not necessarily guaranteed by polycentricity.

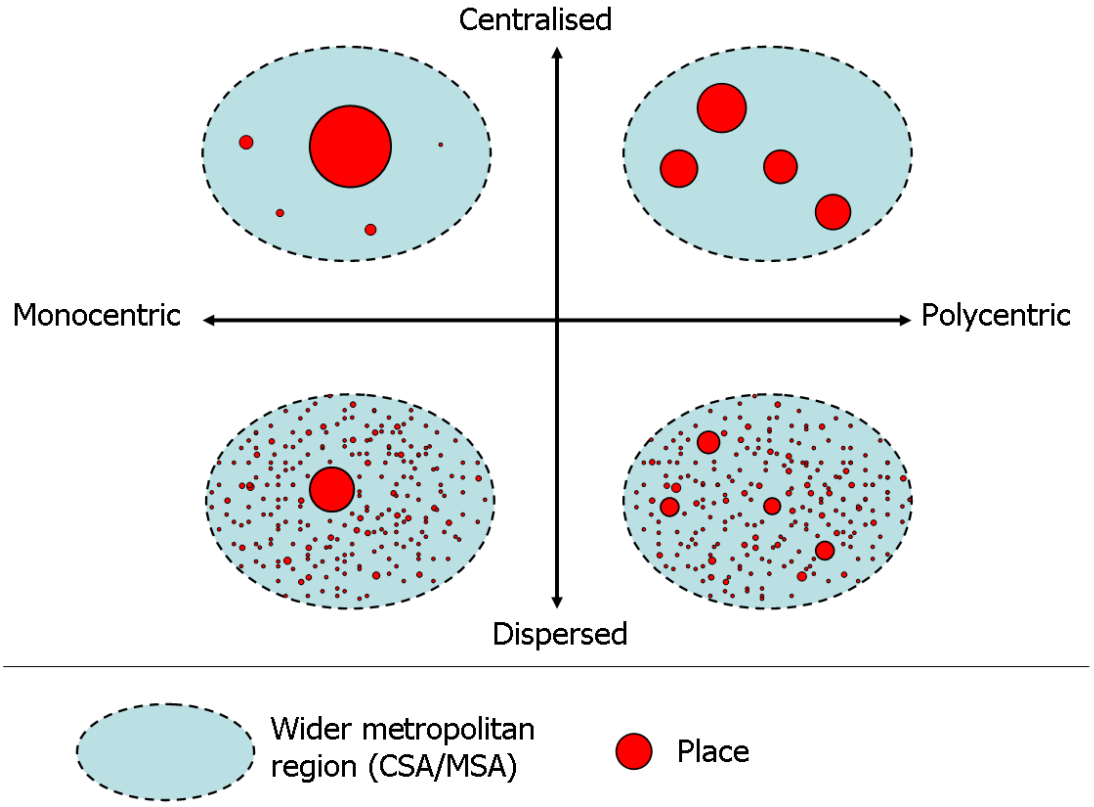

Figure 6-6 Spectra of urban spatial structure (Source: Burger and Meijers[33])

[32] Evert Meijers and Martijn Burger, "Urban Spatial Structure and Labor Productivity in U.S. Metropolitan Areas" (Leuven, Belgium, Regional Studies Association annual conference 'Understanding and Shaping Regions: Spatial, Social and Economic Futures', April 6-8, 2009).

Unsurprisingly, the regression analyses—which include controls for the endogeneity, or unclear causality, between labor productivity (output per worker) and spatial structure—reveal negative effects of dispersion on the productivity of the metropolitan labor force. The study also provides supporting evidence that polycentricity (independent of other factors like size, education, etc.) improves labor productivity and that therefore urbanization externalities do indeed act through network connections in addition to acting by means of direct proximity. More interestingly, the effect of absolute size seems to moderate the gains of polycentricity. The same increment in polycentricity is less effective for an area with a larger population than for one with a smaller population. The implications of these finding are not entirely clear but at the least point to the need for more inquiry. The scale of analysis in the study varies considerably in the distances involved: the data set includes Denver-Aurora-Bolder, CO; Springfield, MA; and Boston-Worcester-Mancester, MA-RI-NH, for example. The authors do posit one explanation for the size effect: at a smaller scale intergovernmental cooperation may be more effective at managing the benefits of polycentricity. This hints at potential gains from cooperation at the scale of the Coimbra-Leiria central region in Portugal and reemphasizes that phenomenon like polycentricity need not yield the same functional results across different scales of geography.

The physical composition of space remains important. From a spatial equity perspective, the two configurations illustrated in Figure 6-7 would appear identical if one uses measures that simply count the number of people or jobs within each defined boundary. In environmental and economic terms, however, these two configurations can yield very different results. Thus, the degree of dispersion versus centralization should be considered as a semi-independent characteristic of regional architecture.

[33] Ibid.

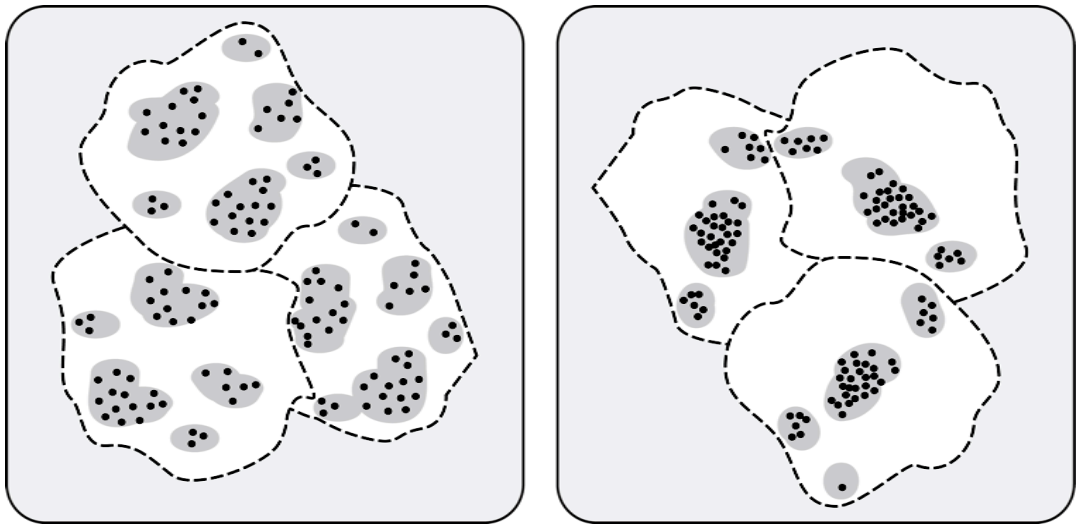

Figure 6-7 The number of points within each boundary is identical. However, the left-hand figure represents a more dispersed pattern of settlement, resulting in more urbanized land. The right-hand figure demonstrates more clustering, thus leaving a greater amount of space unpopulated.

6.3 Application to Portugal – a demonstration of methodology and related challenges

This section further explores the measures outlined in the Burger and Meijers methodology via an application to commuting data from Portugal in two years, 1991 and 2001. This application reveals the challenges associated within measuring polycentricity and hints at a number of alternate approaches that may be better suited to support infrastructure investment decisions. In particular, this application demonstrates the sensitivity of centrality measures to the selection of boundaries and the challenges of using metrics that are distance-blind and do not account for the physical composition of space.

6.3.1 Boundary selection

This analysis uses the NUTS (nomenclature of territorial units for statistics) classification developed by the European Union for consideration and statistical analysis of socioeconomic conditions. The NUTS 2 scale is used for analysis and application of regional policies, including the distribution of EU Structural Funds.[34] To manage applications for and distribution of these funds, Portugal is divided into de-concentrated jurisdictions of the central government called Regional Development Commissions (*Comissão de Coordenação e Desenvolvimento Regional*),

[34] The NUTS classification system changes every few years. The boundaries used here are from the NUTS 2010 classification.

which coincide with the NUTS 2 boundaries.[35] As discussed in Chapter 3, other ad-hoc and special purpose regional organizations exist but none of these provide the consistent or non-overlapping boundaries necessary for this analysis.

PT 16 in the NUTS 2 classification for the Região do Centro or central region of Portugal (Figure 6-8). This region includes the study-cities of Coimbra and Leiria. PT 17 is the NUTS 2 classification for the Lisbon region of Portugal. Centered on the largest city in Portugal, this region is much smaller geographically (about 1/10 the land area) but has similar employment totals as the Centro region (Figure 6-9).

The boundaries used to analyze the polycentricity of a region should, as close as is possible, coincide with areas that act as functionally coherent regions. The NUTS 2 classification conveniently aligns with municipal boundaries used for census data collection in Portugal. Nevertheless, it is worthwhile to ask: how close do these boundaries come to capturing functionally unified regions? The commute sheds of dominant cities in each region (Coimbra and Lisbon) are an instructive first approximation of functionally integrated areas.

Figure 6-10 compares Coimbra's commute shed in 1991 and 2001 to the boundaries of the Centro Region. The PT 16 region is larger than might be necessary to capture Coimbra's commuting alone; it is appropriate, however, for a polycentric region with multiple relevant commute destinations. Coimbra, as the third largest city in Portugal, also has significant interactions with the other dominant cities of Porto, to the north, and Lisbon, to the south. Figure 6-11 overlays the boundaries of PT 17, the Lisbon region, onto the commute shed of Lisbon. Represented are both the total magnitude of commuting and the flows as a percentage of Lisbon's total employment. While Lisbon, as Portugal's largest city, does draw commuters from a large part of mainland Portugal, the PT 17 boundaries encompass the municipalities that contribute most significantly to Lisbon's labor supply. As with Coimbra, between 1991 and 2001, Lisbon expanded its reach. The municipality itself actually lost internal commuting trips in absolute terms, pointing towards a more decentralized metropolitan area.

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[35] J. S. Nelson, "The Portuguese Surface Transportation Policy and Finance System: Current Status." *MIT Portugal Program Working Paper Series* (2008).

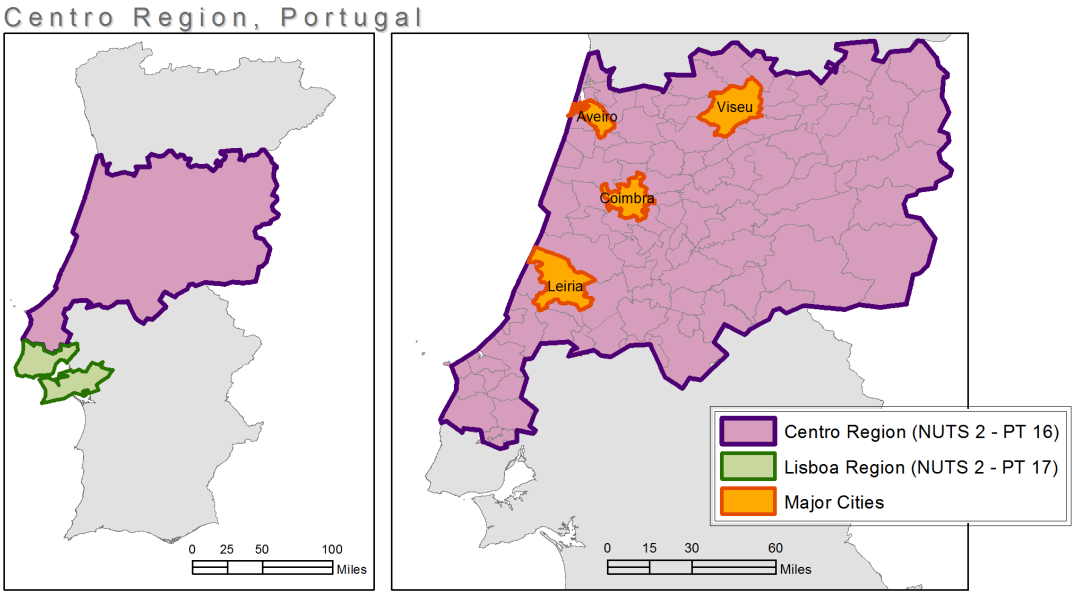

Figure 6-8 NUTS 2 Regions of Portugal – Centro Region (Source: Author)

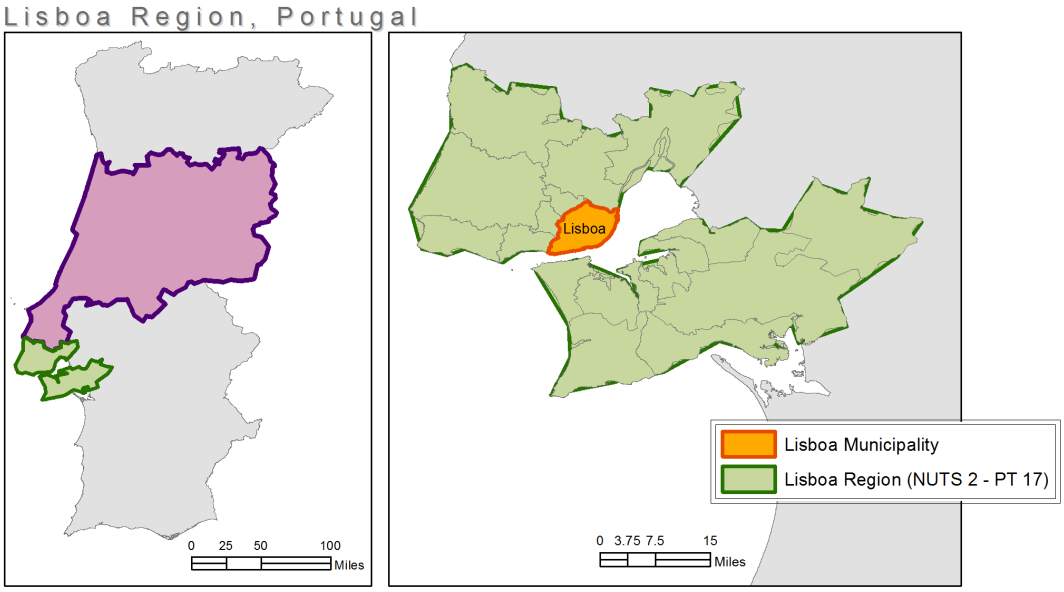

Figure 6-9 NUTS 2 Regions of Portugal – Lisboa Region (Source: Author)

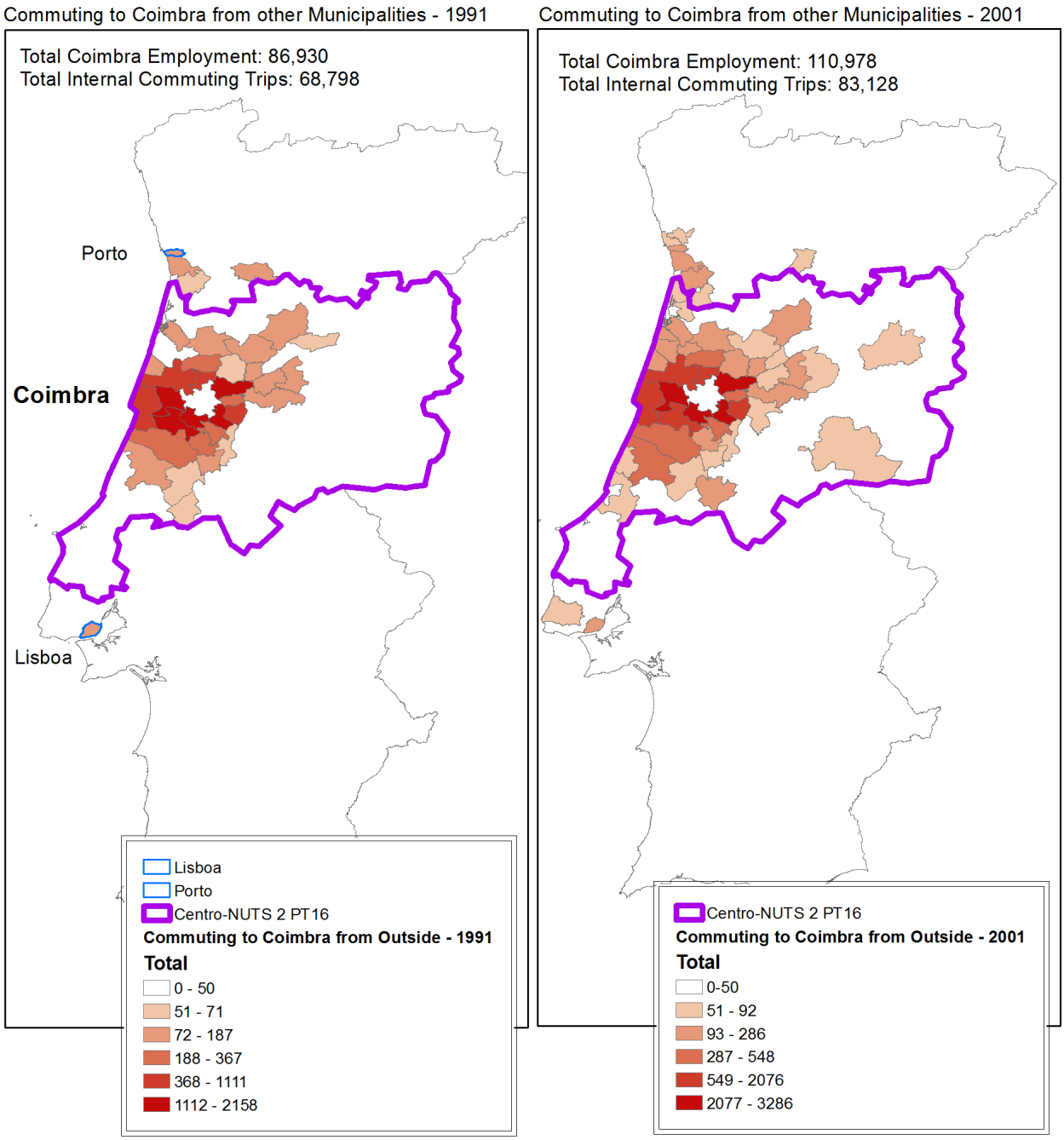

Figure 6-10 Commuting to Coimbra (by magnitude), the largest city in the Centro region, 1991 and 2001 (Source: Author, data from INE) [36]

[36] Data source: Census 1991, 2001(Instituto Nacional de Estatística, INE - http://www.ine.pt/)

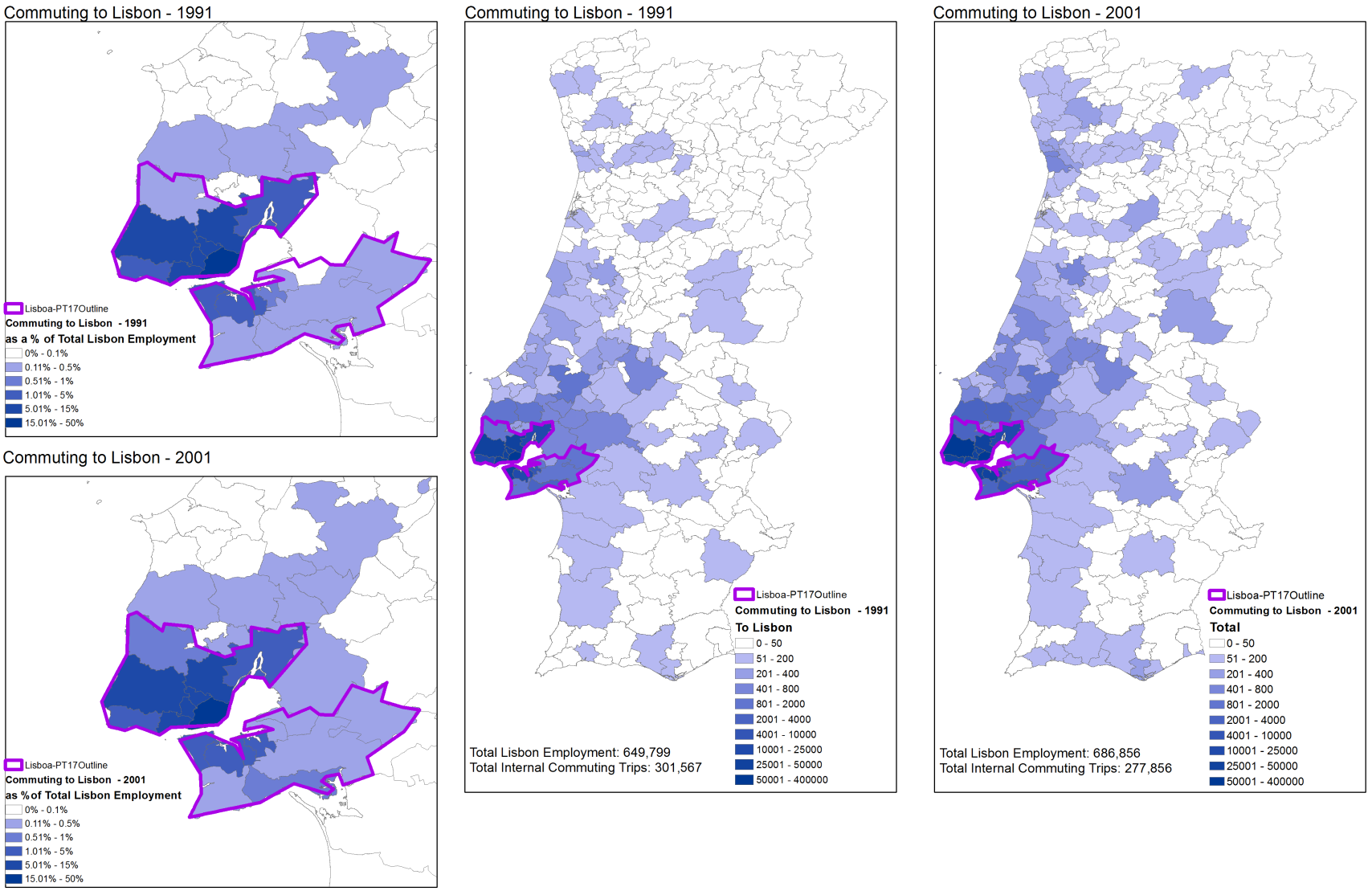

Figure 6-11 Commuting to Lisbon (by magnitude and %), the largest city in the Lisbon Region, 1991 and 2001 (Source: Author, data from INE)

6.3.2 Centro region

Using municipal level commuting data, the Centro region is analyzed in terms of *nodality*, a measure of absolute importance of municipalities, and *centrality* (both internal and external), which measures relative importance. Nodality is the sum of all incoming commuter flows for a given municipality (equivalent to total employment). It includes trips originating both within and outside of the Centro Region. Figure 6-12 below highlights the cities with the highest nodality in 1991: Coimbra, Leiria, Aveiro, and Viseu. The ranking remained the same in 2001 (Table B-1 and FIGURE B-1 in the Appendix).

Internal centrality captures the importance of a municipality as an employment center for other municipalities within the region. As can be seen in Figure 6-12, the 1991 ranking of municipalities according to this metric is not identical to that using nodality. Coimbra unsurprisingly ranks first in both total employment and in its "surplus importance" to the Centro region. The four largest cities in the region are also in the top six when ranked according to internal centrality (Table B-2 and B-3 in the Appendix).

External centrality is the "surplus importance" of a municipality relative to origins outside of the defined region. At this scale, external centrality turns out to be a misleading metric, given the influence of boundary conditions (Table B-4 in the Appendix). With the exception of Coimbra (and possibly Aveiro), which as a large city is expected to have greater geographic reach, the other municipalities with highest-ranked external centrality are all located close to the border of PT16, the selected NUTS 2 region (see Figure 6-12). Therefore, high scores for external centrality do not necessarily indicate longer-distance commuting. The results in 2001 are similarly ambiguous due to the effects of the region's boundary (see Figure B-1 and Table B-5 in the Appendix), although the magnitude of commuter flows from outside the region is noticeably greater by 2001. To unpack the importance of commute trips from more remote areas, one would need to look in more depth at the flows between each municipal origin-destination pair and consider the average commuting distance involved.

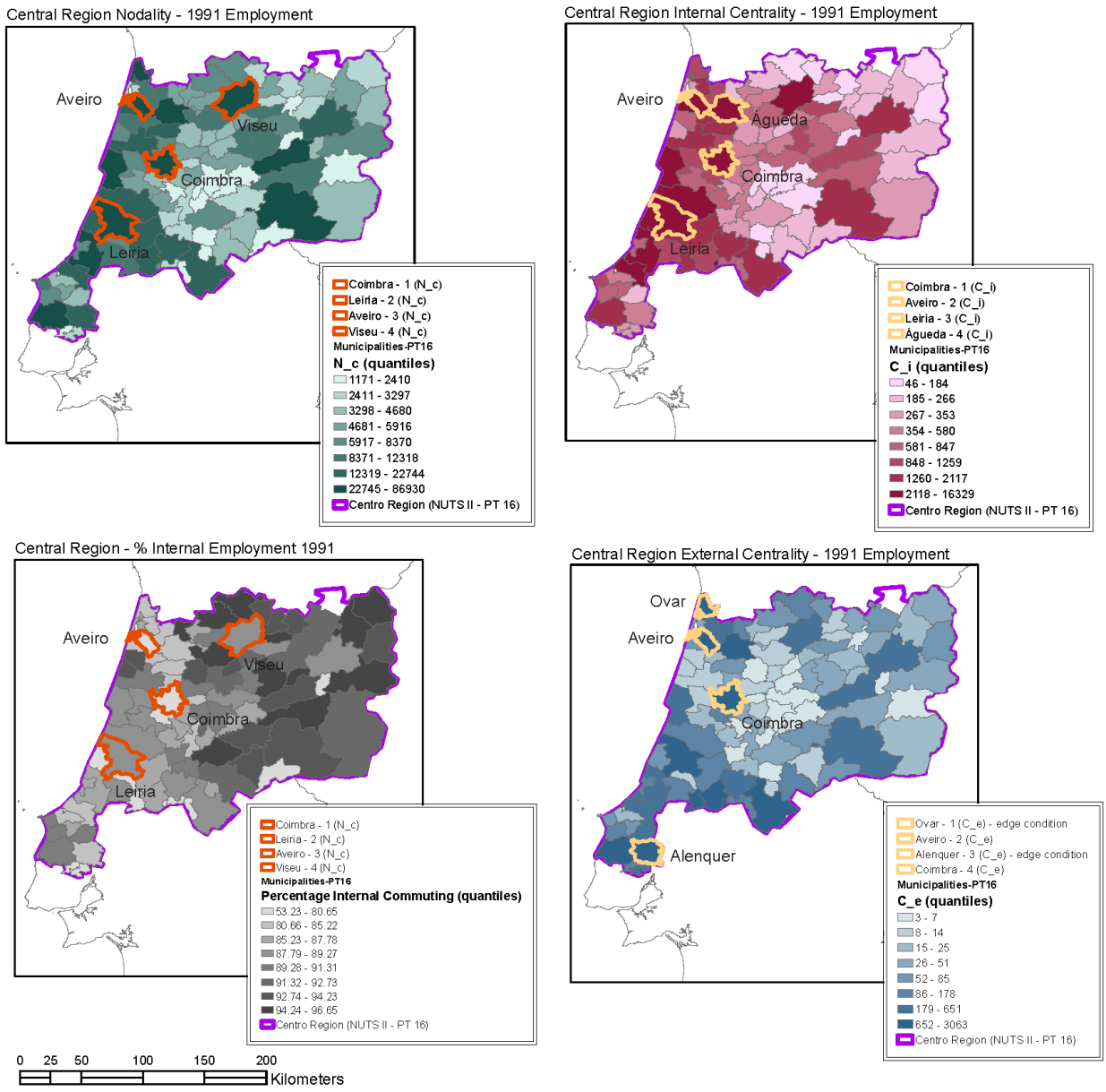

Figure 6-12 Employment nodality and centrality in the Centro region, 1991 (Source: Author, data from INE)

Based on calculations of nodality and centrality for each municipality in the Centro region, we now follow the methodology proposed by Burger and Meijers which uses a rank-size distribution to translate these measures of importance into a single metric capturing how *balanced* or polycentric a region is.[37] The slope of the regression line through a rank-size distribution of the nodality and centrality scores of the largest centers in a region is used to

[37] Burger and Meijers, *Form Follows Function? Linking Morphological and Functional Polycentricity*, 1127

measure the morphological and functional polycentricity, respectively. The steeper the slope, the more hierarchical a region is.

Table 6-1 Centro region rank-size slope as a measure of polycentricity (1991 and 2001)

	1991		***2001***	
Slope of Rank-Size	**n=4**	**n=3**	**n=4**	**n=3**
Nodality	-0.399	-0.424	-0.363	-0.367
Internal Centrality	-0.729	-0.639	-0.699	-0.515

Table 6-1 reports the slope of a regression line using a rank-size distribution of either the 3 or 4 highest scoring municipalities by nodality and internal centrality. A similar analysis was not conducted for external centrality, given the misleading influence of the region's boundaries.

Using this approach, the Centro region can be described as more polycentric by absolute employment (nodality) than by surplus importance within the region (internal centrality). According to the Burger and Meijers nomenclature, that makes the region more *morphologically* than *functionally* polycentric.[38] This reaffirms our previous observation that hierarchy, particularly in functional terms, is a salient characteristic of regional structure and thus should be accounted for in regional growth strategies.

Looking at the change from 1991 to 2001, the Centro region becomes more polycentric by both nodality and internal centrality. Unclear from this measured change, however, is the degree to which increased polycentricity is associated with sprawling development patterns and the spatial dispersion of development. Sprawl is certainly an issue with which Portugal grapples, but the phenomenon is *not* necessarily one-and-the-same with increased polycentricity. That depends on the corresponding changes in built form associated with more balanced employment distributions and commuter flows.

6.3.3 Lisbon region

The same methodology from above is now applied to the Lisbon region. Consistent with the EU's efforts to define NUTS 2 in socioeconomic terms, the Lisbon region is much smaller in terms of area than the Centro region but has roughly the same employment. Figure 6-13 shows the municipalities with the highest nodality in 1991: Lisbon, Sintra, Loures, and Almada. Lisbon,

[38] Ibid.

with its traditional downtown and central business district, is noticeably dominant in employment. Lisbon, Sintra, and Loures remain in the top three ranked spots in 2001 (Table B-6 in the Appendix).

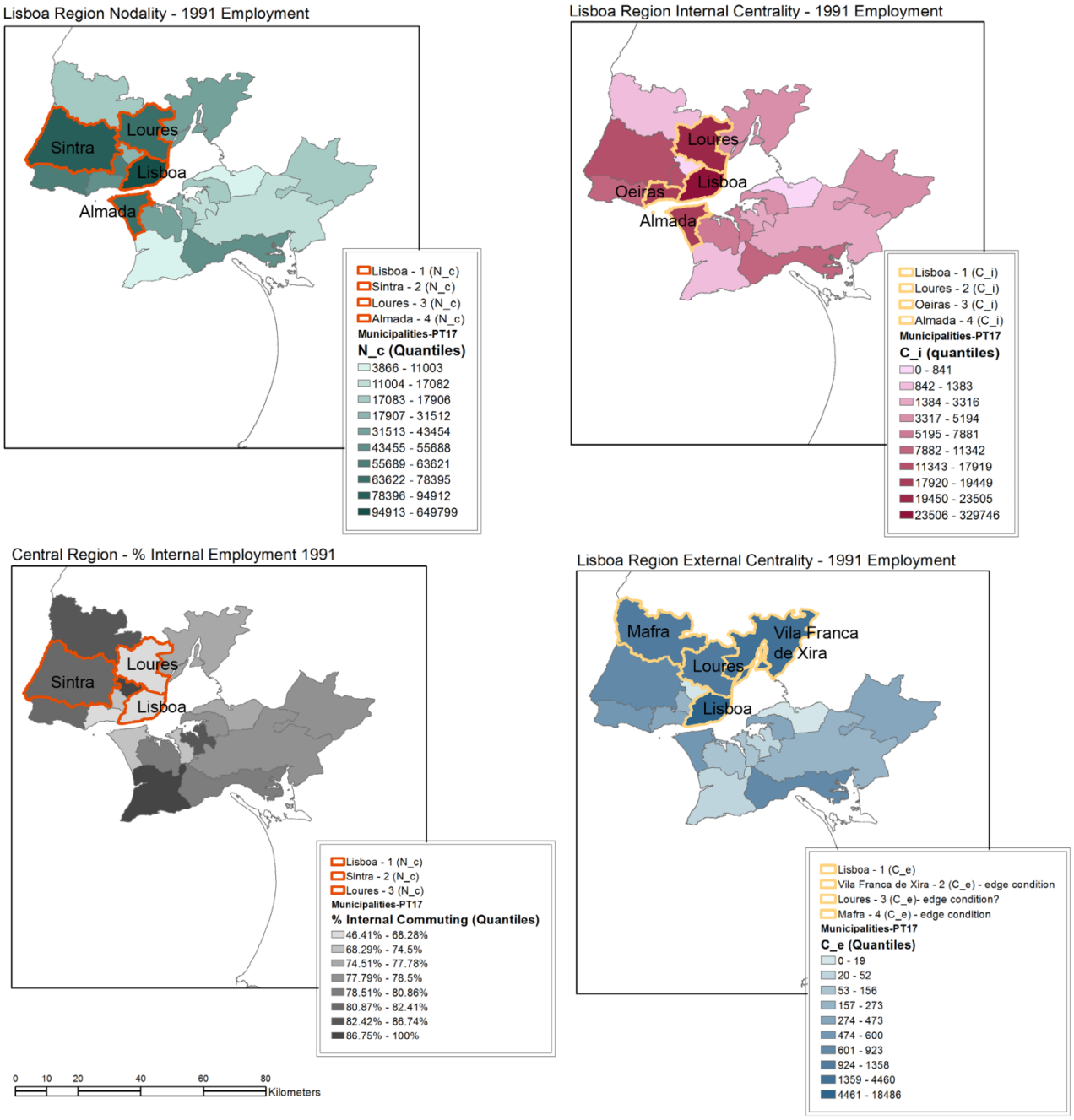

Figure 6-13 Employment nodality and centrality in the Lisbon region, 1991 (Source: Author, data from INE)

As with the Centro region, the ranking of the top four municipalities (Figure 6-13 and Figure B-2 in the Appendix) in the Lisbon region by internal centrality is different from that based on nodality. The municipality of Lisbon dominates by centrality as well as nodality. Sintra, Loures, and Almada, the next three largest municipalities in the region, remain in the top six when ranked by centrality (Table 6-2 and Table B-7 in the Appendix).

Table 6-2 Lisbon region internal centrality – nodality comparison (1991)

Municipality in Lisboa	C_{ci}	*Nodality (rank)*	C_{ci} *as a % of Nodality*
1. Lisboa	329,746	649,799 (1)	51%
2. Loures	23,505	78,395 (3)	30%
3. Oeiras	19,449	55,120 (8)	35%
4. Almada	18,859	64,073 (4)	29%
5. Amadora	17,919	57,544 (6)	31%
6. Sintra	15,969	94,912 (2)	17%

Unlike the Centro region, the area around Lisbon is one contiguously developed metropolitan area, served by a unified metropolitan transit agency. The *Autoridade Metropolitana de Transportes de Lisboa* coordinates public transportation across "Grande Lisboa" and the Sétubal peninsula.[39] The level to which municipalities exchange commuting flows within the region, as captured by the percentage of municipal employment that comes from another Lisbon municipality (C_{ci} *as a percentage of Nodality* in Table 6-2), is therefore higher than in the Centro region (compare to Table B-2 in the Appendix). Centrality as a percentage of nodality is slightly higher on average in 2001 (26%), compared to 1991 (21%), indicating a higher degree of exchange between municipalities within the region.

Next, given the importance of the Lisbon metropolitan area to Portugal as a whole, it is important to consider its external centrality, the "surplus importance" of municipalities that extends beyond the region (Table B-8 and B-9 in the Appendix). As was the case in the Centro region, however, and with the exception of the municipality of Lisbon itself, measures of external centrality are likely confounded by boundary conditions (see Figure 6-13 and Figure B-2 in the Appendix).

[39] "Âmbito Territorial." Autoridade Metropolitana de Transportes de Lisboa, http://www.amtl.pt/ (accessed April 2, 2103).

Given the calculations of nodality and centrality for each municipality in the Lisbon region, we again follow the methodology proposed by Burger and Meijers and use a rank-size distribution to translate these measures of importance into a single measure of polycentricity.[40] The steeper the slope of the regression line through a rank-size distribution, the more hierarchical the region is.

Table 6-3 Lisbon region rank-size slope as a measure of polycentricity (1991 and 2001)

	1991		***2001***	
Slope of Rank-Size	**n=4**	**n=3**	**n=4**	**n=3**
Nodality	-1.213	-1.384	-1.111	-1.263
Internal Centrality	-1.535	-1.861	-1.440	-1.709

As expected, the magnitudes of the slopes indicate that the Lisbon region is much more monocentric than the Centro region (Table 6-3); it is a monopolar region centered on the single dominant municipality of Lisbon. Important to remember, however, is that these measures are distance-blind. The geographic area of the Lisbon region is approximately an order of magnitude smaller than that of the Centro region and so physical distance is less of a barrier to intermunicipal flows.

Measured by internal centrality, the Lisbon region is again much more monocentric than the Centro region. Comparing the slope using nodality versus internal centrality shows that the Lisbon region is more polycentric by total employment than by internal centrality, i.e. it is more "morphologically" than "functionally" polycentric. As with the Centro region, hierarchy is more prominent when measured using commuter flows than one might be led to believe, looking at the distribution of employment totals, only. This observation highlights how different conclusions can be reached depending on the metrics used and whether they capture functional relationships. A similar analysis was not conducted for external centrality, given the possibly misleading influence of the region's boundaries. As in the case of the Centro region, the Lisbon region also became more polycentric from 1991 to 2001, both morphologically and functionally.

[40] Burger and Meijers, *Form Follows Function? Linking Morphological and Functional Polycentricity*, 1127

6.4 Connecting performance measures with goals and decision making

6.4.1 An accessibility based approach

At the beginning of this chapter, we discussed the need for performance measures to guide investment and decision-making for HSR and related local policies. While the diverse set of stakeholders and decision-makers involved in complex system planning may not ever achieve full agreement on appropriate target levels for performance, the *process* of defining and evaluating the measures themselves, even without consensus on exact targets levels, can create a shared understanding of the complex system being addressed. In some ways, the selected measures comprise the *language* with which various strategic alternatives are discussed and assessed. "What we measure is an important reflection of how we understand the world and how we make choices."[41] Unclear language is likely to hinder the decision-making process, particular at later stages of implementation when realized uncertainty requires adaptive decision-making.[42]

Performance measures are intended to "mark the progress from the current to the desired future state."[43] To most effectively chart change, the selected measures should reflect goals and objectives and provide decision support. That is, the results from a performance-based analysis should help "decision makers better understand the likely outcomes of choices." To do that, the measures need to be connected to the universe of decisions being considered and be sufficiently specific so as to distinguish between different alternatives.[44]

If the investment under consideration is the development of new transport infrastructure, then selected performance measures will ideally reflect changes in the transport system. The measures of regional structure used in the previous section are distance-blind. In some ways, that is good, in that the measures can be applied to any functionally coherent region, regardless of geographic scale. However, as demonstrated above, the sensitivity to boundary conditions is a limitation: the inability to differentiate between short and long commutes means that what is

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[41] Matthew Bishop and Michael Green, "We are what we Measure," World Policy Institute, http://www.worldpolicy.org/journal/spring2011/we-are-what-we-measure (accessed May 19, 2013).

[42] J. Innes and D. Booher, "Consensus Building and Complex Adaptive Systems – A Framework for Evaluating Collaborative Planning," *APA Journal* 65, no. 4 (1999), 412-423.

[43] Sussman et al., *The "CLIOS Process": A User's Guide*

[44] Steven Pickrell and Lance Neumann, "Use of Performance Measures in Transportation Decision Making" (Irvine, California, Transportation Research Board, October 29–November 1, 2001).

measured does not necessarily capture the influence of the transport system on polycentricity or regional structure.

In fact, it is not the "distance-blind" or scale-free nature of the measures that is at issue, but rather—more precisely—the fact that they are "access-blind." The concept of a *discontinuous region* introduced earlier in this thesis is predicated on the ability of high-speed transport technology to bring close in time points in space that are separated by large physical distances. Similarly, certain likely benefits from polycentric or mega-regional development are dependent on *functional* connections between urban centers. It is travel time (along with other service characteristics), not travel distance, which impedes the formation of such functional connections.

Being "access-blind" is a difficulty that plagues much of the existing economic literature aimed at measuring the benefits of agglomeration. Earlier in the literature review (Chapter 2), we indentified network-based agglomeration as one of the key economic drivers of inter-urban polycentricity. Meijers et al. argue that positive and negative urbanization externalities act at different scales and that therefore it makes sense at a certain point to encourage polycentric growth across multiple cities, rather than the continued expansion of a large dominant metropolis. Transport-enabled polycentricity can allow cities to benefit from agglomeration externalities among connected cities, while avoiding negative externalities like pollution and congestion that seem to be more spatially constrained. To mark progress towards the normative goal of using HSR to encourage network-based forms of agglomeration, we would be best served by measures that capture the relationships between accessibility and agglomeration.

Measuring production agglomeration economies requires measures of overall economic activity within a certain locality:

> A key issue in understanding the spatial scope of agglomeration economies relates to the construction of the agglomeration term itself. This needs to be a variable that represents the potential opportunities for a firm to benefit from the agglomeration mechanisms in its locality. Second, locality must be defined.[45]

Two common methods of aggregation are to a) count all relevant activity (e.g, jobs or workers) within the same neighborhood as a firm, as defined by a distinct boundary (administrative or

[45] Daniel J. Graham and Patricia C. Melo, "Assessment of Wider Economic Impacts of High-Speed Rail for Great Britain," *Transportation Research Record: Journal of the Transportation Research Board* 2261 (2011), 15.

otherwise), or to b) aggregate by weighting closer activities higher that those located further away. The latter method uses a distance-decay function identical in form to "gravity-based" accessibility indices used in transport assessments:

$$A_{it} = \sum_{j \neq i} d_{ijt}^{-\alpha} z_{jt}$$

Source: Graham and Melo[46]

Where:

- A_{it} is the effective density of site *i* at time *t*,
- d_{ijt} is the connectedness of site *i* with site *j* (measured as either straight-line distance or some other version of access cost)
- α is a positive decay parameter that results in activities at location *j* having less influence on location *i* as distance between *i* and *j* increases,
- and z_{jt} is the quantity of activity (e.g. jobs) at location *j* and time *t*.

The difference between "market potential" measures from economic geography and accessibility indices in transportation is that the former tend to use straight distance rather than network distance or network travel times. Daniel Graham's work advances the study of production agglomeration economies by adopting the use of network-based travel time measurements. He does so to arrive more directly at underlying mechanism of agglomeration: "Distance is simply a proxy for the transport costs or travel time separating two locations."[47] Similarly, "polycentricity" may only be a proxy or convenient shorthand for more targeted goals such as: a more even distribution of economic growth and opportunity, relief from certain negative externalities of urbanization, network agglomeration, environmentally-sound forms of compact development, and the creation of bi-directional and mutually supportive relationships between cities.

Beyond accounting for travel costs, accessibility measures also emphasize the relationship between people or firms to which access is given and the activities or resources to which those people or firms want access. Agglomeration studies focus on production externalities associated with greater access. Accessibility can also be useful when considering equity goals, if equity is defined as equality of opportunity (as opposed to equality of outcomes), because accessibility is a measure of opportunity.

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[46] Ibid.

[47] Ibid.

Graham also investigates the differential effect of distance for different trip purposes by separating commuter and business trips in his estimation process. This differentiation points to important follow-up questions: access *to* what and *for* what? That is, what *kinds* of accessibility are most important to the wider economic benefits of agglomeration?

6.4.2 Complementarity and the nature of support roles across an urban hierarchy

Advocates of more balanced regional growth are in search of a sustainable and equitable way for urban systems to continue growing within a globalized economy. At the core of polycentricity's promise is the idea that each developed area (and undeveloped area) within an urban system has its own role to play. The goal is to create a mutually supportive network of cities that together yield a better quality of life than if each area remains independently competitive with its neighbors. Hall emphasizes *complementarity*—the ability to combine functions amongst cities so as to be mutually enhancing—as the key to the benefits of polycentricity.[48] The notion is certainly enticing; it hints at a resolution between global competitive economies that prioritize dominant urban centers and concentrate benefits, on the one hand, and the distributional goals of "cohesion" and more equitable distributions of social and environmental welfare, trade, and economic growth, on the other.

In reality, every city will engage in both competitive and complementary relationships. Therefore, if we are interested in setting up a framework for intentional encouragement of polycentricity development, we first need to understand the motivation for and gains from various location decisions, as well as the resulting functional linkages between activity clusters across a region. Why do some firms or offices pay a premium for central locations within large metropolises while others choose to decentralize, thus supporting a more polycentric system of spatial organization? Similarly, how do households weigh housing costs against various commute options? Hall and Pain argue that polycentricity cannot be disassociated from the simultaneous rise of a new urban hierarchy: that of *World Cities*.[49] Certainly it seems that hierarchy, at multiple geographic scales, is a lasting characteristic of our urban systems. The duality of dispersion and hierarchy demands nuanced consideration of inter-city functional relationships.

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[48] Hall and Pain, *The Polycentric Metropolis: Learning from Mega-City Regions in Europe*

[49] Ibid.

The competitive paradigm of a global market means that as markets open up, firms have to compete within larger and larger networks while still providing depth in local markets. To succeed, firms maintain both close contact with customers who may be spatially dispersed and a high level of inter-firm communication and cooperation at the global scale, including increasing cross-sector alliances.[50] Complex interactions seems best supported by the intense information exchanges that take place in dense urban environments, particularly in cities such as London and Lisbon that sit at the top of their respective urban hierarchies.[51] Yet, while certain activities increasingly concentrate in large cities, others may disperse to smaller urban centers, to take advantage of lower costs or gain access to more regional markets. Location preferences differ across sectors and firm type. National and international firms concentrate in large metropolises where the benefits of agglomeration economies and the potential for complex inter-firm and cross-sector relationships are more pronounced. Businesses aimed primarily at regional markets tend to locate closer to their clients, as they depend more on personal relationships. Similarly some sectors require more face-to-face interaction than others. Accountancy and management, for example, tend to have more regional offices while banking, advertising, and law are more likely to have single centralized offices.[52]

The question is not whether regional urban systems should be balanced *or* hierarchical but rather, what kinds of connections between urban centers are mutually supportive and likely to improve economic competitiveness? Yet even understanding what drives location choices is difficult. Agent-based models of firm and household location decisions are complex and data-hungry. At the scale of a discontinuous region, much in-depth modeling is intractable. Therefore, while economic, transport, and land-use modeling remain important tools in understanding the relationship between policy and regional growth patterns, there remains a significant degree of uncertainty that is best met by a combination of technical expertise and local knowledge. Economic development policies in general and HSR-supportive development policies in particular are much more successful when they build on existing local and regional strengths.

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[50] Inter-sectoral information exchanges are often associated with innovation. Additionally, in order for a firm to have broad global reach, it must be at least as good as a specialist, *unless* the firm packages services in a different way. Offering integrated services is one way to remain competitive in the global market (Hall 2006, 201).

[51] Ibid.

[52] Ibid.

While a national planning entity can recognize and facilitate that kind of growth, local knowledge provides richer insight into available opportunities, latent demand, and existing and future needs. In Chapter 7, we use a comparative case of Coimbra, Portugal and Birmingham, UK to examine how inter-jurisdictional planning can best incorporate local knowledge and expertise into a national HSR planning process.

6.5 A summary of key regional characteristics – developing a shared understanding

This chapter sought to unpack the concept of "polycentricity"—to take a step back and understand the underlying goals motivating policy-makers (particularly from the European Union) in their pursuit of polycentricity. We examined a number of defining characteristics for polycentricity and considered their relationship to the intent of achieving equitable, environmental, and economic sustainability. The examination of various aspects of regional structure (along with ways of measuring them) has yielded a clarified understanding of goals for HSR. This chapter does not purport to determine the absolute normative value of polycentricity. Rather, we find that polycentricity is a multi-faceted and multi-scaled idea and that the adoption of a particular measure of polycentricity as a singular goal, to the exclusion of other metrics, can lead to obfuscation of underlying sustainability objectives.

Therefore, in the interest of supporting future research and political dialogue, we offer the following discussion of key regional characteristics. The hope is that by developing a clarified language for these ideas, we will be brought one step closer to a strong and coherent set of objectives and performance measures for HSR and corresponding regional restructuring.

Morphological polycentricity, a balance in the distribution of size of urban centers, seems to have primarily social and economic implications. Socially, a more balanced distribution of activity across a region is likely to influence both normative social equity goals and more pragmatic political considerations. Depending on the relationships between space and actual accessibility (as determined by the transport network), achieving a more even distribution of activity could result in greater equity of opportunity across a region. Additionally, geographic boundaries are still what define districts for the purpose of government elections and so there is a natural political inclination towards distributing economic or demographic mass in geographic space. In economic terms, de-concentration of businesses or households from congested metropolises can help avoid the negative externalities of growth. Assuming functional

relationships (among newly dispersed activities) still need to be maintained, that avoidance comes with a corresponding cost—the cost of transporting people between more distant centers. HSR is a technology that reduces transport costs (i.e. time), thus making it more beneficial to network smaller cities together with larger ones, rather than struggling to accommodate growth within an already congested metropolis.

In general, policy-makers are often faced with a tradeoff when considering national or regional growth strategies: to what extent are we willing to accept less overall economic growth due to dispersion and reduced agglomeration externalities, for the sake of achieving a more equitable distribution of economic opportunity within a region? In the case of HSR, we suggest that directing attention towards smaller intermediate cities will help in navigating this tension; with the introduction of HSR service, these cities can become centers for augmented agglomeration benefits while also delivering improved accessibility and greater development to less prominent areas of a country.

Already in our discussion of morphological polycentricity, we started to consider functional connections among cities and the influence of urban form on agglomeration benefits. Morphological polycentricity alone does not ensure that existence of flows (commuter, business trips, etc.) *between* cities. Nor does it necessarily capture the densities of development and therefore the environmental and economic benefits of a given development pattern.

Therefore, we employ additional concepts to provide a more complete understanding of polycentric regional architectures, beginning with **functional relationships**. Transport infrastructure and information technology enables the flow of people and ideas and allows for a more efficient sorting of activities across space. Functional connections are the substance of network agglomeration, a key economic goal. Ease of transport can allow businesses and households to select locations according to their own complex set of priorities, thus (in principle) pushing each location further towards its 'highest and best use.' A business may choose to relocate to a smaller city to save money while maintaining access to clients or collaborators in a larger city. Alternately, a household may choose a different style of living outside a big city while still maintaining access to certain jobs that concentrated in large metropolises. Because functional connections often require complex face-to-face interactions, denser urban environments (like those supported by a centrally located rail station) are privileged points of

exchange, thus producing a promising synergy with environmental goals that also call for denser development. In the case of rail access, businesses are likely over time to cluster around stations in smaller cities; these new areas can then attract "reverse" commuters and business trips *from* larger cities. A smaller city is most likely to benefit from new HSR if it its connectivity enables two-way interactions with other cities.

Still, there are distinctions to be made between the **density** of network connections between cities and the degree to which they are balanced or **reciprocal**. Dominant cities within an urban **hierarchy** play a specialized role as gateways to the global economy. Moreover, relational hierarchy shows some signs of influence over and above what would be expected, taking into account city size alone. Given two cities of the same size, one at the top of a regional hierarchy and one located adjacent to a much larger city, the former will have greater influence. Thus, the equity-oriented goal of achieving more balanced relationships between cities must be tempered by adequate acknowledgment of the importance of hierarchy.

Hierarchy acts at multiple scales. Lisbon and London, as the largest cities in Portugal and the UK respectively, each perform particular specialized functions that provide benefit to the rest of their nation, while also functioning with their own daily commuting patterns. Moving down a level in geographic terms, cities like Coimbra and Birmingham serve as regional hubs of activity that again can benefit their surrounding region. They simultaneously play support roles to the larger cities (Lisbon and London), and participate in their own local labor and commercial markets. The challenge is to develop policy that addresses **the multiplicity of roles** played by most urban areas and the bi-directional support relationships that exist between settlements of almost all types. We do not yet have clear directives from economic theory on how to build **complementary** relationships among cities. What we do know is that new economic growth tends to build on prior strengths. Therefore, the planning process for HSR should consciously seek to integrate local knowledge.

Finally, the composition of physical space is independently important to both environmental and economic sustainability objectives. Proximity accounts for many of the benefits of urban agglomeration and is not necessarily guaranteed by morphological or functional polycentricity. Thus, the degree of **dispersion versus centralization** in terms of urban form needs to be considered. Goals of reducing land consumption and encouraging productivity gains

from agglomeration will not be adequately captured without this category of performance measure.

The next chapters of this thesis return to a pair of specific planning contexts. We investigate whether institutional structures in Portugal and the UK are capable of delivering a HSR system that achieves its spatial and distributional objectives. In particular, Chapters 7 and 8 focus attention on Coimbra, Portugal and Birmingham, UK—two cities that perform a multiplicity of roles within their respective regional and megaregional systems. Chapter 8 also explicitly considers the need for good decision-making that remains committed to a project's overall goals and objectives, over time and under conditions of long-term uncertainty. The analysis compares institutional contexts and mechanisms available for inter-jurisdictional HSR planning, both at the initial design and evaluation phase, and through ongoing implementation and management of the system.

7 Learning Across Contexts: HSR Planning in the United Kingdom

Chapter 6 took a broad theory-based perspective on the dual top-down and bottom-up motivations (i.e. national, regional, and local) behind HSR implementation. Chapters 7 and 8 return to the constraints and opportunities provided by specific planning contexts. We seek lessons for successfully combining top-down and bottom-up approaches. Introducing the comparative case of ongoing HSR planning in the United Kingdom expands our understanding of the mechanisms available for effective inter-jurisdictional HSR planning. Having adopted an agenda of sustainability and hence equitable growth, we now ask—do existing policy tools and institutional structures have what it takes to design and deliver a successful HSR system?

These two chapters (7 and 8) also address temporal aspects of HSR system design. Under the long-term uncertainty characteristic of large infrastructure projects, technical alternatives will necessarily evolve over time as new information and new situations require. The case of Portugal makes it amply clear that exogenous economic and political trends can drastically affect both the timing and substance of an infrastructure project. Therefore, taking a robust systems perspective means that we not only design organizations to govern HSR infrastructure and operations, but that we also think carefully about the streams of planning decisions (the processes) into which the project will enter. Effective strategic planning is more than a matter of finding, with some 'black box,' the 'optimal' design solution and then choosing the best delivery vehicle for that design (although this is undoubtedly close to reality for certain parts of the technical system). Rather, design and implementation will also be an exercise in discovery. In particular, integrating HSR into local contexts will involve uncovering and responding to local knowledge and needs. Whether intentionally or unintentionally, HSR will build on what is already in the areas served (local economy, demographics, local transport). As policy makers and engineers, we are interested in the 'levers' that can be intentionally influenced and built upon.

Existing processes and evaluations mechanisms affect the level to which diverse channels of knowledge are incorporated into ongoing and iterative system design. We here juxtapose the UK case, a live project in a well-developed but still early phase, with the (suspended) Portuguese project. By doing so, these chapters highlight the importance of multiple stages along a project's timeline, from conception through to implementation and beyond. The analysis also pays

particular attention to the secondary cities of Coimbra, Portugal and Birmingham, UK. Both cities play a multiplicity of roles. They support and are supported by the major metropolises of Lisbon and London respectively. At the same time, each plays a dominant within its own region. Given the importance of layered hierarchies and concerns with the distribution of benefit, these two cases are individually and collectively instructive.

Our comparative analysis appears in the next chapter. This chapter focuses on the context of HSR planning in the UK. First we present the details of the overall HSR project in the UK. Next, the details of two stations are presented: Old Oak Common in the Greater London Area (GLA) and the Birmingham city center station in the West Midlands region. Background is provided on the local governmental agencies involved in each area and we explain the value of each case. Following, in Chapter 8, a set of frameworks from the fields of engineering systems and political science are presented. These frameworks are then used for the remainder of the chapter to structure an examination of two stages of system planning: (1) Initial design and project evaluation, and (2) Ongoing management, with a focus on managing the inevitable uncertainties with which the project will be faced.

7.1 Introduction to the HS2 project in the United Kingdom

High Speed Two (HS2) is the name of the HSR project currently in planning stages in the UK. High Speed One (HS1) refers to the already built connection between London and the Channel Tunnel. The latter forms an international link that connects London to Paris is just over two hours and to Brussels in under two hours.[1] Figure 7-1 illustrates the UK government's proposed HSR network. While the government is ultimately interested in further connections to the north, the HS2 project comprises the Y-shaped network between the major cities of London, Birmingham, Leeds, and Manchester.

The project is aimed at improving the competitiveness of the UK economy, providing an outlet for the 'overheated' London real estate market, and providing a more uniform distribution of economic activity between the London-dominated southeast and the rest of the country:

> High speed rail would bring central London to within 49 minutes of central Birmingham, and within 80 minutes or less of Leeds and Manchester. By slashing

[1] "International Rail Services." High Speed 1, http://highspeed1.co.uk/rail/international-rail-services/ (accessed April 18, 2013).

journey times and linking to our major international gateways, it has the potential to help bridge the North-South divide that has for too long limited growth outside London and the South East.[2]

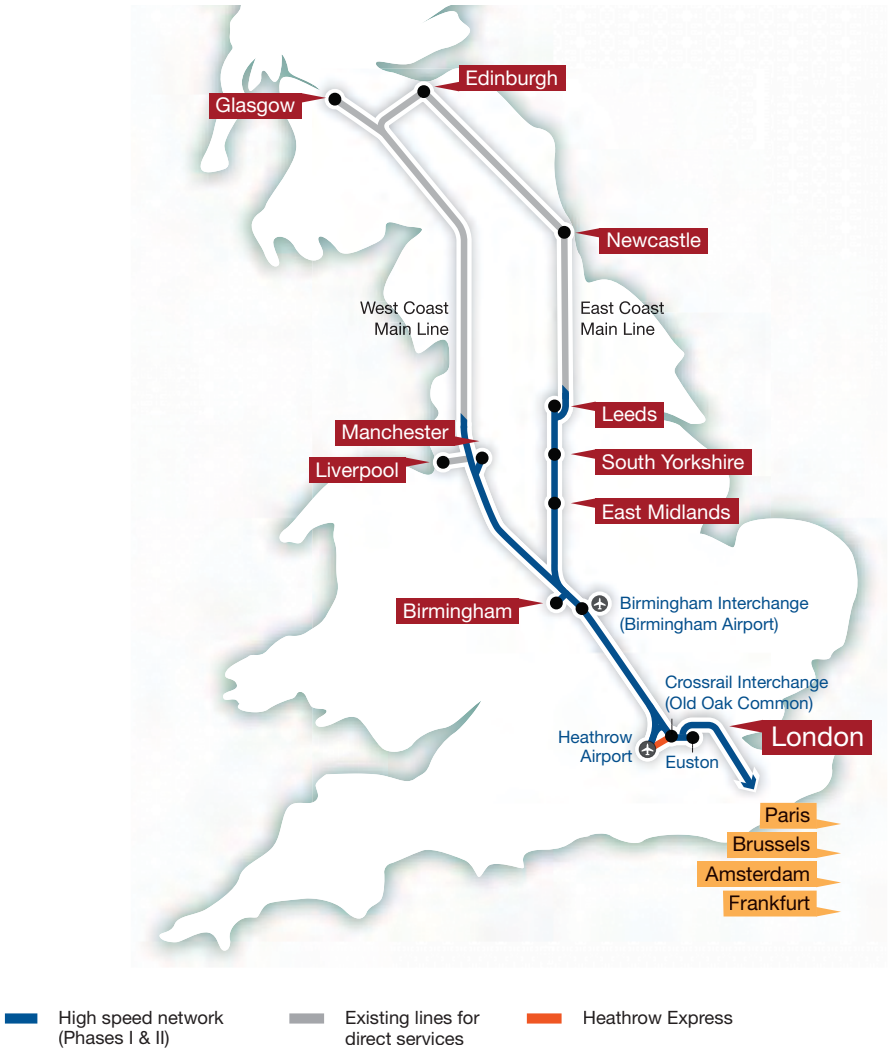

Figure 7-1 The UK government's proposed national high-speed rail network (Source: DfT[3])

HS2 is broken up into two implementation phases. Phase One will build the link between HS1, London, and Birmingham. The line from London to Birmingham will be approximately 140 miles long. Phase Two covers the connections to Manchester and Leeds and includes a spur to Heathrow airport. The link from Birmingham to Manchester will be around 95 miles long

[2] Philip Hammond, *Foreword, High Speed Rail: Investing in Britain's Future* (London, UK: Department for Transport (DfT),[2011]).

[3] *High Speed Rail: Investing in Britain's Future* (London, UK: Department for Transport (DfT),[2011c]).

while from Birmingham to Leeds is approximately 116 miles long.[4] HS2 Ltd is owned by the national Department for Transport and is the company responsible for developing HS2, including preparation of all planning and assessment documents.[5]

After a formal consultation on Phase One, a decision on the preferred route was made in 2012. Public consultations have also occurred for the scoping and methodology of an Environmental Impact Assessment (EIA) and for the project's safeguarding, which designates land required for the successful completion of HS2.[6,7] HS2 Ltd is now in the processing of preparing an initial draft Environmental Statement. Once an additional consultation is completed, a finalized draft of the Environmental Statement will form the basis of the Hybrid Bill,[8] the authorizing legislation that will be submitted to Parliament and then subjected to an extensive process of vetting before final approval or "Royal Assent."[9] The Phase One consultation also included consultation on an "Appraisal of Sustainability." Feedback on this appraisal serves as a starting point to the EIA.[10] Phase One was initially targeted to begin construction in 2017, but delays are likely. This analysis focuses on two stations on the Phase One alignment: Old Oak Common, in London, and Birmingham.

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[4] "Route, Trains & Cost." High Speed Two (HS2) Limited, http://www.hs2.org.uk/about-hs2/facts-figures/route-trains-cost (accessed April 18, 2013).

[5] "About HS2 Ltd." HS2 Ltd, http://www.hs2.org.uk/about-hs2-ltd (accessed April 25, 2013).

[6] "EIA Scoping and Methodology Consultation." HS2 Ltd, http://www.hs2.org.uk/have-your-say/environment/scoping-and-methodology-consultation (accessed May 5, 2013).

[7] "Safeguarding Consultation (London to West Midlands)." Department for Transport (DfT), http://highspeedrail.dft.gov.uk/consultations/safeguarding-consultation-london-west-midlands (accessed May 5, 2013).

[8] So called because it combines public and private law, the former of which applies to classes of people and the latter of which deals with specific people.

[9] "Key Dates." High Speed Two (HS2) Limited, http://www.hs2.org.uk/about-hs2/key-dates (accessed April 18, 2013).

[10] "Environmental Impact Assessment." Department for Transport (DfT), http://highspeedrail.dft.gov.uk/node/3541 (accessed May 5, 2013).

7.2 Old Oak Common station, London

Old Oak Common (OOC) is located on the western side of the area governed by the Greater London Authority (GLA), on the boundary between what is considered outer and inner London (Figure 7-2). It is in one of the poorest areas in London.[11]

Figure 7-2 Location of Old Oak Common within the Greater London Area (Source: Dijkhuis and Siraut [12])

The site includes a unique convergence of transport infrastructure and a significant amount of industrial land. The proposed HSR station at OOC is viewed by Transport for London and the London mayor's office as an opportunity to create a strategic interchange for west London and to achieve considerable area regeneration (Interview, TfL, unpublished data).[13] To further this end, London (a powerful but nevertheless non-national government agency) is advocating for an adjustment of the HS2 plans to include London Overground connections.

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[11] "High Speed Rail for H&F." London Borough of Hammersmith & Fulham, http://www.lbhf.gov.uk/Directory/News/HS2.asp (accessed April 21, 2013).

[12] Ibid.

[13] Interview, Michael Colella, Julian Ware, Andrew Wallace, Peter Moth, and Simon Weaver. Transport for London (TfL), January 7, 2013.

7.2.1 A complex institutional and physical environment

As a station-area, OOC is complex in both governance and physical terms. Beginning with governance: OOC is on the northern boundary of the Hammersmith & Fulham borough of London. Three other boroughs—Brent, Ealing, and Kensington & Chelsea border it. Established in 1999, the GLA is a governance structure unique to the London area of the UK (Figure 7-6).[14] Within the GLA, the elected London mayor acts as a 'super mayor' with responsibilities that include strategic transport, housing, and economic development planning. The mayor's office sets budgets for the Metropolitan Police, Transport for London (TfL), the London Development Agency and London Fire Brigade.[15] Under the GLA are thirty-three municipalities: thirty-two London Boroughs and the City of London Corporation, which governs the central business district. Boroughs control ninety-five percent of London's road network (excluding a number of strategic routes under TfL) as well as land use regulation, education, and other local services.[16] TfL, which operates at the GLA level, manages the London public transport system and a number of strategic roadways.

Physically, OOC is located adjacent to a large number of currently unconnected transport systems (Figure 7-3): The London Overground and Southern rail services come in at Willesden Junction to the north. The Bakerloo Line of the London Underground also connects at Willesden Junction. The Central Line of the Underground serves North Acton to the west and East Acton to the south. The stations have limited utility for the area, however, except in the most western parcels. Bus routes run along the periphery. The site is also in proximity to primary roadways, the A40 and the A406, which are both subject to significant congestion. Crossrail, a major project currently under construction to improve east-west connectivity in London (including access to Heathrow airport), will also run across the site. This fact, along with the proposed

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[14] "Greater London Authority." LONDON.GOV.UK, http://www.london.gov.uk/mayor-assembly/gla (accessed April 18, 2013).

[15] "Mayor of London." LONDON.GOV.UK, http://www.london.gov.uk/mayor-assembly/mayor (accessed April 18, 2013).

[16] "London Boroughs." London European Partnership for Transport, London Councils, http://www.londoncouncils.gov.uk/services/lept/boroughmap/ (accessed April 18, 2013).

siting of the HS2 station, has led planners to identify OOC as a potential major west London interchange.[17]

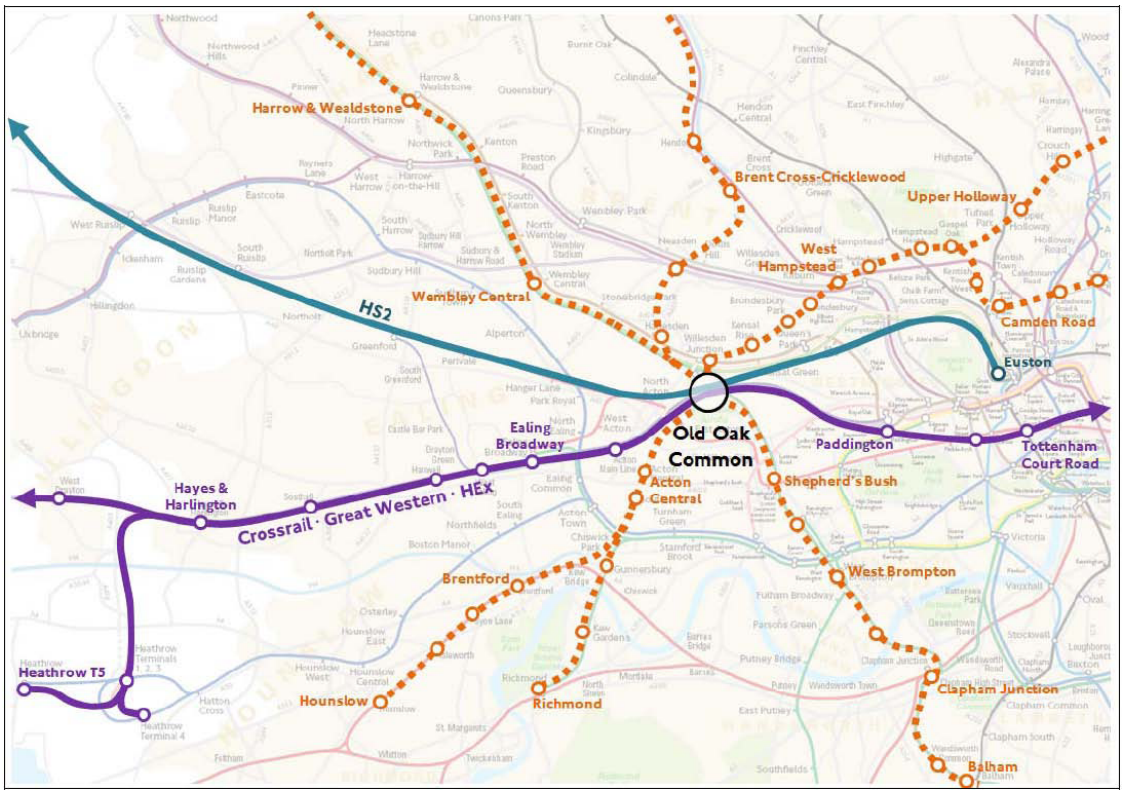

Figure 7-3 Proposed intermodal hub for HS2, Crossrail, and the London Overground (pictured in orange). Source: Moth[18]

7.2.2 Redevelopment potential and long timelines for redevelopment

Currently the OOC area is industrial, with a mix of old and newly built facilities. Recent facility upgrades mean that at least some of the area's industrial uses are still of relevance to the London economy. Long timelines are likely to be involved in any redevelopment effort, given the difficulty of re-siting these industrial uses. The Grand Union Canal and adjacent recreational path offer amenities that could be capitalized in any new real estate endeavor (Figure 7-4). Adjacent to the OOC area, an Imperial College satellite campus is being established, thus hinting

[17] Peter Dijkhuis and John Siraut, *Old Oak Common: Gross Value Added, Final Report* (London: SKM Colin Buchanan,[2012]).

[18] Peter Moth, *ADDITIONAL RAIL CONNECTIONS AT OLD OAK COMMON: Feasibility Report* (London: Transport for London,[2012]).

at the potential of the area. However, the site faces serious development challenges due to its vast amount of transport infrastructure and complex and fragmented geometry (Figure 7-5):

> Currently, the majority of the study area comprises existing rail lines and sidings (which will become the Crossrail depot for maintenance and stabling facilities); the former Eurostar Depot to the south of the Great Western Main Line to be used for the new IEP (Intercity Express Programme); the Grand Union Canal; numerous roads, bridges and underpasses; and, various steep embankments. It should be noted that in any development scenario these infrastructure elements will need to be addressed…This will inevitably increase development costs, restrict the development area, and require innovative design solutions to create a coherent new city precinct.[19]

Local accessibility to the HSR station and to any new residential or commercial developments will be a particular challenge given the fragmentation of buildable parcels and lack of permeability at the pedestrian scale. Nevertheless, the site is considered to have considerable redevelopment potential in London's highly land-constrained real estate market. While the various land parcels in the station-area are leased to different bodies, most of the land itself is owned by Network Rail, the owner and operator of the UK's rail network, thus simplifying to some extent strategies for future development (Colella, unpublished data).[20]

Figure 7-4 Grand Union Canal – a recreational opportunity (Source: Author)

7.2.3 Value of OOC as a case study

The Old Oak Common station-area offers insight into the HSR planning process because of two particular aspects of its local context: First, because of its location in an area governed by the GLA, OOC is situated within a planning system that provides a unique structure for regional

[19] Dijkhuis and Siraut, *Old Oak Common: Gross Value Added, Final Report*

[20] Personal communication, Michael Colella, Transport for London. May 13, 2013.

government and national-local interactions. In particular, we will examine the importance of the Opportunity Area Planning Framework (OAPF) and the possible creation of a Mayoral Development Corporation (MDC) to deal with inter-jurisdictional planning. We also note the considerable influence of TfL as an organization with considerable independent resources and that represents the mobility interests of the UK's dominant city—in contrast to the lesser influence available to secondary cities like Coimbra or Birmingham. Second, OOC is a case study that draws attention to the long timelines involved in urban redevelopment, as well the inherent uncertainties of planning for such long timeline and the sensitivity of outcomes to initial decisions.

Figure 7-5 Complex and fragmented landscape at OOC (Source: Dijkhuis and Siraut[21])

7.3 Secondary city – Birmingham station

Birmingham is located 110 miles from London. The second most populous area (with just over 1 million people) in the UK, Birmingham sits atop the regional hierarchy of the West Midlands. HS2 offers the chance to enhance this position while also bringing Birmingham within

[21] Ibid.

easy commuting distance of central London.[22] Compared to Old Oak Common in London, the Birmingham station is situated within a more fragmented institutional structure. Lacking the unifying institution of the GLA, the station will be influenced by a number of planning entities including the Birmingham and surrounding municipalities; newly created Local Enterprise Partnerships (LEPs); Centro, the regional transit regulator; and possibly the Core Cities Cabinet, a cooperative advocacy group for major cities outside of London. Given the shared influence of multiple institutions and local governmental entities (Figure 7-6), cooperation is again of importance for Birmingham an the surrounding West Midlands region, as in the Portuguese cases already examined in Chapter 4.

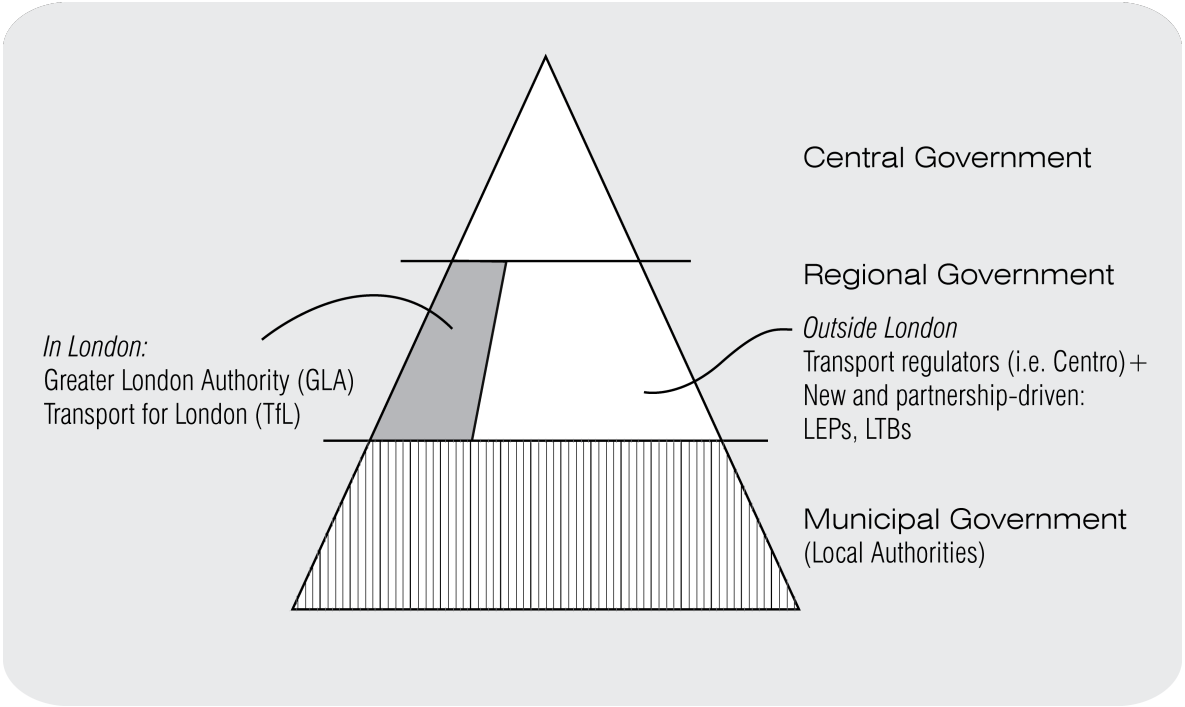

Figure 7-6 Comparing forms of regional government in London and elsewhere in the UK (Source: Author)

7.3.1 Devolution and the need for cooperative governance

Outside of London, the UK Localism Act of 2011 abolished regional strategies in favor of a strategy of devolution of powers to local governments. The law established a "duty to cooperate" based on the argument that regional strategies were bureaucratic impositions and that

[22] *Birmingham Big City Plan: City Center Masterplan* (Birmingham: Birmingham City Council,[2011a]).

local governments should cooperate out of *self-interest*, not because they are ordered to.[23] The law emphasizes "sustainable development or use of land for or in connection with infrastructure that is strategic and has or would have a significant impact on at least two planning areas" as a context in which cooperation should be considered. There are, however, no formal requirements for cooperation.[24]

The law did create a number of new planning bodies intended to support local partnership-driven development. Local Enterprise Partnerships (LEPs) are boards with membership from both the public and private sectors. The Greater Birmingham and Solihul LEP (GBSLEP), which covers nine municipalities, has an eighteen-member board—ten from the local business community, seven from local authorities, and one to represent universities.[25] LEPs have access to funding sources intended to facilitate private investment in local economies.[26] The GBSLEP has established a revolving fund using national funding that is intended to support programmatic rather than project-by-project investment in infrastructure.[27] In addition, the Localism Act also set the stage for devolution of transport funding starting in 2015, by means of new Local Transport Boards (LTBs). LTBs are voluntary partnerships between local authorities; in most cases the LEP will be the LTB, although in the case of Birmingham, overlapping boundaries of the GBSLEP with other adjacent LEPs makes LTB boundaries currently unclear. In some ways they are similar to US Metropolitan Planning Organizations. Funding for LTBs will be allocated by formula on the basis of population with LTBs responsible for submitting lists of priority projects.[28]

As with LEP-driven planning, the expectation of this model of transport funding is that local government entities will cooperate out of self-interest to achieve larger projects of regional

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[23] *A Plain English Guide to the Localism Act* (London: Department for Communities and Local Government,[2011e]).

[24] *Duty to Co-Operate in Relation to Planning of Sustainable Development, Localism Act 2011* (2011): Chapter 1 Section 110.

[25] "GBSLEP Board of Directors." Greater Birmingham and Solihul Local Enterprise Partnership, http://centreofenterprise.com/board-director/ (accessed April 21, 2013).

[26] "Regional Growth Fund." Greater Birmingham and Solihul Local Enterprise Partnership, http://centreofenterprise.com/rgf/ (accessed April 21, 2013).

[27] *Growing Places Fund: Prospectus* Department for Communities and Local Government,[2011b]).

[28] *Local Frameworks for Funding Major Transport Schemes: Guidance for Local Transport Bodies* (London: Department for Transport,[2011d]).

importance, and that the economic case for infrastructure investment will be clear enough to secure private investment:

> With funding devolved to LTBs operating broadly on LEP geographies the ability to fund larger local major schemes will depend on pooled funding and securing additional third-party funding. The onus will be on LTBs to ensure they take advantage of the opportunities to collaborate and jointly fund projects with their neighbours.[29]

Here again, the promise of regional cooperation emerges. It is tempered, however, by the challenge of coordinating across multiple overlapping forms of local and regional government, each with their own limited resources. While almost always a challenge, fiscal pressures are at present exacerbated by tight global economic conditions. Moreover, while LTBs may be an appropriate delivery vehicle for investments in regional connectivity that supports HSR, it is likely that the national government will have a strategic role to play in guiding and funding at least a portion of those investments. As we saw in Chapter 4, the altered equilibrium created by HSR does introduce new incentives for regional cooperation within the catchment areas of HSR stations. The incentives however are likely to require pointed support from the national government for true cooperation to be realized and for these efforts to be successful.

7.3.2 Public transport in the West Midlands

The single most prominent entity in Birmingham's transportation sector is Centro, the West Midlands Integrated Transport Authority (not to be confused with the region of the same name in Portugal). Originally the West Midlands Passenger Transport Executive (WMPTE), Centro became primarily a coordinating entity after the UK bus system (outside London) was deregulated and privatized in 1985. While it does not operate any services, it does work to coordinate fare integration, to provide good passenger information, and to engage in other activities that promote public transportation in the region. Centro is the receiving entity for national and European Community funding for the region. It is also funded in part by local taxes.[30]

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[29] Ibid.

[30] "Introduction." Centro, http://www.centro.org.uk/corporateinformation/introduction.aspx (accessed April 22, 2013).

While not an operator, the organization is nevertheless influential. In coordination with the ongoing tram project in Birmingham (see Section 7.3.3), Centro worked with local bus operators to create new transfer hub locations. Centro cannot dictate routes operated by private operators, but they can advocate for more coordinated service, using their system-wide perspective to advocate for change that individual operators ultimately make out of self-interest (Interview, Rackliff, unpublished data).[31] This guidance of private operators is promising for future coordination efforts of private bus service in the Centro region around Coimbra, Portugal. Centro also supports rail stations in the region and participate in regional rail planning activities.[32] Finally, the ongoing tram project to extend the Midland Metro falls in large part under Centro's authority, as the owning agency (again, they do not operate service).[33]

7.3.3 Local proposals that predate HSR

Two interrelated local Birmingham projects predate the HS2 planning process: the Midland Metro extension and a new economic development initiative on the east side of downtown Birmingham. Located in precisely the same geography as the proposed HSR station, these two projects will be affected by the manner in which HS2 is implemented. Moreover, the projects—aimed (partially) at providing an accessible and immediate urban experience for HSR users—are the ideal types of HSR-supportive initiatives and therefore likely to affect the overall success of the HS2 project.

Figure 7-7 shows the location of the planned HS2 station, proposed route for phase 2 of the Midlands Metro extension, and Eastside economic development area around the station. The Midlands metro already operates service from Wolverhampton to Birmingham, a distance of approximately thirteen miles, with twenty-three stations.[34] The terminating station currently is Snow Hill, located a fifteen-minute walk from Moor Street Station and the planned Curzon Street HS2 station. Already approved is an extension of the tramway to New Street Station, which is being rebuilt (Figure 7-7).

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[31] Interview, Toby Rackliff, Centro. Birmingham, January 11, 2013.

[32] "Rail Stations." Centro, http://www.centro.org.uk/rail/railstations.aspx (accessed April 22, 2013).

[33] "Introduction."

[34] "Network West Midlands - Metro Map." Network West Midlands, http://www.networkwestmidlands.co.uk/metro/trammap.aspx (accessed April 22, 2013).

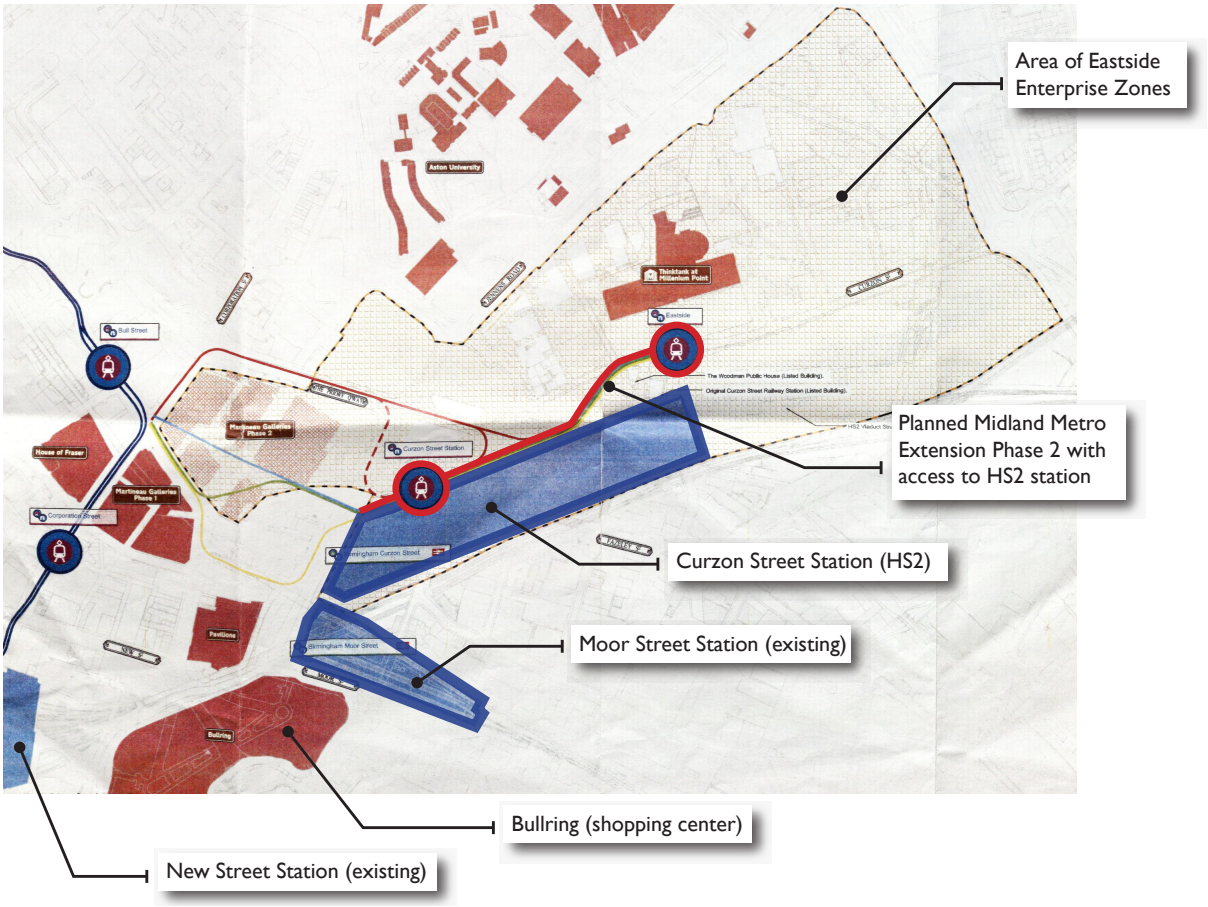

Figure 7-7 Birmingham HS2 station area with Eastside development zone and metro extension (Source: Author, using Centro base-map[35])

Phase 2 of the metro extension is intended to further link New Street, a key rail interchange for Birmingham, with the HS2 station and beyond.[36] The City Centre Enterprise Zone was set up by the Greater Birmingham and Solihull LEP in April 2011 prior to approval of the HS2 preferred route in 2012. It covers twenty-six sites including three that are adjacent to the HS2 station and collectively referred to as "Eastside."[37, 38] Creation of an Enterprise Zone allows the LEP to offer incentives for development. Eastside will take advantage of funding for site

[35] Mott MacDonald, "Midland Metro Phase 2 High Speed 2 Link Route Options" (Reference drawing, Centro, Birmingham, 2012).

[36] "Midland Metro Reopens After Easter Closure." Centro, http://www.centro.org.uk/newsroom/PressReleases/PressRelease56981.aspx (accessed April 22, 2013).

[37] "Birmingham City Centre Enterprise Zone." City of Birmingham, http://bigcityplan.birmingham.gov.uk/ez-main/ (accessed April 22, 2013).

[38] *Birmingham City Centre Enterprise Zone: Prospectus* (Birmingham: Birmingham City Council,[2013a]).

development, access, and infrastructure; a simplified planning process; broadband Internet service; reduced business taxes; and business development support.[39] Co-location of these three projects is promising but also results in a set of detailed demands regarding project design and the phasing of implementation—demands that can only be met through inter-jurisdictional planning.

7.3.4 Value of Birmingham as a case study

The planning process surrounding the city-center station in Birmingham is instructive for a number of reasons. First, the case highlights the challenges and risks associated with integrating local initiatives into a national HSR planning process. In particular, the Birmingham station demonstrates how uncertainty may block easy integration of local proposals into HSR project evaluation. The station-area plans also present examples of the attention to detail required for effective station planning. Local officials are making an effort to ensure easy pedestrian and transit access to the station and to ensure that immediate decisions regarding station design are adequately sensitive to directions of future growth in the area. Finally, conversations within the larger West Midlands region regarding released conventional rail system capacity reveal how HSR investment can require reconsideration of other regional transport strategies.

7.4 A summary of key points – Old Oak Common and Birmingham City Center

This chapter presented details of the UK HSR project and in particular the planned stations of interest at Old Oak Common, in west London, and Birmingham City Center. We focus in particular on the institutional environments for each station in recognition of the fact that designs for HSR are not independent of the institutional sphere from which they emerge. Additionally, existing local and regional governance structures will a play a role in implementation and ongoing management of HSR and local supportive endeavors. Each case offers a particular set of local conditions. In Chapter 8, these details contribute to a deeper understanding of the interface between local government and national HSR planning.

Old Oak Common is notable because of the station-area's physical complexity and significant redevelopment potential. The case emphasizes the importance of long-term uncertainty related to land use changes and redevelopment schemes. Additionally, because of its

[39] Ibid.

location within the Greater London Area, OOC has a unique structure available for regional government and national-local interactions.

Birmingham is a case that is more comparable to efforts in Coimbra, Portugal. Like Coimbra, Birmingham sits atop the regional hierarchy in the West Midlands. Any HSR-related redevelopment in the city, therefore, will be of considerable interest to both local and regional planning entities. LEPs and LTBs offer a platform for regional coordination of HSR-supportive initiatives. Additionally, the Birmingham station is notable because of existing plans for a metro extension and economic development initiative in the area of the proposed HSR station. These highlight the detail-oriented planning required for successful integration of local initiatives into national HSR efforts.

In Chapter 8, the Birmingham case is used to demonstrate how uncertainty can block easy incorporation of not-fully-committed local proposals into HSR project evaluations.

8 Inter-jurisdictional planning from start to finish

Following the general discussion presented in Chapter 7, we now delve more deeply, seeking lessons that can be gleaned from a joint understanding of HSR planning in Portugal and the UK.

8.1 Frameworks from engineering systems and political science

This analysis uses analytical frameworks from the fields of engineering systems and political science. These frameworks help us understand both the problems at hand and the possibilities offered by specific institutional arrangements and planning mechanisms from the UK and Portuguese planning systems.

8.1.1 Policy windows

In 1985 political scientist John Kingdon published *Agendas, Alternatives, and Public Policies* in which he developed a theory for the making of public policy.[1] Writing about the fragmented and often opaque policy process in the United States, Kingdon presents a model in which three streams converge to yield "policy windows." These are: problems, policy, and the political. First, a *problem* is collectively recognized. Second, some *policy* is identified to solve the problem, as stated. The policy may even have predated collective identification of the problem. Third, the *political* will must exist. Without any of these ingredients, action is unlikely. The key therefore is to recognize policy windows when they occur and to take advantage of them:

> ..the role played by *policy entrepreneurs* both and inside and outside of government in constructing and utilizing agenda-setting opportunities—labeled *policy windows*—to bring issues onto government agendas.[2]

The present situation in the UK can be described according to this model:

- Problem(s): The UK recognizes a threefold problem of (1) an unequal distribution of economic benefit across the country (an issue further highlighted by the current economic

[1] John W. Kingdon, *Agendas, Alternatives, and Public Policies*, 1st ed. (Boston: Little Brown, 1984).

[2] Michael Howlett, M. Ramesh and Anthony Perl, "Agenda Setting," in *Studying Public Policy: Policy Cycles & Policy Subsystems*, 3rd ed. (New York: Oxford University Press, 2009), 103.

crisis); (2) negative environmental consequences from existing growth patterns; and (3) constraints imposed on growth by congestion in the London metropolitan area.

- Policy: Largely due to the efforts of the UK advocacy group *Greengauge 21*, high-speed rail has been widely accepted as a solution to the problems outlined above.[3]
- Political: Both major parties in the UK are in favor of the HS2 project. The Conservative government wants to demonstrate their capacity 'to get things done.' The Labour party is interested in the socioeconomic and environmental case for HSR. Cities across the UK want economic stimulus from the project. London's skepticism about investments in local connectivity (e.g. Overground connections at Old Oak Common) is the most influential partial opposition to HS2 (Ware, unpublished data).[4]

The opportunity is significant. However, the convergence of the problem, policy, and political "streams" also poses a risk: what if a policy window appears without the policy itself having been adequately developed to solve the problems collectively identified? Given the scale of investment and effort needed for HSR, not realizing full potential benefits is a significant hazard. One source of risk is the ability of existing institutions to find and implement the best solution. The CLIOS process, which outlines the need for bundling institutional and technical alternatives, offers insight into the challenge.[5]

But first, a note on Portugal's suspended HSR planning process: Portugal had been but is no longer in possession of a true policy window for HSR. At present, austerity measures and unemployment are far more pressing problems. National political will for large infrastructure expenditures is unlikely to return before urgent economic issues are dealt with. Nevertheless, the suspension provides an opportunity for perfecting HSR policy—while waiting for the three "streams" to converge yet again.

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[3] "High-Speed Rail Will be Britain's New Transport System for the 21st century." Greengauge 21, http://www.greengauge21.net/ (accessed April 24, 2013).

[4] Interview, Julian Ware, Transport for London (TfL). London, January 7, 2013.

[5] Joseph M. Sussman et al., *The "CLIOS Process": A User's Guide* (Cambridge: Massachusetts Institute of Technology,[2009]).

8.1.2 CLIOS – bundling institutional and technical alternatives

The CLIOS process is a process for studying complex, large-scale, interconnected, open, sociotechnical (CLIOS) systems, of which HSR is certainly one. The method begins with a representation phase in which a system is described as a set of physical or technical subsystems within an institutional sphere. This embeddedness is referred to as *nested complexity* and is one of the fundamental characteristics of CLIOS systems.[6] Because of nested complexity, problem solving for CLIOS systems requires that technical and institutional efforts be coordinated:

> Usually, strategic alternatives that influence the physical domain need to be complemented by changes in the institutional sphere that would make the implementation of the alternative possible.[7]

This model recognizes that regardless of the effectiveness of any particular technical solution, its implementation depends on decision-makers' ability to act by means of policy levers—those components of the technical system that are "most directly controlled or influenced by decisions taken by the actors…on the institutional sphere."[8]

8.1.3 Adaptive decision-making

The CLIOS process teaches us to bundle institutional and technical changes to achieve a target level of performance; but, if viewed statically, this is still a somewhat constrained model of system management, particularly given long-term uncertainty. Adding the dimension of time, Dunn discusses the difference between deliberate and emergent strategies. Deliberate strategy is intentional and *objective-driven*. It can be reflected in both plans and in rules or processes adopted by an organization. Over time, as an organization responds to changes in its environment, it will continue to make decisions. Some will be based on the original plans and adopted rules while others are adapted to suit new conditions. The actual trajectory of decisions is what Dunn refers to as emergent strategy (Figure 8-1).[9]

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[6] Ibid.

[7] Ibid.

[8] Ibid.

[9] Travis Dunn, "The Geography of Strategy: An Exploration of Alternative Frameworks for Transportation Infrastructure Strategy Development" (Doctor of Philosophy in Civil & Environmental Engineering, Massachusetts Institute of Technology), 45.

The inevitability of emergent strategy does not invalidate or reduce the need for deliberate strategy. Quite the opposite: components of deliberate strategy including initial decisions regarding technical alternatives, the definitions of performance, and decision-making processes can set the stage for better emergent strategy. In the case of HSR, adaptive decision-making will depend, in part, on the networks of communication and control in place between various stakeholders. It will also depend on the degree to which initial decisions anticipate and establish the flexibility to deal with both *known* and *unknown* unknowns.

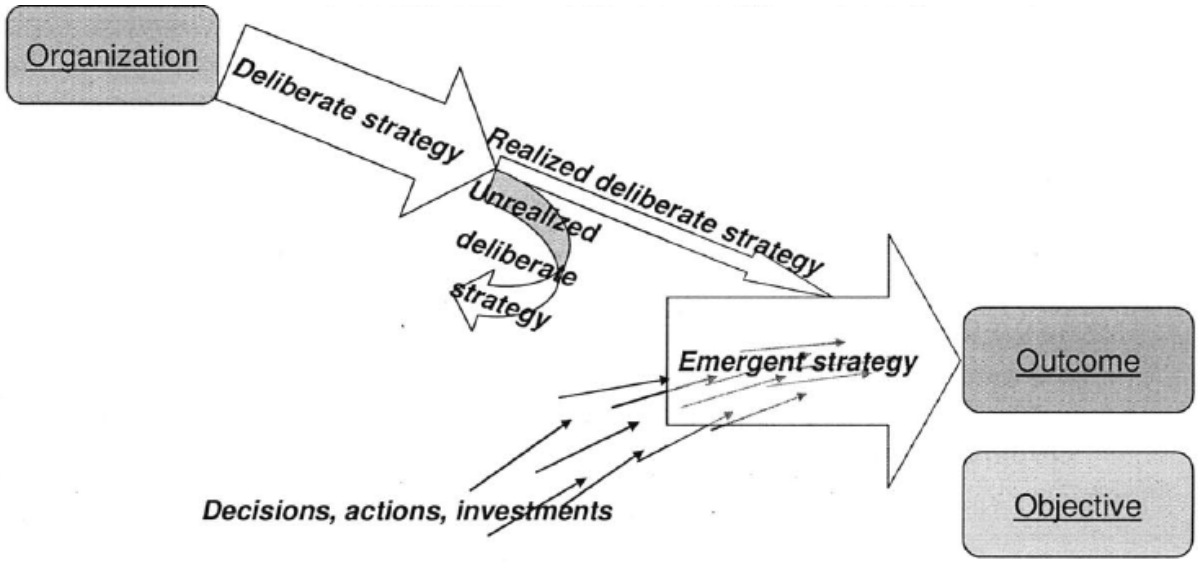

Figure 8-1 Deliberate and emergent strategy (Source: Dunn[10] based on Mintzberg, et al.[11])

8.1.4 Project design, evaluation, and implementation – a timeline of decisions

Given the importance of emergent strategies, we direct our analysis of HSR to examine the decision making process at multiple points in time. This chapter focuses broadly on two stages: (1) initial project design and evaluation and (2) ongoing management. Project design and evaluation are iterative processes. As will be demonstrated by the UK's HS2 environmental impact assessment process, methods of evaluation ultimately influence the adopted design of a project and therefore its expected impact. Long-term management also depends in part on the quality of initial decisions. Important initial conditions will be the focus of the second part of our comparative investigation.

[10] Ibid.

[11] H. Mintzberg, B. Ahlstrand and J. Lampel, *Strategy Safari* (New York: Free Press, 1998).

In many cases, the lessons learned from the UK and Portugal raise a number of further questions. We do highlight these; our guiding premise throughout is that to successfully bundle technical and institutional alternatives, decision-makers need to:

(a) Select and commit to the best alternative, by means of a project design and evaluation phase before the beginning of project implementation;[12]

(b) Have a framework in place that has the best chance of carrying the original design intentions through given long-term uncertainty, while continuing to learn.

Success in either category requires joint efforts across many organizations. The cases of HSR planning in the UK and Portugal offer initial approaches to achieve these ends.

8.2 Local involvement in HSR project design and evaluation

8.2.1 The UK environmental process: mitigation and its challenges as a concept

As in many countries, including Portugal and the US, an Environmental Impact Assessment (EIA) is one of the primary statutory evaluation processes required for the UK HSR project. Because it is legally required for most projects, development of an "Environmental Statement" is a process for which the government is held publically accountable. Its methods, therefore, are influential in determining the substance and details of a project, including the level of attention paid to local planning considerations.

Part of the impact statement is an assessment of significant impacts in traffic and transport. To address any impacts, the draft UK Environmental Statement will include proposed mitigation measures. Once comments from stakeholders have been taken into account, HS2 will finalize the Environmental Statement and submit it to Parliament as part of the Hybrid Bill authorizing process. Mitigations are of interest because they raise issues regarding the inclusion of HSR-supportive local projects. To mitigate is to reduce the severity of predicted, assumed negative, impacts. The transport assessment predicts 'downsides' (e.g. added congestion on local streets surrounding a station) and then develops mitigation efforts to correct or ameliorate them. Not recognized is the possibility of creating greater benefit; mitigations may in fact be an

[12] Sussman et al., *The "CLIOS Process": A User's Guide*

opportunity to increase the 'upsides' of an HSR project, by means of local complementary efforts.

There are challenges to pursuing a broadened approach that considers the potential benefits of complementary efforts: As in the case of Birmingham, already existing complementary projects may not be fully committed and therefore add an additional level of uncertainty to project evaluation. In other situations, local authorities may not have the resources or interest in developing HSR-supportive policies, thus making their implementation even more dependent on initiative (and funding) from the national government. National planning authorities like HS2 Ltd have a real and legitimate need to narrow the scope of assessments to keep them tractable and on-target.

Still, the realized benefits of HSR in wider economic, equity, and environmental terms will depends on local outcomes, regardless of the inclusion or exclusion of specific local initiatives from a national project assessment. Intelligent inclusion of HSR-supportive projects into the assessment framework could justify a more positive distribution of predicted benefits, because of the reduced uncertainty regarding the local context of a new HSR station and service. Rather than ameliorating predicted negative impacts with mitigations, proposals for HSR supportive initiatives (whether new or pre-existing) are likely to increase the benefits side of a benefit-cost analysis. Of course, their analytical inclusion still leaves wide open the question of who should pay for any mitigation. Nor does this approach eliminate political uncertainty that affects the realization of local efforts. Nevertheless, acknowledging the importance of connecting HSR into local contexts within a formal evaluation document is a form of on-the-record support from the national government. Inclusion makes the case, publicly, that the project's success depends partly on complementary efforts and thus increases the likelihood of allocating necessary resources in the eventual authorization and budget allocation process.

8.2.2 Birmingham's interests: joint station-area planning

Birmingham's ongoing metro efforts and development planning in the area of the HSR station provide examples of the types of local initiatives that could be included into project evaluation. In its consultation response to the Appraisal of Sustainability, which forms the basis of the EIA, Centro urges HS2 Ltd to consider local land use and accessibility changes. Centro

claims that the wider benefits included in the assessment are conservatively low because land use is assumed not to change:

> The DfT have assumed no changes to land use will occur as a result of HSR which is not consistent with regeneration proposals associated with the High Speed Rail stations in the West Midlands, e.g. Eastside in Birmingham city centre.[13]

To collect further information, a number of meetings were conducted with representatives from Centro and the Birmingham City Council in January of 2013.[14] According to these officials, there are aspects of the Eastside and Birmingham metro plans that are highly dependent on the manner in which the HS2 station is built. The outer boundary of the station on Curzon Street determines the precise alignment for Centro's planned metro extension. Centro is advocating for the safeguarding of joint work sites for HS2 and the metro, as the projects are likely to occur in close sequence if not simultaneously. Design of the HS2 station will affect other longer-term growth plans in Birmingham as well. The Eastside Masterplan includes proposals for an additional entrance on the south side of the station and for improved pedestrian connectivity to Digbeth, a neighborhood where two more Enterprise Zone sites are located (Figure 8-2).[15,16] Permeability of the station for pedestrians affects the attractiveness of those sites for future development.

Officials from Centro and the city of Birmingham cite some difficulty in coordinating the transfer of information between HS2 Ltd. and themselves. At the January 2013 meetings in Birmingham, a group of TfL employees was also present to discuss HS2. Centro officials mentioned that they were actively pushing the Department for Transport to include concourse connections between the existing Moor Street and planned Curzon Street stations in their list of "sponsor requirements" for HS2, as well as for an improved link to New Street Station which is the key rail interchange for Birmingham. Sponsor requirements are the requirements issued by the Department of Transport for their subsidiary HS2 Ltd. to follow in delivering HS2. Centro

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[13] "All Comments Submitted by Respondent 49672/Centro/Transport, Infrastructure Or Utility Organisation." HS2 Ltd, http://highspeedrailresponses.dft.gov.uk/s2css/viewusercomments.asp?usr=49672 (accessed April 25, 2013).

[14] Meetings, Chris Tunstall and Richard Leonard, Birmingham City Council; Mike Ogden, Maria Pilar-Machancoses, and Toby Rackliff, Centro. Michael Colella, Peter Moth, and Andres Wallace, Transport for London. Birmingham, January 11, 2013.

[15] *Eastside Masterplan: Curzon District* (Birmingham: Birmingham City Council,[2011]).

[16] *Birmingham City Centre Enterprise Zone: Prospectus* (Birmingham: Birmingham City Council,[2013]).

then asked TfL for advice on pursuing this request. Because of its prominent position in London, TfL already has a formalized relationship with HS2 Ltd. and was given drafts of the project's "Sponsor Requirements." They turn out to include some of the very things Birmingham was pushing for:

> 2.72 The HS2 Station at Curzon Street will:
>
> - include a concourse common with Birmingham Moor Street
> - include an interchange facility to be agreed with Centro[17]

TfL and Centro have different levels of access to the national planning process. These differences highlight the difficulties sometimes faced by secondary cities. However, the meeting between the two transport agencies also points to the potential for inter-city collaboration and knowledge sharing.

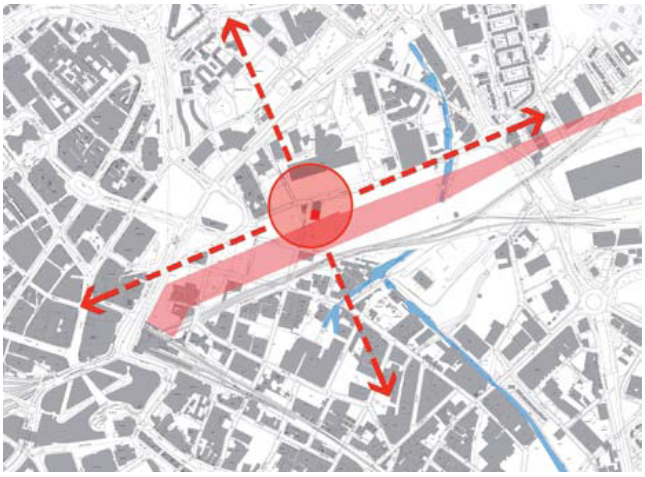

Figure 8-2 Desired pedestrian connectivity through the HSR station, including towards Digbeth to the south (Source: Birmingham City Council[18])

8.2.3 The London model for local input

From a local authority's perspective the exclusion of HSR-supportive initiatives is undoubtedly frustrating, but there are legitimate barriers to their inclusion. The national government is reluctant to include projects like the Midlands metro extension that have not yet been full committed because of the uncertainty of their realization. Similarly, proposals for land use changes carry with them a significant amount of uncertainty and are dependent on the real

[17] *DfT HS2 Sponsor's Requirements V2.5* (London: UK Department for Transport,[2012]).

[18] *Eastside Masterplan: Curzon District*

estate market (see Section 8.3.1). Nevertheless, our study of London reveals ways in which the national-level environmental process can include acknowledgment of local development and connectivity efforts. Applying these approaches beyond London will require concerted effort as smaller cities have less leverage and direct access to the national government than London.

The first formalized method of local input we found is a contractual relationship between TfL and HS2 Ltd. The relationship secures TfL's assistance with progressing plans for the HS2 while also allowing the agency to influence those plans for the benefit of London. In accordance with the agreement, TfL submits requirements to HS2 Ltd., which are then coordinated with DfT's sponsor requirements. Regarding Euston station, the most central London HSR station, DfT has agreed to make some provisions for an eventual interchange with Crossrail 2, another large-scale London rail project still in early planning stages. The goal is to "future-proof" the design so that is does not become unworkable with the realization of later projects (Colella, unpublished data).[19]

Another approach to managing uncertainty, this time for station-area redevelopment, is that put in place by the Opportunity Area Planning Framework (OAPF). An OAPF was created to guide the redevelopment efforts surrounding Old Oak Common station. Local authorities (municipalities), HS2 Ltd., and TfL are all members of the framework. As part of the OAPF process, growth scenarios are produced. These then feed back into analysis performed by HS2 Ltd. as a sensitivity test for their proposals. The tests identify the scale of the environmental and transport impacts and are published as part of the Environmental Impact Assessment. Now on record, these results can hopefully influence the design of HS2 to include future proofing and scalability in anticipation of future growth in the area (Colella, unpublished data).[20] The use of growth and land use change scenarios produced by an inter-jurisdictional planning framework is a promising technique for incorporating local land use proposals into HSR assessment, despite the proposals' uncertainty.

[19] Personal communication, Michael Colella, Transport for London. February 20, 2013.

[20] Personal communication, Michael Colella, Transport for London. February 20, 2013.

8.2.4 Revisiting the Coimbra model

It now makes sense to revisit the Coimbra Urbanization plan, this time as a solution to a now rephrased problem: how can local and national plans regarding HSR and station-areas be coordinated in a manner that effectively deals with long-term uncertainty? A formalized relationship between the City of Coimbra and REFER, the infrastructure manager, enables coordination of both initial design decisions and ongoing management. Bi-directional communication helped support a station design that can work in multiple future scenarios—including the suspension of the HSR project itself. The future of HSR in Portugal and the Coimbra Urbanization Plan remains uncertain due to fiscal constraints. Nevertheless, the joint planning process did yield a more flexible design approach: if the more general Coimbra station plan goes ahead without HSR, it will not preclude future expansion to accommodate HSR passengers (see Section 4.3.3).

8.2.5 A summary of potential mechanisms for local input

Based on observations in the UK and Portugal, Table 8-1 presents a summary of potential tactics to support local input to HSR planning and assessment. The discussion column details specific cases of each model and highlights remaining questions that deserve further study.

Table 8-1 Tactics for supporting local input to a national planning and assessment process

Tactic	*Discussion*
Formalized cooperative agreements	This model was used in Portugal for the station-area urbanization plan in Coimbra. The national involvement seemed to have expedited certain planning activities at the local and regional levels. The contractual relationship that allows TfL to input local requirements into the national planning process also falls under this model. This approach is subject to the risk that local input will receive acknowledgment but not follow-through in the actual HSR designs. A particularly challenging issue is the cost structure for local proposals. National entities will be reluctant to increase the cost (or complexity) of the overall project—particularly given how difficult it is to quantify the benefit of local HSR-supportive initiatives. Possibilities for ensuring follow-through under these agreements include:[21] • Local representation in decision making groups • Specific contractual agreements that require the HSR promoter to follow local plans when siting stations, etc.

[21] Special thanks to Michael Colella of TfL for providing detailed feedback and input regarding these approaches.

	• Designation of a certain percentage of HSR funds for complementary schemes • Clear inclusion of local accessibility requirements in HSR authorizing documents
Targeted funds/other resources	Oftentimes local authorities are faced with limited resources that constrain their ability to develop HSR-supportive policies. Targeted funds or other planning resources can address this, while also securing improved overall performance and also incentivizing inter-jurisdictional cooperation. The Enterprise Zone (EZ) in place in Birmingham actually predates the HS2 project. It offers one model that could in the future be targeted specifically at station-areas. The national UK Enterprise Zone program provides for streamlined planning and business rate relief (tax relief). It also allows retention of business rates so that tax revenue from an area can be reinvested locally—thus incentivizing development-supportive policies at the local level. There is also a question as to the geographic scale at which the funding should be applied: In the UK, LEPs already exists to encourage regional cooperation and these are the responsible entities for EZs. In Portugal at present, most planning is constrained to the municipal level. It may make sense to consider a scale that more closely matches the larger catchment area of an HSR station so that not only the immediate station area but also regional issues may be addressed.
Inter-jurisdictional development of growth and land use change scenario	The OAPF process used in London follows this model; it provides a means of incorporating ongoing local plans into the initial project assessments even if they are not yet fully committed (e.g. land use plans, planned transport investments, etc.). By developing solutions amongst multiple stakeholders, the OAPF hopefully produces a more robust set of development scenarios. While the scenario input model is one method of assessing uncertainty, one might also consider whether there is an appropriate *threshold* for the inclusion of not yet fully committed plans in an HSR system's evaluation. Are there ways for pointed inclusion of local initiatives to actually reduce the uncertainty of development around HSR stations?
Joint advocacy	Findings in Chapter 4 from Portugal indicate that inter-jurisdictional cooperation is perhaps most relevant at the smaller regional scale of an HSR station's area of influence. Nevertheless, the observed knowledge sharing between TfL and Centro indicate that there may be a place for cooperation between cities at the scale of a discontinuous region,[22] by virtue of shared situations and needs. In the UK, the Core Cities Cabinet already advocates for the largest cities outside London. They could play an important role in developing processes for incorporating local and regional concerns into the national HSR planning framework. Phased implementation of HSR also means that inter-city knowledge sharing has the potential to translate into longer-term learning.

[22] See Chapter 4 for a more complete discussion of discontinuous regions.

8.3 Ongoing management in an inter-jurisdictional environment

Section 8.2 dealt with uncertainty as a challenge for incorporating local policies into HSR project evaluation. Moving further along a project's timeline, this section addresses the need for ongoing management and adaptive decision-making in an inter-jurisdictional environment subject to long-term uncertainty. Designing the institutional structure for ongoing management is a challenge precisely because we cannot anticipate fully the future conditions to which an engineering system will have to adapt. Therefore, while acknowledging that there is much to be studied in the broad field of system management, we here focus on initial conditions that can guide an HSR system through inevitable adaptation and help support successful emergent strategies.

8.3.1 Motivation: the uncertainty of urban redevelopment schemes

Before discussing potential strategies for managing long-term implementation uncertainty, this section examines one particular source of uncertainty: the market forces behind real estate development. A retrospective look at an earlier complex redevelopment project in the London area provides motivation for incorporating flexibility into station-area designs.

Despite the best efforts of planners and politicians, it is hard to predict large economic shifts that can drive transformative land use changes. Good accessibility provided by transportation infrastructure is but one ingredient in a complicated recipe for successful urban development. The London Docklands area of London is a case in point. Growth in the global financial sector, along with various pro-development policies and the construction of new transport infrastructure, drove development of London's second finance district (outside the traditional CBD) in the Canary Wharf area of the Docklands.[23] Remarkable growth in Canary Wharf, and more generally in the Docklands, only occurred after a protracted and at times misdirected process of planning—an iterative imagining and reimagining of the future of the area. The high-density commercial redevelopment of the Docklands, and particularly of Canary Wharf, that eventually came to fruition in the late 1990s is a far cry from the low-density landscape originally envisioned in planning documents produced two decades before.

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[23] ""The London Office Market: Geography," in DEVELOPER." LSE Cities Program, http://www2.lse.ac.uk/LSECities/citiesProgramme/pdf/bankside123/05DeveloperAW45pgs.pdf (accessed April 17, 2013).

The London Docklands Strategic Plan published in July 1976 largely focused on rebuilding the failing port area on its historical economic model. The plan proposed a number of industrial zones aimed at recovering lost manufacturing jobs. Its low-density built form is a far cry from the high-rise format that ultimately succeeded in the area. Beginning in 1977, government funding was used to fill in dock basins. Rather than predicting the real estate value of an extensive waterfront, the basins were viewed as an engineering problem to be addressed. 1.3 million square feet of factory and warehouse space was built by 1980, along with a modest number of housing units. None of this earlier construction anticipated the high-density clusters of office buildings that now form the skyline of Canary Wharf (Figure 8-3). Even after completion of the first phase of high-rise office buildings in the early 1990s and the opening of the Docklands Light Railway in 1987, the office buildings remained mostly empty until the end of that decade when the Jubilee Line Extension was opened (1999) and the global finance sector really began to take off.[24,25] The long timeline and initial missteps associated with this area's redevelopment highlight the inherent uncertainties of large-scale real estate development projects. The Docklands serve as a caution against purely deterministic predictions of land use changes in HSR station areas, particularly the area of Old Oak Common in greater London.

Figure 8-3 High-rise buildings in Canary Wharf (Source: Author)

[24] "Docklands Light Railway." Transport for London, http://www.tfl.gov.uk/corporate/modesoftransport/1530.aspx (accessed April 26, 2013).

[25] "Before LDDC." London Docklands Development Corporation, http://www.lddc-history.org.uk/beforelddc/ (accessed April 17, 2013).

8.3.2 A "real-options" framework

In studying long-term implementation uncertainty for HSR in the Northeast Corridor of the United States, Peña-Alcaraz et al. used a combination of the CLIOS process, scenario planning, and flexibility analysis.[26] In particular, they utilized a "real-options" framework to assess the potential benefit of incorporating initial flexibility into HSR system design. While their approach was aimed at broader questions of technology and the appropriate management structure for HSR, the same lens offers insight into more localized decisions regarding land use planning around stations. A real option is:

> "*the right, but not the obligation, [for the option holder] to take some action at a future date at a predetermined price.*" In other words, a potential option holder (decision-maker) can design flexibility now in order to create or maintain the possibility of taking a potential action in the future.[27]

At Old Oak Common, planners are faced with determining the most productive use of the land around the station. Judgments from the Opportunity Area Planning Framework process (see 8.2.3) will influence both local zoning designations and infrastructure decisions that affect what can and cannot be built. Residential development is the safest bet in current market conditions and therefore the most attractive with a short-term cost recovery goal. Taking a longer view might result in a decision to pursue more mixed-use development with both residential and commercial (and possibly even some remaining industrial) uses. Commercial development tends to be more speculative and have a longer timeline for returns. It is therefore riskier but also likely more strategic (Interview, TfL, unpublished data).[28] However, based on our understanding of the uses most likely to benefit from HSR and create further benefit from agglomeration forces, a mix of uses is more likely to be the "highest and best use" in the long term than is a single-use tract of housing (see Chapter 6). Local authorities also tend to be interested in commercial developments because of the greater tax revenues they generate.

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[26] Maite Peña-Alcaraz et al., "Analysis of High-Speed Rail Implementation Alternatives in the Northeast Corridor: The Role of Institutional and Technological Flexibility" (Washington, D.C., Transportation Research Board, Jan 13-17, 2013).

[27] Ibid.

[28] Interview, Michael Colella, Julian Ware, Andrew Wallace, Peter Moth, and Simon Weaver. Transport for London (TfL), January 7, 2013.

There is a case to be made for phased implementation, starting with less risky residential developments adjacent to existing neighborhoods, rather than in the more industrial core of OOC. That way uses can gradually build on one another. Still, some immediate infrastructure decisions do have implications for even a more incremental development strategy. For OOC, designers must choose whether and how much decking to build above the rail yards that comprise a large percentage of the land closest to the station. Decking is expensive and is not justified by lower density development scenarios. Compared to housing, commercial uses will benefit more from immediate station proximity (refer to the discussion of origin and destination users in Chapter 5.4). Decking is less costly to construct initially during overall station construction (thus buying a real option) than later once demand for higher density development has materialized. This is just one example of how initial flexibility can be a powerful tool in enabling decision-makers to respond to future changes, thus improving overall HSR system performance. Peña-Alcaraz et al. provide others.[29]

8.3.3 Formal cooperative management

Given the inter-jurisdictional nature of HSR-supportive transport and development policies, ongoing management will also necessarily be cooperative, whether formally or informally. The Greater London Area, because of its unique governance structure, offers a formal mechanism for coordination between local authorities that in some ways meets the ideal model of regional governance. The Mayoral Development Corporation is an entity that can be established anywhere in the GLA with custom-defined boundaries to meet the development challenges at hand. It is, in some ways, a more targeted and powerful version of an Enterprise Zone.

Established by the Localism Act of 2011, the Mayoral Development Corporation was first used for redevelopment efforts in East London that were pursued in concert with the London Olympics. Under the Localism Act, the mayor of London can, after a process of consultation with local authorities and subject to rejection by the London Assembly, designate any area within the GLA as a Mayoral development area. Boundaries of the area do not have to match municipal boundaries and can include non-contiguous parcels. An MDC is then established with

[29] Ibid.

the goal of securing regeneration of its area.[30] The mayor can decide to make the MDC the local planning authority for any or all of the area—thus in effect becoming the municipal government but with special-purpose boundaries to match the development needs of an area. The MDC is governed by a mayor-appointed board, with representation from affected borough councils. Its powers include 'planning powers' (which determine allowable land uses) and the use of certain financing mechanisms to support development.

The MDC is a unique and powerful planning tool for dealing with issues (like station-area planning) that are best suited to a scale of analysis and control greater than that of a single municipality. While a useful precedent, undoubtedly deserving close study, the likelihood of securing authorizing legislation for similar mechanisms elsewhere may be limited. Therefore, we also consider strategies for supporting informal cooperative management.

8.3.4 Informal strategies

As discussed earlier in Chapter 4, HSR is a unique opportunity in that it has the potential to shake up a prior competitive landscape enough to incentivize reconsideration of inter-jurisdictional relationships. Thus far, we have highlighted three forms of cooperation:

- National-local: Incorporation of local knowledge and complementary initiatives into the national HSR planning process is necessary to achieve the full extent of benefits.
- Local-local, within a region: Within an HSR station's region of influence, smaller cities have an incentive to cooperate so as to secure benefits of HSR without losing out to large metropolitan areas.
- Local-local, across a discontinuous region: Cities located relatively far from each other but sharing the same situation of a new HSR station may benefit from joint advocacy and learning from each other's strategies.

In each case, certain efforts will be clearly identifiable at the beginning as needing inter-jurisdictional coordination. Others, however, will emerge later, as demand for HSR service and new development materializes. As conditions change, the continuing strength of cooperative efforts will depend in part on the strength and clarity of their initial goals and objectives, as well

[30] *Mayoral Development Corporations, Localism Act 2011* (2011): Part 8 Chapter 2.

as the level of buy-in achieved across stakeholder groups. Chapter 6 considered, in depth, the definition of goals and performance measures. The UK case brings us one more reminder of the importance of appropriately defined performance measures, this time with an intermodal perspective. Up to this point we have concerned ourselves with other modes of transportation mostly as a means of transport to and from HSR stations. We focused on the level of integration of the HSR system with existing urban and regional mobility systems.

Regional stakeholders in the West Midlands of the UK are pushing for a more strategic view of intermodal HSR planning, extending beyond access modes, to consider the effects of released capacity on the conventional rail network. The Birmingham Chamber of Commerce Group (BCCG) highlights political tension across the region and argues for a broader scope of analysis in order to more intentionally distribute economic benefits from HSR investment, including to those areas not directly served:

> The BCCG would like to take the opportunity to stress that within the West Midlands, a number of our members do question the local connectivity enhancements, in particular BCCG members in South Staffordshire. Lichfield District Council and Tamworth Borough Council have indicated that they *fail to see how they will benefit* from HSR.
>
> As we understand it, Lichfield would tangibly benefit from the released capacity as they would see extra services from Lichfield Trent Valley and Tamworth to London. However, the *Government needs to do more to increase awareness of these benefits, and it needs to encourage LEPs/Local Authorities to be innovative in proposing new services and routes as a result of released capacity.*[31]

The question of what to do with released rail capacity may be a higher priority in the UK than in Portugal, because of faster overall growth and greater congestion in the UK. However, it raises a more general point about HSR: its implementation is an opportunity to take a step back and evaluate the state of a region's transport (or planning) system, in general. This is equally true in Portugal. As interviews with Coimbra's municipal public transit operator reveal, the Coimbra area struggles to coordinate mass transit for the region as a whole—given that inter-municipal bus service is managed by private operators with limited incentives or resources to cooperate.

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[31] "All Comments Submitted by Respondent 52184/Birmingham Chamber of Commerce/Other Representative Group." HS2 Ltd, http://highspeedrailresponses.dft.gov.uk/s2css/viewusercomments.asp?usr=52184 (accessed April 28, 2013). Emphasis added.

Similarly, HSR planning highlights the struggles associated with coordinating development and transport decisions in Portugal. Too often the link between land use and transit service planning is reactive. Sprawling growth makes it hard to serve the ever-expanding commuter shed of Coimbra with public transit. HSR offers an opportunity to rethink the relationship between transport investment and land use strategies.

Using HSR as an opportunity to think strategically about the land use and transport system, as a whole, is one way to pursue the distribution of benefits of new HSR service beyond cities with a station to surrounding areas. Significant research is still needed to find the best approaches to managing the distributional impact of HSR. Nevertheless, clearly defining a set of objectives that includes equity impacts will be a step towards giving secondary HSR cities *and* cities not directly served by HSR the attention they require. This includes consideration of other modes and development strategies that can help deliver benefits from HSR throughout a region.

Additionally, by leveraging the incentives for cooperation provided by HSR to work on wider regional issues, a broader and stronger coalition for change can be created. With more than HSR on the table, the HSR system has a better chance of achieving its potential—while at the same time the inter-jurisdictional partnerships needed to support HSR will gain durability from stakeholders interested in the broader vision of equitable, economically viable, and environmentally supportive regional growth. This approach to HSR development will undoubtedly require additional resources, beyond a bare-bones approach. Still, given the scope of the professed agenda for HSR, it would be inconsistent not to pursue the full extent of benefits that are the claimed target of such a large investment program.

8.4 Conclusions

This chapter uses case studies from the UK to investigate the ability of variety of policy mechanisms to facilitate inter-jurisdictional planning. The approaches fit broadly into two stages of a project: 1) initial design and evaluation, and 2) ongoing management. We observe the influence of evaluation on design. The prioritization of objectives and methods of measuring benefit influence what is ultimately selected as the preferred alternative for HSR system design. Earlier in Portugal we saw this in terms of station location: neglecting the needs of future destination users and the impact of future development can lead to locating a station external to a city, where it is easiest to construct and to access by automobile from surrounding communities.

In the UK, we observed how the uncertainty of local plans and land use changes makes it difficult to calculate future benefits from station-area development. Exclusion of such efforts from a project assessment runs the risk of producing a station design that is inadequately integrated into the local context.

Regarding ongoing management, we highlight the importance of initial conditions to decision makers' ability to respond to future conditions that cannot be anticipated fully. Emergent strategies that ultimately guide implementation of a project are shaped by the deliberate strategies created at the outset. Deliberate strategies can be formalized as plans or be institutionalized by means of rules and processes. This chapter focuses on structures that can be established at the outset for ongoing inter-jurisdictional collaborative management and emphasizes the importance of appropriately defined performance measures in guiding these collaborations. We emphasize that leveraging the incentives for cooperation provided by HSR to work on wider regional issues is one approach to building a broader and stronger coalition for change.

Having completed our discussion of inter-jurisdictional HSR planning in both Portugal and UK, the next and final chapter provides a summary of this thesis and lists the major conclusions that can be drawn from this work.

9 Conclusions

This chapter summarizes the findings of this thesis and discusses recommendations for Portugal's future HSR system. In addition, we suggest future research directions that have been identified during the course of this work.

9.1 Learning from a systems approach to high-speed rail

While perhaps not explicitly setting out to do so, this thesis has made use of a systems way of thinking to better understand high-speed rail, its spatial implications, and the institutional relationships necessary to guide successful implementation. Our investigation spanned multiple geographic scales of the physical environment and institutional sphere, examined ways of coupling institutional change with technological change, and addressed the importance of uncertainty as a driver of system behavior. The goal of this thesis was to improve understanding of the role that HSR could play in guiding sustainable future growth. We sought insight into how this large-scale infrastructure investment might be used to meet demands for greater connectivity with a globalized economy, while *also* addressing the significant environmental challenges that are so critical in today's world. The two themes of this thesis were *space* and inter-jurisdictional *relationships*. Space is the fundamental building block of urban and regional planning. In accordance with a systems perspective, we approached high-speed rail not as a single technology but rather as a multi-scale system that shapes and is shaped by the institutional sphere within which it is embedded.

We focused in particular on smaller intermediate cities brought within one-hour's travel time of a larger metropolis (in this thesis, Lisbon or London) by planned HSR services. Mid-distance service (<250 km) has particularly strong spatial implications as it can forge commuting relationships between cities and expand labor markets to the scale of new *discontinuous regions*— single labor and commercial markets that spans large distances but do not include all intermediate areas. Looking to the future, both Portugal and the United Kingdom (UK) are planning HSR systems that will provide this type of mid-distance service. These were the subjects of our study. Secondary cities are often disadvantaged in terms of planning resources and advocacy power. At the same time, they require explicit attention if HSR is to achieve its objective of creating a network of mutually supportive cities. Local knowledge and policy will

improve HSR design and implementation by helping to ensure smooth interfaces between HSR and existing urban and mobility systems, thus creating a system that is regionally viable. Transit and pedestrian-accessible stations located within existing urban cores are best suited to inducing new economic growth that also adheres to a more compact and therefore more environmentally sustainable means of increasing general welfare within a region.

Smaller intermediate cities are also important to the goal of creating future networks of mutually supportive cities. In the course of this thesis, we have made the argument that network agglomeration forces at the *inter-city* scale actually depend on *localized* issues of urban form and station accessibility. Moreover, hierarchy turns out to be a salient feature of regional systems of cities, with cities atop a hierarchy playing gateway roles to the larger economy. Cities like Coimbra in Portugal and Birmingham in the UK are therefore of particular interest; HSR can enhance these cities' importance for their immediately surrounding areas. Simultaneously, the cities can be brought into new discontinuous regions to play a new support role for major metropolises that in turn connect to the global economy.

Because of its ability to directly connect city centers across large distances, HSR is uniquely positioned to affect future patterns of urbanization. Moreover, as we discovered, HSR has the potential to enable a "pattern break"—to induce new ways of thinking about urbanization, regional connectivity, and governance. The scope of change that can be put into effect by HSR creates greater incentives for collaborative action across multiple scales of government than those that normally exist. Still, given the uncertainty of HSR's future impacts—on land use and on economic integration within discontinuous regions—concerted efforts will be required to secure multi-scalar commitments to institutional change. As we have demonstrated, these commitments are imperative to selecting a suite of policy responses that allow HSR to realize its potential as a sustainable technology.

9.2 Seeking a holistically sustainable realization of HSR

The guiding motivation for this thesis has been the "3E" model of holistic sustainability. HSR holds significant potential in each of the three areas:

- Economy: this is most often the starting point for advocates of HSR. The goal is to relieve congestion within larger urban areas, overcome distance, and build competitive networks of cities that act as functional economic units in the global market;
- Environment: environmental sustainability acts at (at least) two spatial scales. HSR can reintroduce incentives for compact urban growth, locally, which in turn can benefit regional ecosystems by helping to preserve habitats and protect watersheds in the interstitial, less developed, spaces of a discontinuous region;
- Equity: this may be the most difficult goal to define and achieve. Understood in spatial terms, the ambition is as follows: by connecting central and peripheral areas, a more efficient economic system can be built that will bring benefit to all parts of a region, even including those without direct HSR service.

Successful achievement of each aspect listed above requires coordinated policy efforts across levels of government and at different moments along a project's timeline. For example, station location is largely determined at the national (or sometimes international) level of government and fairly early on in the process of system design. The selected location—whether external to a city or more centrally accessible—will then be a major driver of subsequent decisions and sustainability outcomes. Land use policies that can be used to support compact station-oriented development, on the other hand, are primarily under the control of local authorities, and will likely need to evolve over time as real estate markets respond to the increment in accessibility provided by new HSR service. Nevertheless, the structure for these emergent strategies will be partially determined by deliberate strategies in place at the beginning of a project. The national government can guide this process by creating policy instruments and offering strategic guidance for local HSR-supportive efforts. To best achieve system-level HSR objectives, national governments will likely need to contribute funding to local development or connectivity initiatives that are then implemented by local or regional government entities.

Finally, this thesis focuses on two major sources of uncertainty that drive performance of an HSR system: (1) The distribution of power to influence HSR across sectors and between national, regional, and local jurisdictions, and (2) The high degree of uncertainty associated with land use changes and agglomeration benefits. Because of this uncertainty, we gave careful

consideration to both stakeholder perspectives and incentives, and to the theoretical logic underlying objectives of HSR. Only by considering both can deliberate strategy be developed to support both initial decision-making and ongoing organizational learning, such that HSR realizes its potential as a sustainable investment.

9.3 Methods

A number of different methods were used as part of this investigation: First, interviews with local and national officials in Portugal offered a window into stakeholder priorities and motivations, particularly the sometimes less attended to sub-national government stakeholders in Évora, Leiria, and Coimbra. These three cities represent the geographic scale of a new discontinuous region centered on Lisbon, Portugal's capital and dominant metropolis.

Second, site visits and documentation of the urban environment offered a retrospective understanding of two cities already connected to Lisbon by rail lines that are currently used for daily commuting. Changing the scope of analysis from the prior regional or even megaregional perspective, that analysis examined the urban form and human experience aspects of Cascais and Santarém. These two cities represent a scale that is already integrated into Lisbon's labor market by both the automobile and by train service.

Next, a broader theory-based approach used ideas from economic geography to explain the concept of polycentricity and its bearing on HSR-supported regional and megaregional restructuring. Finally, additional case study material from the UK offers a more detailed perspective on station-area planning and the role of uncertainty in inter-jurisdictional HSR planning, evaluation, and implementation. Birmingham, UK serves as a parallel case to Coimbra, Portugal and focuses our attention on secondary cities at the top of their own regional hierarchy.

Based on these various investigations, a number of lessons were derived; these are presented in the following section.

Figure 9-1 shows the cities studied as part of this thesis. Note the relevance of different geographic scales and levels within the regional hierarchy.

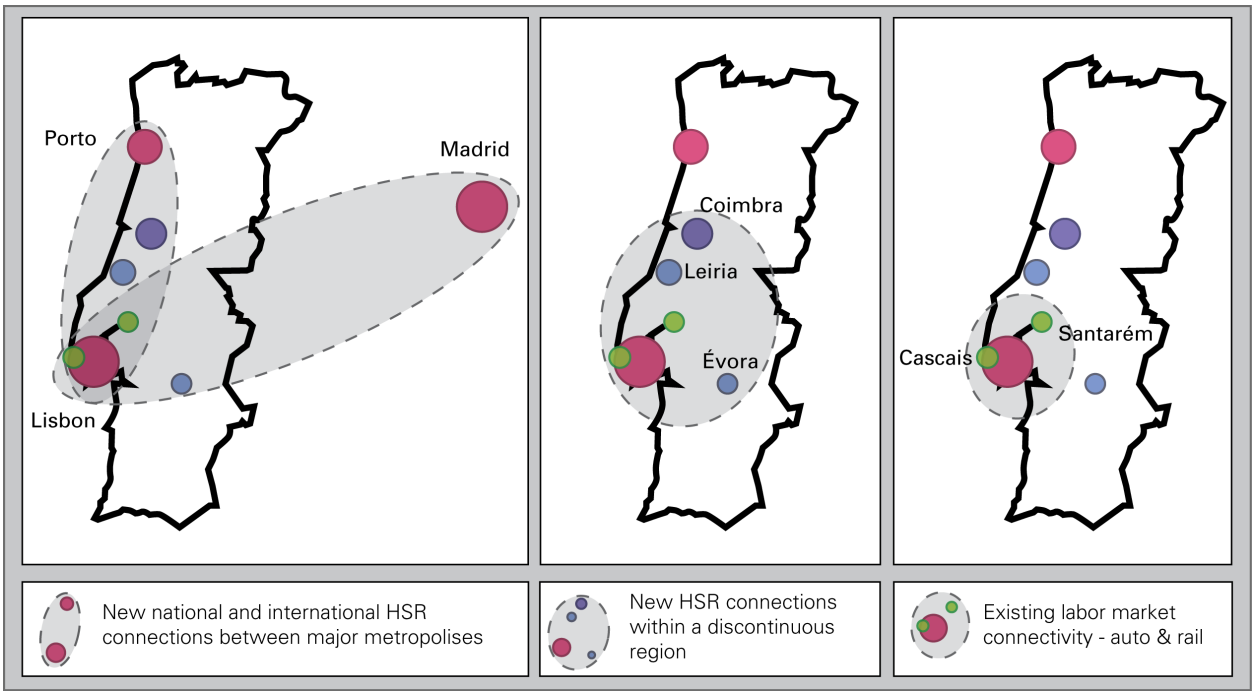

Figure 9-1 Multiple geographic scales of relevance for the analysis of HSR (Source: Author)

9.4 Summary of Findings

The following are the overarching findings derived from this thesis:

- ***Speed is a necessary but not sufficient condition for HSR to achieve its potential as a technology; the spatial implications of HSR connect to a powerful set of sustainability goals.***

HSR can change the time-space landscape. The technology has greater potential than air travel to affect urbanization patterns because of its ability to directly connect city centers and avoid the significant security-driven pre-boarding time associated with air travel. HSR therefore can be a powerful driver of land use and development patterns. And while speed and the increment in accessibility offered by HSR are necessary enablers of HSR-induced socioeconomic restructuring, speed alone is not sufficient for HSR to achieve sustainability.

In an increasingly environmentally conscious world, it has become clear that not all development patterns—and *therefore* not all systems of mobility provision—are identical or even similar from an environmental sustainability perspective. Current sprawling and land-consumptive forms of urban and regional growth are partially attributable to the relatively isotropic fields of access created by the personal automobile. Lower-density forms of growth degrade ecosystems and contribute to greater overall resource consumption. In contrast, rail and

other forms of mass transit have historically supported denser urban development around stations, the system's privileged points of access. High-speed rail, therefore, is a potentially transformative technology that can support a return to more sustainable centralized patterns of urbanization while still enabling the creation of social and economic connections across greater distances within a globalized economy.

- ***High speed rail planning should be guided by a holistic sustainability goal aimed at equitable and environmentally supportive economic growth.***

The spatial implications of HSR extend beyond environmental sustainability to a distributional equity agenda and to broad goals of economic development.

Advocates for HSR promote its ability to achieve mutually supportive and equitable growth. By connecting urban centers, HSR service can built on global economic forces that tend to prioritize urban centers in order to take advantage of agglomeration economies. At the same time, HSR systems may help support more complementary relationships between cities.

One goal of the planned Portuguese HSR network is to create a functionally linked system of cities, each playing their own mutually supportive role, that can better compete in the global market. Similarly distributional, the UK's HSR project is posited as a way of addressing growth constraints in London while simultaneously encouraging growth in the rest of the country.

For HSR to achieve its full potential, all three sustainability objectives—environmental protection, economic growth, and social equity—must guide its design and implementation. To do that in turn requires inter-jurisdictional planning to an unprecedented degree. It also requires efforts to clarify the relationship between different aspects of regional structure and the threefold goals of sustainability.

- ***High-speed rail's integration with local land use and mobility systems is critical if HSR is to be successful in supporting network-based agglomeration economies.***

Agglomeration is the benefit that firms and workers gain from being in proximity to other firms and workers. Studies of agglomeration economies traditionally conceived of proximity *in space* as the enabling factor for these interactions. However, high-speed communication and transport technology, and a reshuffling of the kinds of interactions driving our contemporary

globalized economy, point towards the possibility of using HSR to benefit from network-based agglomeration economies at the scale of a discontinuous region.

The dominant urban activity has changed from goods handling to the handling of information. Many business location choices are now determined by trade-offs between the need for face-to-face contact and the expense of centrality, in terms of rents and the cost of moving people in congested urban centers. Globalization and information technology have created non-physical networks of linkages that are now overlaid onto the physical systems of built urban form and transport. Nevertheless, despite ease of communication, technology does not always substitute for face-to-face interaction. Agglomeration economies continue to demand spatial proximity and thus negate complete dispersion.

However, there are certain constraints on growth in single monocentric urban centers. Evidence indicates that positive and negative urban externalities operate at different geographic scales. Negative externalities (pollution, congestion) seem to be more spatially constrained than positives ones (knowledge spillovers, labor pooling, etc.). "(Positive) external economies are not confined to a well-defined single urban core, but, instead, can be shared among a group of functionally linked settlements."[1]

Therefore, HSR should be intentionally designed to enable megaregional network agglomeration. Agglomeration increases with increased human interaction. To fully capitalize on this potential requires a focus on the human aspects of the interface between cities and the HSR network. Making the connection as seamless as possible, from initial origin to final destination, will remove barriers to interaction and maximize the realization of benefits from networked agglomeration. Access to and from stations via efficient forms of urban transportation is a vital component of this.

- ***Effective high-speed rail planning and implementation requires the integration of a variety of forms of knowledge and expertise.***

The success of a HSR project depends in part on the degree to which HSR service is integrated into other local transport and land use systems. Ideal HSR planning would include

[1] Evert Meijers and Martijn Burger, "Urban Spatial Structure and Labor Productivity in U.S. Metropolitan Areas" (Leuven, Belgium, Regional Studies Association annual conference 'Understanding and Shaping Regions: Spatial, Social and Economic Futures', April 6-8, 2009).

provisions for encouraging station-area development as well as modifications to existing transit to provide good accessibility to a station. In most cases, these decisions will require a substantial degree of coordination across government jurisdictions. For station-area planning, national-local relationships may be of the greatest importance, as municipalities control land use regulations while the national government controls station design. For public transit, coordination is likely to be necessary across local jurisdictional boundaries, given that the catchment area for a HSR service is broader geographically than a single municipality.

Apart from crossing governance boundaries, those interactions also involve the integration of multiple forms of expertise. For example, within Portugal, REFER is the entity with the most knowledge and background on how to deliver a rail system, complete with functional and accessible rail stations. They even have some prior experience with creating stations that serve as hubs within areas of urban development. What a national infrastructure agency may not be as well equipped to do is ensure that the station integrates well with the local urban context or is consistent with existing or planned mobility systems. Provision of information about local destinations, the use of way-finding mechanisms such as signage and distinct paving outside the station, and the creation of visible and easy to use transfer points to other modes (buses, taxis) may be generalizable ideas but require site-specific knowledge and implementation.

- ***HSR creates powerful new incentives for intra-regional and national-local collaborative efforts.***

The scale and scope of HSR and related connectivity and development initiatives mean that inter-jurisdictional coordination will be an element of the HSR planning and implementation process. Because power and expertise is distributed among multiple local entities and the national government, some degree of voluntary cooperation will be an inevitable part of a successful HSR project. Thankfully, the potential for HSR to induce socioeconomic restructuring across large geographic areas also creates incentives for cooperation between parts of government—incentives that would not be large enough for projects of a smaller scale.

Stakeholder interviews presented in Chapter 4 reveal changing attitudes towards regional identity and urban governance as result of HSR. The simultaneously local and national/global relevance of HSR creates conditions in which local and national planning entities share interests

and therefore partner in ongoing planning efforts (i.e. the Coimbra Urbanization Plan discussed in 4.3.3). HSR may also provide an incentive to rethink inter-municipal regional cooperation. Increased accessibility from HSR can be a double-edged sword. Both Leiria and Coimbra officials cited the risk of losing overnight tourism and business stays because of shorter travel times to Lisbon. The changing competitive landscape may, according to these officials, motivate a shift from competitive inter-municipal relationships to more cooperative planning within the Centro Region of Portugal. Taking advantage of this potentially powerful incentive structure should be part of any national strategy for HSR.

- ***New models of commuting may develop as a result of HSR's implementation. These will, however, be relevant to a relatively small fraction of the population.***

Because of cost, the higher levels of intercity accessibility offered by HSR are not expected by local officials in Évora, Leiria, and Coimbra to be uniformly relevant to all their citizens (Chapter 4). Rather, based on the attitudes of Portuguese officials and evidence from other cities like Ciudad Real in Spain, we can assert that HSR commuting is likely to be relevant to a few particular demographics—namely skilled business, education, and health professionals. Public officials within both Évora and Coimbra anticipate new models of commuting in which HSR enables multi-destination commuting or work patterns that only require commuting a few times per week. This new model of commuting blurs the functional distinction between business travel and journey-to-work commuting and may require a reassessment of current analytical categories used to study user needs. Additionally, the differential relevance of HSR service across a city's population may result in social changes within a city. Like Ciudad Real in Spain, smaller intermediate cities in Coimbra might develop dual identities, simultaneously existing in relative self-sufficiency, with a given labor market structure and socioeconomic base, and as networked entities within a new "discontinuous region."

- ***HSR planning should account for the needs of a diverse set of users.***

HSR can offer multiple kinds of connections within a region:

- Between businesses connecting to each other through increasingly frequent and multi-destination business trips;

- Between employees connecting to employers through longer-distance (but not longer-time) commutes;
- Between people taking advantage of more diverse residential environment choices while maintaining access to cultural amenities within a larger metropolitan area;
- And between visitors using HSR for access to tourist destinations or conferences from major cities or airports.

To facilitate these interactions requires a focus on the HSR experience, namely: the level of access between origins, destinations, and stations; the activity mix and design of the station-area; the transfer experience connecting with local transit (or other access modes) and HSR; and the multi-dimensional quality (speed, frequency, comfort, cost) of the service itself.

We suggest adoption of the user-oriented perspective promoted by Lewis: it considers the *origin user* who is familiar with local transit or is likely to have personal mobility options and the *destination user* who has more limited mobility options for egress from the HSR system but also is likely to have more targeted destinations (i.e. centers of business or cultural activity).[2] Planning for true door-to-door integration of cities and for successful competition with the automobile must account for the needs of both these groups.

With intentional planning, the benefits of a new HSR station can also be extended beyond users of the HSR service itself. Apart from HSR passengers, those with the potential to benefit more indirectly include: businesses that cluster in station-areas to be near other businesses that use HSR, the regional labor market that serves those new businesses, and regional travelers who may benefit from other HSR-related changes in the regional transport system—for example, released rail capacity in the UK West Midlands that would become available for additional freight and shorter-distance regional rail services (see Chapter 8).

[2] Paul Lewis, "Planning for a Regional Rail System: Analysis of High Speed and High Quality Rail in the Basque Region" (S.M. in Transportation, Massachusetts Institute of Technology. Dept. of Civil and Environmental Engineering.), .

- ***Station location is a powerful determinant of not only local land-use impacts, but also of the level of interest and attention that local governments pay to HSR-supportive initiatives.***

Evidence from site visits to Cascais and Satarém demonstrate the criticality of station location in both functional and symbolic terms (Chapter 5). All else being equal, greenfield development tends to be more straight-forward. In order to achieve more compact patterns of growth, something is needed to overcome the costs of urban reinvestment (i.e. infill); a rail station can play that catalytic role. Given the spatially defined environmental and economic goals of HSR, the system should be designed to reintroduce incentives for centralized and contained development.

Chapter 4 demonstrated that station location is a determining factor in the level of attention a municipality is willing to give a station-area. Partially due to the planned non-central location of their stations, both Évora and Leiria favor a 'wait-and-see' planning approach. External stations are less likely to receive in-depth consideration and even if they are addressed, determining appropriate development objectives for an external station-area is not an easy process. In Portugal, the land use regulatory system only gives clear grounds for a city to reject a private sector development proposal if it does not comply with *existing* regulatory documents prepared by the municipality. A city may not necessarily have zoning documents developed to any level of detail within a newly urbanizing area, due to constrained planning resources. If that is the case, there is no mechanism for applying new conditions in response to a proposal. Therefore, if intentional station-area development is a national objective of HSR, as we believe it should be, involvement in or support for local land-use planning by the national government is merited—as is careful selection of the site for the station in the first place.

- ***"The Paradox of Sustainability" and neglect of future destination users can lead to misplacement of HSR stations in external locations.***

Failing to consider the needs of both origin and destination users can lead to a decision-making process for station placement that gives disproportionate weight to current rather than targeted future conditions. A station might be sited outside a city to a) reduce HSR travel times between dominant O-D pairs, b) provide easy auto access to a region as a whole, and c) avoid costs associated with construction in an already built up area. The benefits of all three of these aspects are relatively easy to calculate based on current conditions or extrapolations thereof.

What such a decision does not acknowledge is the much more uncertain long-term growth impacts of HSR service (as opposed to the demands coming from existing categories of users).

Central stations have been shown to be better for destination users and in Spain have proven better for building up business in smaller cities.[3] It is easier to attract new businesses to areas that already have some critical mass of activity, as the perceived development risk is lower. Since that prior concentration tends to be in more central locations, a centrally located HSR station has more to build on to attract investment than the accessibility increment from HSR alone. Therefore, while short-term objectives may be met with an external station placement, longer-term land use and growth objectives (which are central to the spatial objectives of HSR implementation) point towards choosing a more central location.

A "Paradox of Sustainability" also contributes to the selection of external station locations in Portugal: Environmental regulations (against noise, etc.) drive away infill development and centrally located rail stations.[4] This in turn negatively impacts global sustainability goals that try to limit energy consumption from access modes (i.e. choosing to walk to the station rather than driving) and the built environment (more compact development as opposed to sprawl). Based on the cases of Cascais and Santarém (Chapter 5), and on other HSR literature, it can be concluded that station centrality really does matter. This means that the plans for external stations in Leiria and Évora are worrisome and likely to hinder the ability of HSR to achieve its claimed agenda of encouraging more sustainable development patterns.

- ***Polycentricity is a multi-faceted and complex concept. The adoption of a particular measure of polycentricity as a goal in and of itself obscures underlying goals and objectives. Instead, the concept needs to be unpacked into different characteristics of regional form, each of which has its own relationship to the 3E's of sustainability.***

To guide a project from initial appraisal through to its long-term impacts requires as much clarity as possible in objectives and corresponding performance measures. Moreover, the challenge of evaluative complexity (differential valuation among stakeholders) becomes even more difficult when ideas, such as "polycentricity," are characterized by a high degree of

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[3] José M. Ureña et al., "Territorial Implications at National and Regional Scales of High-Speed Rail," in *Territorial Implications of High Speed Rail: A Spanish Perspective*, ed. José Maria de Ureña (Farnham, Surrey ; Burlington, VT: Ashgate, 2012), 129.

[4] Credit for this phrase goes to João de Abreu e Silva, Professor, Instituto Superior Técnico, Lisbon.

functional ambiguity. The adoption of a particular measure of polycentricity as a goal in and of itself obscures underlying goals and objectives. Chapter 6 presents a number of ways of describing and measuring regional spatial structure with the goal of more precisely linking performance measures with overarching goals for regional restructuring. It highlights the difference between morphological polycentricity, which refers to an even distribution in the size of urban centers, and functional polycentricity, which designates a balance in flows (commuter trips, for example) as the defining characteristic of polycentricity. Additionally, our analysis reveals that functional polycentricity and network density are separate concepts that should not be confused. Increasing connectivity does not necessarily result in reciprocal relationships, and thus network density and functional reciprocity are best considered independently when assessing objectives.

- ***Hierarchy is an increasingly important characteristic of urban systems and should be taken into account when developing regional HSR strategies.***

Rather than considering balance and hierarchy in a dichotomous relationship, it is more worthwhile to consider the urban system as a layered architecture of different kinds of networks: some of them more balanced than others. Some emphasize complementarity among cities as the key to the benefits of polycentricity. In reality, every city will engage in both competitive and complementary relationships and one city can simultaneously perform multiple roles within a regional system. The question is not whether regional urban systems should be balanced *or* hierarchical but rather, what kinds of connections between urban centers are mutually supportive and likely to improve economic competitiveness, overall?

Dominant cities within an urban hierarchy play a specialized role as gateways to the global economy. Moreover, relational hierarchy shows some signs of influence over and above what would be expected, taking into account city size alone. Given two cities of the same size, one at the top of a regional hierarchy and one located adjacent to a much larger city, the former will have greater influence. Thus, the goal of achieving more balanced relationships between cities must be tempered by adequate acknowledgment of the importance of hierarchy. Cities that play a dominant role within smaller regions, like Coimbra in the Centro region of Portugal and Birmingham in the West Midlands of the UK, deserve special consideration within HSR planning. These cities serve as regional hubs of activity that can benefit their surrounding region.

They simultaneously play support roles to the larger cities (Lisbon and London), and act as privileged gateways to their own regional economies. While politically attractive, attempts to distribute economic activity to such an extent so as to counteract agglomeration benefits will not ultimately improve overall economic conditions in a region. Instead, HSR planning should acknowledge the special role that will be played by cities with new stations while also taking a broad look at regional economic conditions and transport systems to ensure a distribution of benefit.

- ***Consideration of functional relationships between cities and the needs of various users of an HSR system is important. However, urban form is independently important in both economic and environmental terms.***

Sprawling development patterns can exist in both monocentric and polycentric urban systems. Proximity and the efficient use of space, which accounts for many of the benefits of urban agglomeration, are not guaranteed by polycentricity. Therefore, the degree of dispersion versus centralization in the development patterns likely to be supported by HSR should be made an explicit component of the evaluative structure for HSR.

The case to be made for sustainability is likely different for polycentric regions *in general* and for the specific case of HSR-enabled polycentricity. In fact, spatial discontinuity (between urban centers) may only come into its own as a matter of environmental significance with the longer-distance connections enabled by HSR. What HSR brings to the discussion is the potential to create commuting connections within polycentric systems that are disassociated from the negative environmental impacts of the automobile.

- ***An accessibility-based (rather than a distance-blind or boundary-dependent) approach to understanding regional structure may help to better connect performance measures and decision-making.***

The application of polycentricity metrics to commuting data from Portugal in Chapter 6.3 reveals a number of challenges associated within measuring polycentricity and hints at alternate approaches that may be better suited to supporting infrastructure investment decisions. In particular, the analysis in Chapter 6 demonstrates the sensitivity of centrality measures to the selection of boundaries and the challenges of using metrics that are distance-blind and do not account for the physical composition of space.

Performance measures are intended to "mark the progress from the current to the desired future state."[5] To most effectively chart change, measures should reflect goals and objectives and provide decision support. If the investment under consideration is development of new transport infrastructure, then selected performance measures will ideally reflect changes in the performance of the transport system. The measures of regional structure used in Chapter 6 are "access-blind." The concept of a discontinuous region introduced in this thesis is predicated on the ability of high-speed transport technology to bring close in time points in space that are separated by large physical distances. Similarly, many of the likely benefits from polycentric or mega-regional development are dependent on functional connections between urban centers. It is travel time (along with other service characteristics), not travel distance, which impedes the formation of such functional connections.

New accessibility-metric based approaches to measuring agglomeration economies are likely to improve our understanding of the pros and cons of different ways of architecting our urban systems, and how transport infrastructure can support or enable a preferred architecture (see Chapter 6.4.1). Accessibility can also be useful when considering equity goals, if equity is defined as equality of opportunity (as opposed to equality of outcomes), because accessibility is a measure of opportunity.

- ***HSR's socioeconomic intentions mean that long-term uncertainty should be dealt with in HSR planning and implementation.***

HSR projects are unique in that they pursue socioeconomic objectives that extend beyond the direct transportation investment purpose of reducing travel time to indirect effects often not accounted for in traditional benefit-cost analyses. New mobility patterns and land use changes that are the target of HSR investment are hard or impossible to predict. It is the broad scope of HSR's ambition to reorganize human activity in space that creates both HSR's potential and its considerable implementation risk. Existing project assessment methods have difficulty dealing with the long-term uncertainty of expected HSR benefits. It is common in project evaluation to grapple with costs that have greater certainty and predictability than do benefits. This difficulty is only magnified by the fact that HSR is aimed far beyond the needs of current long distance

[5] Joseph M. Sussman et al., *The "CLIOS Process": A User's Guide* (Cambridge: Massachusetts Institute of Technology,[2009]).

travelers, to future regional connections that have yet to be realized or perhaps even fully imagined.

Since much of the sustainability benefit of HSR is likely to emerge as a result of changing patterns of land use patterns (agglomeration, ecosystem preservation, reduction of sprawl, etc.), assessment of these benefits becomes critical to our ability to select a design that will support those sustainability objectives. Station locations, station-area development, and accessibility/connectivity initiatives are particularly susceptible to being neglected if future benefits are not sufficiently accounted for. By committing to a system design with well-connected and easily accessible stations, and by encouraging local land use policies that support station-area development, HSR planners can reduce the uncertainty of achieving long-term benefits and maximize the potential of the infrastructure investment.

- ***Processes for planning, evaluation, and implementation should be altered to ensure better integration of local policies and HSR-supportive initiatives, with national guidance.***

One approach to managing uncertainty, particularly regarding the evolution of the areas around stations, is to pointedly include local authorities and local HSR-supportive initiatives in the planning and implementation of HSR. The UK case studies in Chapter 8 focus on the uncertainties of land use changes around Old Oak Common in London and of the realization of local HSR-supportive projects in Birmingham. The chapter then proposes approaches for managing those uncertainties, particularly at the beginning of a project, including a "real options" framework and the use of scenarios in local station-area planning. Intentionally pursuing local input, while simultaneously providing strategic guidance at the national level, can help create a HSR plan that gives appropriate weight to future changes, despite their uncertainty. Moreover, local authorities can offer a more complete representation and understanding of local conditions thus supporting better decision-making for the HSR system.

Local or regional authorities, with their local knowledge and institutional capacity, are the best partners for implementing local projects and will in most cases control significant portions of any such efforts. However, to motivate truly regional thinking, avoid more fragmented interests, and support constrained local resources, the national government will likely need to provide additional funding for HSR-supportive efforts. As we saw in Chapter 4, the altered equilibrium created by HSR does introduce new incentives for regional cooperation.

However, those incentives will in many cases, particularly for smaller cities, require pointed support (in the form of funding or other planning resources) from the national government in order to be result in successful collaborative efforts.

- ***Cities expecting to be newly integrated into a discontinuous region by HSR should pursue opportunities for cooperation and knowledge sharing.***

In chapter 4 we found that HSR provides an incentive to rethink inter-municipal cooperation at a regional scale smaller than that of a discontinuous region—i.e. at a scale that matches the area of influence of an HSR station. Chapters 7 and 8 reveal the potential of another type of local-local cooperation, this time across a discontinuous region and between cities that are not necessarily located adjacent to one another. Cities located relatively far from each other but sharing the same situation of a new HSR station may benefit from joint advocacy and learning from each other's strategies. Smaller cities in particular, can benefit from shared strategizing about how to best advocate for local interests within the national planning arena. Observed knowledge sharing between TfL and Centro (Chapter 8.2.2) indicate the potential for learning to occur. Phased implementation of HSR also means that inter-city knowledge sharing has can also translate into longer-term organizational learning.

- ***HSR provides an opportunity—indeed, an imperative—to reexamine broader transport and land-use strategies. Strategic thinking can expand the impact of HSR while also building a stronger coalition to support its implementation and management.***

By shaking up the status quo, HSR can incentivize reconsideration of inter-jurisdictional relationships in order to better plan and implement an HSR system. Certain efforts will be clearly identifiable at the beginning as needing inter-jurisdictional coordination. Others will emerge later, as demand for HSR service and new development materializes. As conditions change, the continuing strength of cooperative efforts will depend in part on the strength and clarity of their initial goals and objectives, as well as the level of buy-in achieved across stakeholder groups.

One way of achieving buy-in across stakeholder groups is by extending the scope of HSR planning to include reconsideration of broader transport and land-use issues that also overlap multiple jurisdictions. Using HSR as an opportunity to think strategically about the land use and transport system, as a whole, is one way to pursue the distribution of benefits of new HSR service beyond cities with stations to surrounding areas without direct service. Additionally, by

leveraging the incentives for cooperation provided by HSR to work on wider regional issues, a broader and stronger coalition for change can be created. With more than HSR on the table, the HSR system has a better chance of achieving its potential. At the same time the inter-jurisdictional partnerships needed to support HSR will gain strength from stakeholders interested in the broader vision of equitable, economically viable, and environmentally supportive regional growth.

To again quote Ureña as we did at the start of this thesis: "High-speed rail infrastructure should not be considered the end objective, but rather the initiation of a long process of developing actions and strategies to enhance its effects."[6]

9.5 Recommendations for Portugal

Implementation of a HSR project is a costly endeavor, in terms of monetary, planning, and political resources. The existence of a policy window—the convergence of problem, policy, and politics[7]—therefore is an opportunity not to be wasted. The very purpose of such a large-scale investment is to look forward to an uncertain but hopeful future. The goal of comprehensive HSR planning is to do our best, in the present, to establish conditions that enable a hoped-for future: a better connected, more economically competitive, environmentally sustainable, and equitable future for our regions and megaregions. To do that in turn requires that we ensure that our (rightfully) lofty aims find a concrete place in the manner in which we make our decisions.

Current economic realities in Portugal have closed the earlier HSR policy window. In anticipation of the future reemergence of a true policy window for HSR in Portugal, we make the following recommendations based on the findings in this thesis:

1. Explicitly adopt an agenda of holistic sustainability for HSR implementation that includes a prioritization of network designs that will encourage compact growth.
2. Reconsider external station locations in Évora and Leiria. These smaller cities are the target of Portuguese policy aimed at creating a megaregion of networked cities that

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[6] José Maria de Ureña, "Preface," in *Territorial Implications of High Speed Rail: A Spanish Perspective*, ed. José Maria de Ureña (Farnham, Surrey ; Burlington, VT: Ashgate, 2012), xix.

[7] John W. Kingdon, *Agendas, Alternatives, and Public Policies*, 1st ed. (Boston: Little Brown, 1984).

spans the country. To benefit from mutually supportive agglomeration economies requires that the economic potential of these smaller cities also be given adequate attention. Central station locations offer greater economic opportunities in the long term while also supporting compact urban growth.

3. Remedy the resource disadvantage of smaller cities by providing targeted resources for HSR-supportive policies. In particular, consider developing a program to help municipalities update their local land use ordinances in response to HSR implementation.

4. Build on the model of the Coimbra urbanization plan to encourage ongoing inter-jurisdictional collaboration. Collaboration between REFER (or the future managing director of HSR implementation) and local governments will produce more robust station and station-area designs and improve the integration of HSR into local land use and mobility systems.

5. Use HSR as an opportunity to develop new thinking regarding the integration of transport and land use planning in Portugal. HSR planning sets in motion a large portion of a country's planning machinery. At the same time, anticipation of a reorganized competitive landscape introduces incentives for cooperation. Portugal can make use of this inertia to experiment with new approaches to existing issues such as the lack of regional transit planning and the present difficulty of coordinating development policies with transport strategies.

9.6 Directions for future research

In the course of this thesis, we have identified a number of directions for research that would benefit future plans for HSR. These are presented here. Additionally, we discuss a number of broader questions of applicability that might be addressed by future work.

9.6.1 Supporting future HSR endeavors

First, significant research is still needed on the best approaches to managing HSR's distributional impact. We understand that investing in cities is an important part of supporting sustainable economic growth. New HSR service can play a catalytic role in local economic development strategies. Hierarchy within urban systems is undeniably important. Moreover,

because of agglomeration economies, focusing large infrastructure efforts like HSR in key urban centers will likely produce more aggregate benefit than distributing a smaller number of investments throughout a region. Nevertheless, we need strategies to ensure that benefit reaches not only HSR cities but also their surroundings. This will include consideration of regional transport networks and development strategies that can deliver benefits more broadly. For example, in the West Midlands, there is some discussion of targeting technical training towards the new HSR industry, in order to ensure that the local labor market can benefit from new train-related employment (in train depots, for example). The existing manufacturing sector of the regional economy would provide the basis for this new industry. Any future research should build on economic development theory. Existing methodologies for developing stakeholder-driven economic development programs may translate well to a HSR application.

Second, more detailed investigations into mechanisms for funding and implementing local HSR-supportive initiatives would be of help. Previous collaborative efforts between national and local governments could be instructive. There are questions that remain regarding appropriate cost bearing structures between local and national governments, or between various local authorities within a region. Similarly, if a national government sets aside funding for connectivity or development initiatives intended to support HSR, at what geographic scale should those funds be distributed? Do regional entities exist that can effectively use these funds or, as in the case of a London MDC, should a new regional entity be created to institute creative thinking at a scale specifically targeted to the problems at hand? There are downsides to too much ad-hoc governance: new institutions, even if composed of representatives from existing institutions, can still lack in experience and long-term institutional capacity. Determining the appropriate balance between custom-designed special purposes governance and more established but less targeted existing institutions will require further study.

From a more theoretical perspective, there is much yet to learn about the drivers of land use change, as well as firm and household location choices: How do different categories of decision-makers respond to the accessibility offered by HSR service? What other kinds of metropolitan-level or regional accessibility are most important in supporting businesses or households that value long-distance megaregional connectivity? For example, is it more important to have easy access between HSR stations and airports, or should greater emphasis be placed on pedestrian accessibility within the immediate area around a station? More generally,

better understanding the valuation of a site by different users would offer insight on how to maximize a station's potential to create benefit.

Finally, returning to the idea of complementarity, we note that new kinds of data can support additional research into the functional connections between cities—the aim being to identify types of functional linkages that are mutually beneficial. Opportunity exists for using newer distributed data sources such as cell phones to track both mobility and information exchanges. New applications of this data and new methodologies for modeling may eventually yield economic, transport, and land-use models that are tractable at the scale of a discontinuous region.

9.6.2 Questions of applicability: an expanded perspective

The research presented here was predicated on the existence of plans for HSR—plans for which we can seek opportunities for improvement, in order to achieve more sustainable outcomes. This work, however, is only the beginning of understanding the potential of HSR as a tool for shaping patterns of future growth. Not addressed by this work is a comparison of the benefits of HSR to those from other possible forms of investment. Similarly, we have thus far not considered the applicability of HSR as a sustainable solution in contexts that are significantly different from those found in Portugal or the UK.

Assuming one accepts the goal of using transport to integrate cities into megaregions, there is still a place for a more careful consideration of modal alternatives. Might air travel or highways, despite environmental limitations, be able to achieve the objective of economic and social connectivity? There may be tradeoffs worth considering between infrastructure costs and the full achievement of 3E-sustainability. One might ask if growth management strategies could ever be used to achieve compact highway- or airport-oriented growth. Admittedly, rail has a better historical record for supporting non-sprawling growth patterns. Still, given the level of investment needed for brand new HSR infrastructure, these questions are worth asking. Similarly, what might be achieved by more incremental upgrades to conventional rail systems? Related to the question of affordability, some might argue that a government would be better off spending the amount of money required for a HSR system on a suite of other policies. While undeniably an important policy discussion, the argument phrased thus assumes full fungibility of

HSR funds for other initiatives. In fact, the level of political buy-in (and therefore funding) achievable for HSR may not be achievable for a collection of smaller initiatives.

Concepts developed in this thesis would also bear scrutiny for their applicability beyond the contexts considered here. For example, we have constrained our examination of polycentricity primarily to an environment of established cities. How might the concept change if applied to a developing world context, where cities are growing rapidly, and brand new developments and infrastructure are the rule rather than the exception? Even Portugal and the United Kingdom present significantly different contexts from one another in terms of overall growth trends. In Portugal where growth is more stagnant and intercity congestion less of an issue, is it worth the level of investment required for HSR in order to redirect development patterns towards a more sustainable form? How strong do environmental benefits and economic gains from network agglomeration have to be in order to justify such an investment? Congestion on the rail network is at present a more clear constraint on growth in the UK than in Portugal. In the United States, a combination of congestion at airports, and on highways and rail, serves to motivate HSR proposals. The difference in levels of growth and congestion across contexts, and its bearing on the cost-effectiveness of HSR, would benefit from additional research.

Historical growth may also be a force that influences the applicability of our ideas. We have here argued quite strongly that HSR stations should be located within urbanized city centers in order to build on prior economic strengths while counteracting the forces of sprawl. Framed thus, HSR is a preventative measure, a way of returning future growth patterns to older patterns of denser urban growth. This model is less applicable in cities that developed entirely in the automobile era and therefore lack a traditional pedestrian-oriented urban core. Newer cities in the United States like Phoenix, Arizona are of this type. In contexts like that, we need to ask: can HSR be use as a trigger to induce entirely new models of growth? That is, under what conditions are the incentives for dense development provided by HSR strong enough to justify placement of a HSR station in a city with no existing core upon which to build?

The research presented here is only the beginning of a journey. We hope that future research will examine the potential of HSR to support long-term sustainability in a broad variety of situations, in addition to those considered here.

* * *

In this thesis, we set out to more clearly define the spatial and distributional objectives of HSR and thereby to support a more informed political discussion on strategies for HSR planning and implementation. We posited a holistic sustainability agenda for HSR and sought insights into how best to link bundles of institutional and technical alternatives to implement an HSR system that meets that set of objectives. In particular, we note the importance of inter-jurisdictional relationships in guiding HSR, because it plays out at multiple scales.

Ultimately, we found that inter-jurisdictional relationships are important, not only to the proper implementation of a HSR project, but also to the process of establishing performance targets and selecting design alternatives. In designing a complex system such as a high-speed rail network, there will always remains a degree of uncertainty, an element of the 'unknown unknown.' It is imperative therefore to establish an institutional structure that can carry sustainability objectives through long-term implementation and management under uncertainty. This is best achieved by developing a strong and coherent set of objectives and performance measures and by developing channels of communication between stakeholders to combine technical rail-related expertise and local contextual knowledge.

In some ways, this thesis has been an effort to create a common language for and shared understanding of the spatial implications of HSR. We thank the reader for their interest, and part ways with the wish that some part of this thesis will offer clarity to future decision-making processes.

Appendices.

Appendix

A Spatial patterning of commuter trips – Évora, Leiria, Coimbra

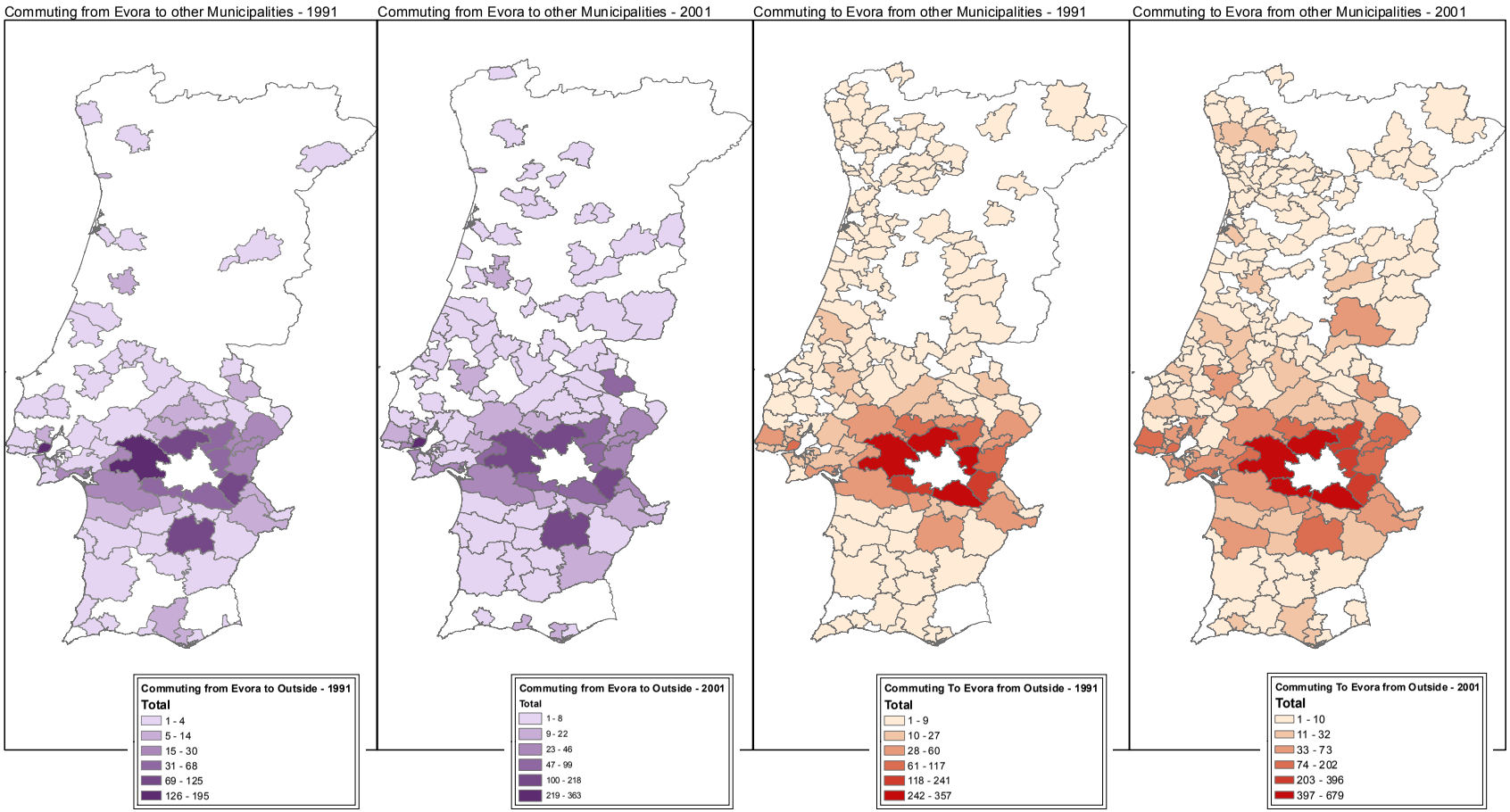

Figure A-1 Commute trips from and to Évora in 1991 and 2001 (Source: Author, data from 1991 and 2001 Census, INE)

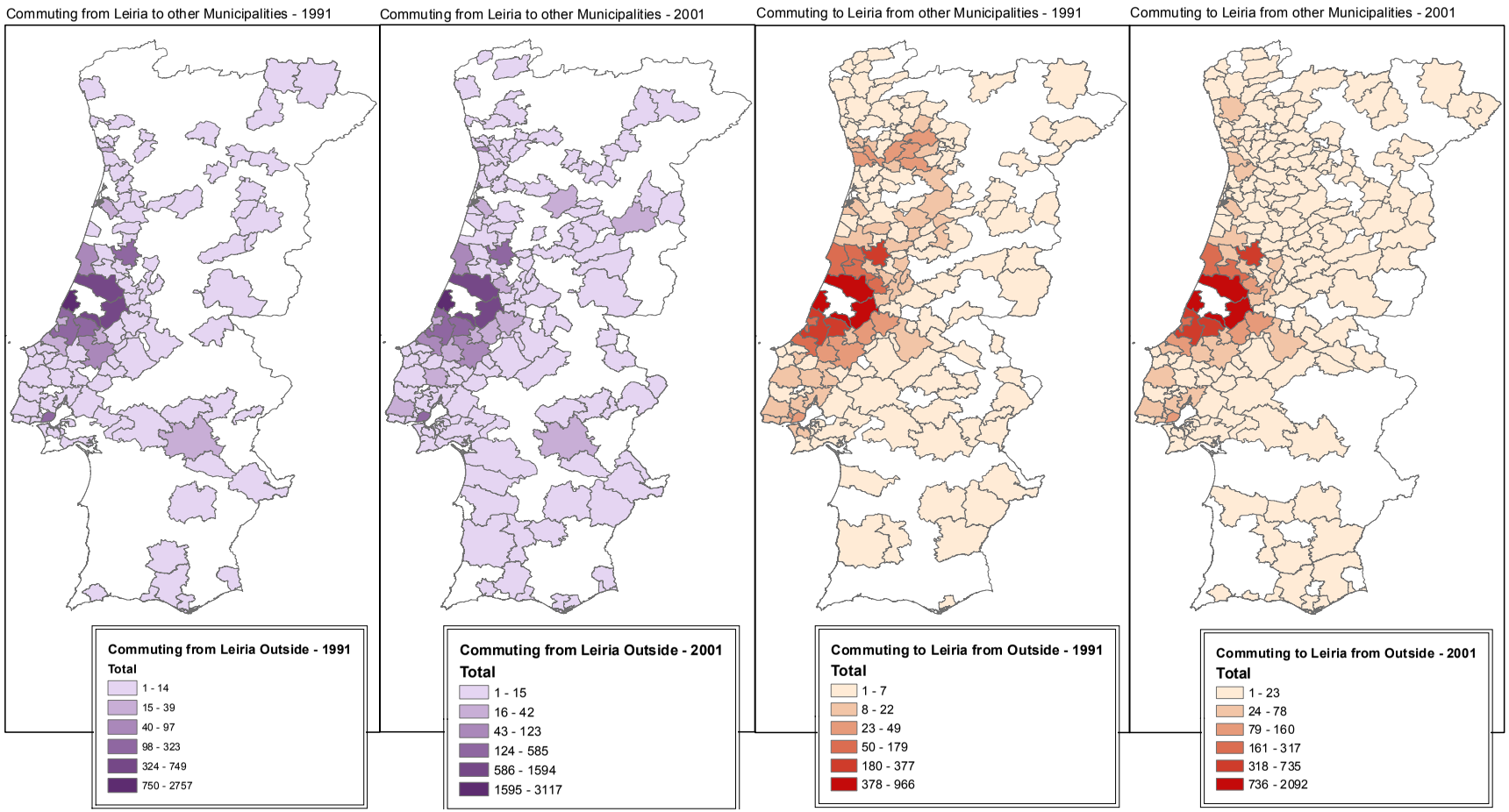

Figure A-2 Commute trips from and to Leiria in 1991 and 2001 (Source: Author, data from 1991 and 2001 Census, INE)

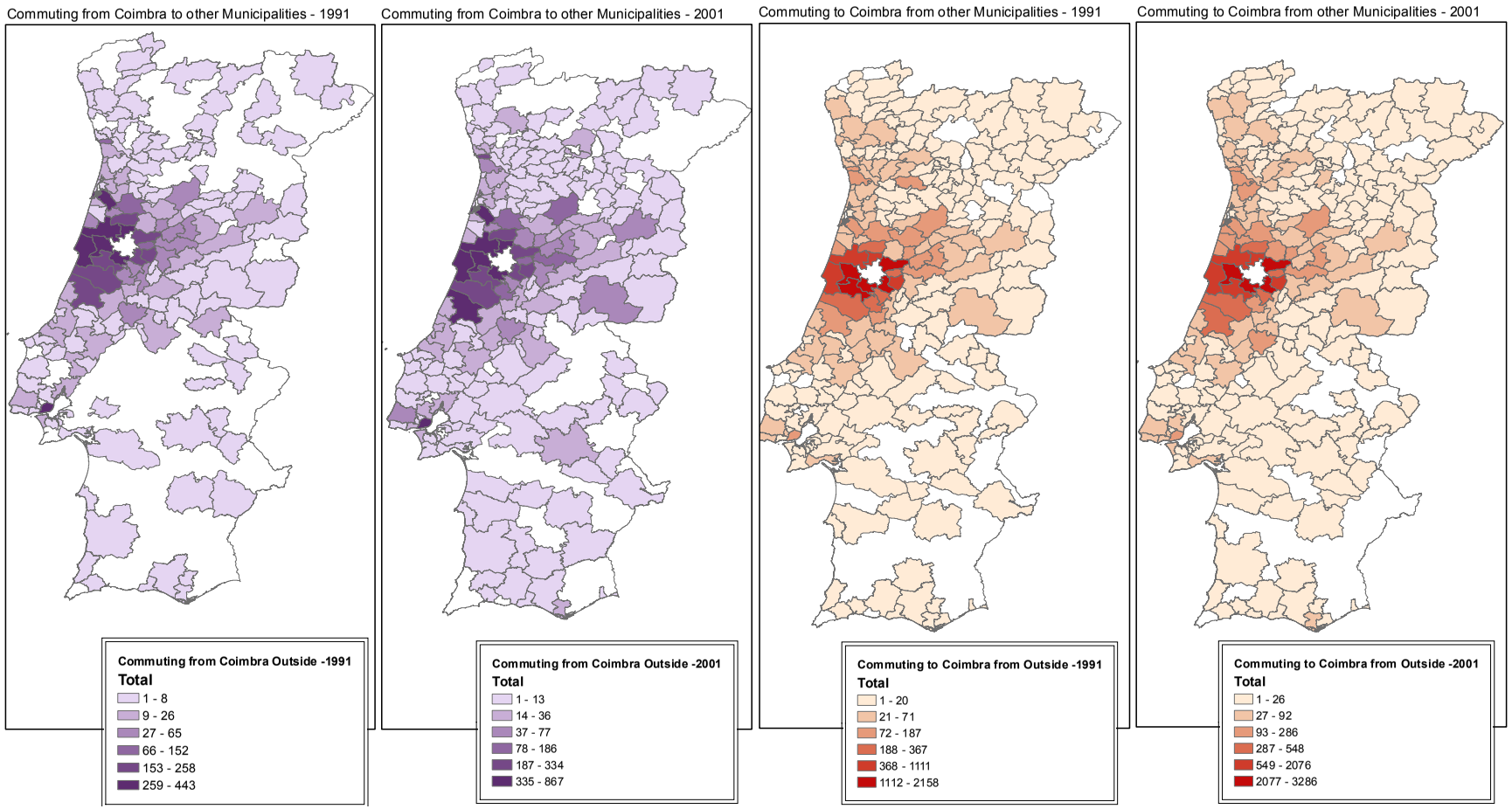

Figure A-3 Commute trips from and to Coimbra in 1991 and 2001 (Source: Author, data from 1991 and 2001 Census, INE)

B Polycentricity Metrics

Table A-1 Centro region nodality in 1991 and 2001

Municipality in Centro	*Nodality (1991)*	*Nodality (2001)*	*Percent Change*
1. Coimbra	86,930	110,978	28%
2. Leiria	51,277	77,022	50%
3. Aveiro	44,694	60,838	36%
4. Viseu	40,250	55,474	38%

Table A-2 Centro region internal centrality – nodality comparison (1991)

Municipality in Centro	C_{ci}	*Nodality (rank)*	C_{ci} *as a % of Nodality*
1. Coimbra	16,329	86,930 (1)	19%
2. Aveiro	10,377	44,694 (3)	23%
3. Leiria	5,452	51,277 (2)	11%
4. Águeda	3,899	27,458 (8)	14%
5. Marinha Grande	3,890	19,278 (14)	20%
6. Viseu	3,669	40,250 (4)	9%

Table A-3 Centro region internal centrality – nodality comparison (2001)

Municipality in Centro	C_{ci}	*Nodality (rank)*	C_{ci} *as a % of Nodality*
1. Coimbra	25,408	110,978 (1)	23%
2. Aveiro	16,598	60,838 (3)	27%
3. Leiria	10,676	77,022 (2)	14%
4. Águeda	5,789	33,338 (7)	17%
5. Viseu	5,686	55,474 (4)	10%
6. Caldas da Rainha	5,280	30,098 (11)	18%

Table A-4 Centro region external centrality - nodality comparison (1991)

Municipality in Centro	C_{ce}	*Nodality (rank)*
1. Ovar	3,063	24333 (11)
2. Aveiro	2,052	44694 (3)
3. Alenquer	1,892	14418 (22)
4. Coimbra	1,803	86930 (1)

Table A-5 Centro region external centrality - nodality comparison (2001)

Municipality in Centro	C_{ce}	*Nodality (rank)*
1. Ovar	5,398 (6)	33,801
2. Alenquer	4,029 (18)	21,457
3. Aveiro	3,831 (3)	60,838
4. Torres Vedras	2,542 (5)	40,626
5. Coimbra	2,442 (1)	11,0978
6. Torres Novas	1,272 (20)	19,206
7. Viseu	1,258 (4)	55,474
8. Leiria	1,200 (2)	77,022

Table A-6 Lisboa region nodality

Municipality in Centro	*Nodality (1991)*	*Nodality (2001)*	*Percent Change*
1. Lisboa	649,799	686,426	6%
2. Sintra	94,912	159,376	68%
3. Loures	78,395	91,689	17%

Table A-7 Lisboa region internal centrality – nodality comparison (2001)

Municipality in Lisboa	C_{ci}	*Nodality (rank)*	C_{ci} *as a % of Nodality*
1. Lisboa	375,915	686,426 (1)	55%
2. Oeiras	40,175	87,974 (4)	46%
3. Loures	26,524	91,689 (3)	29%
4. Sintra	26,109	159,376 (2)	16%
5. Amadora	25,028	72,027 (7)	35%
6. Almada	24,899	80,301 (6)	31%

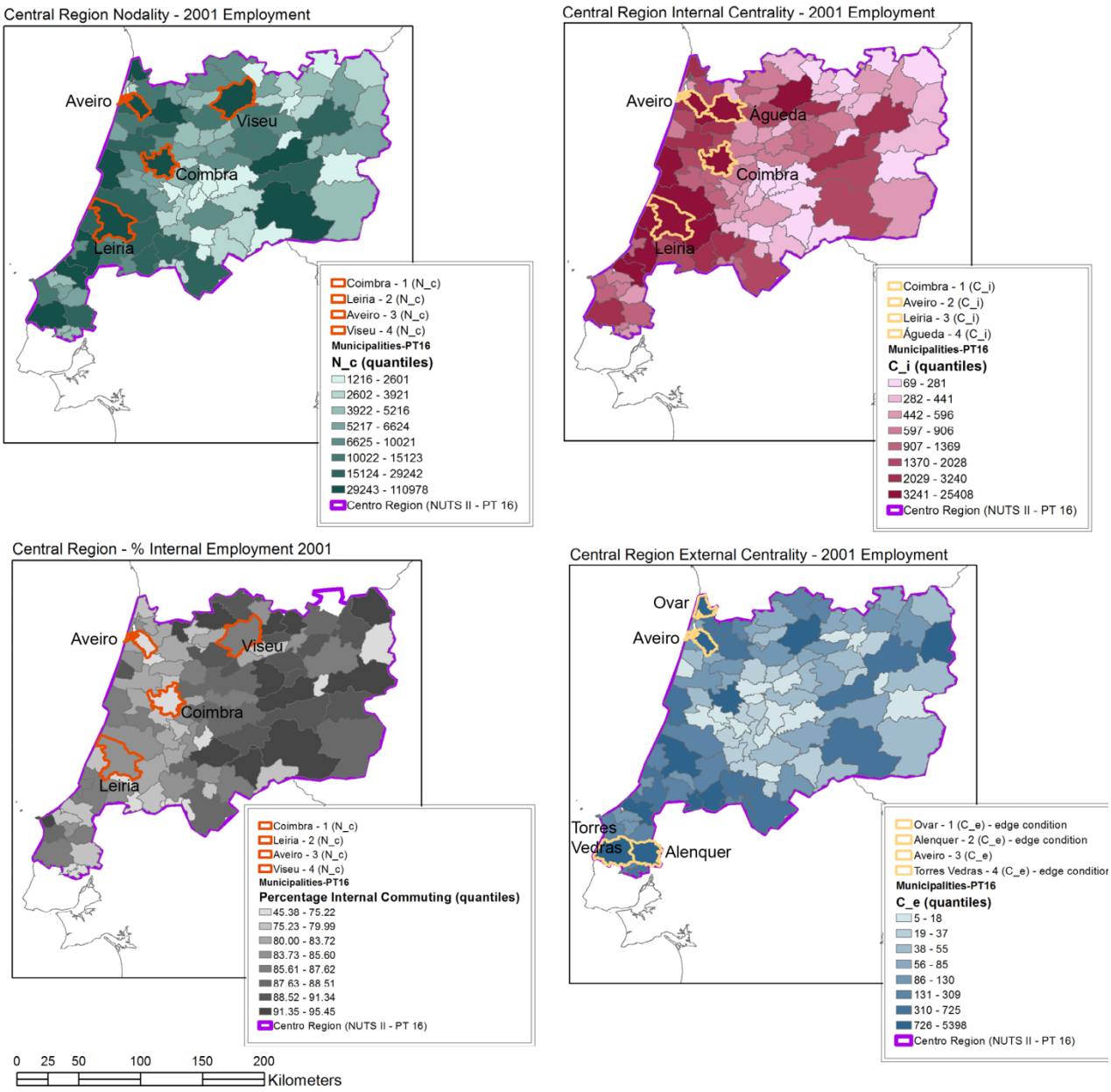

Figure A-4 Employment nodality and centrality in the Centro region, 2001 (Source: Author, data from 2001 Census, INE)

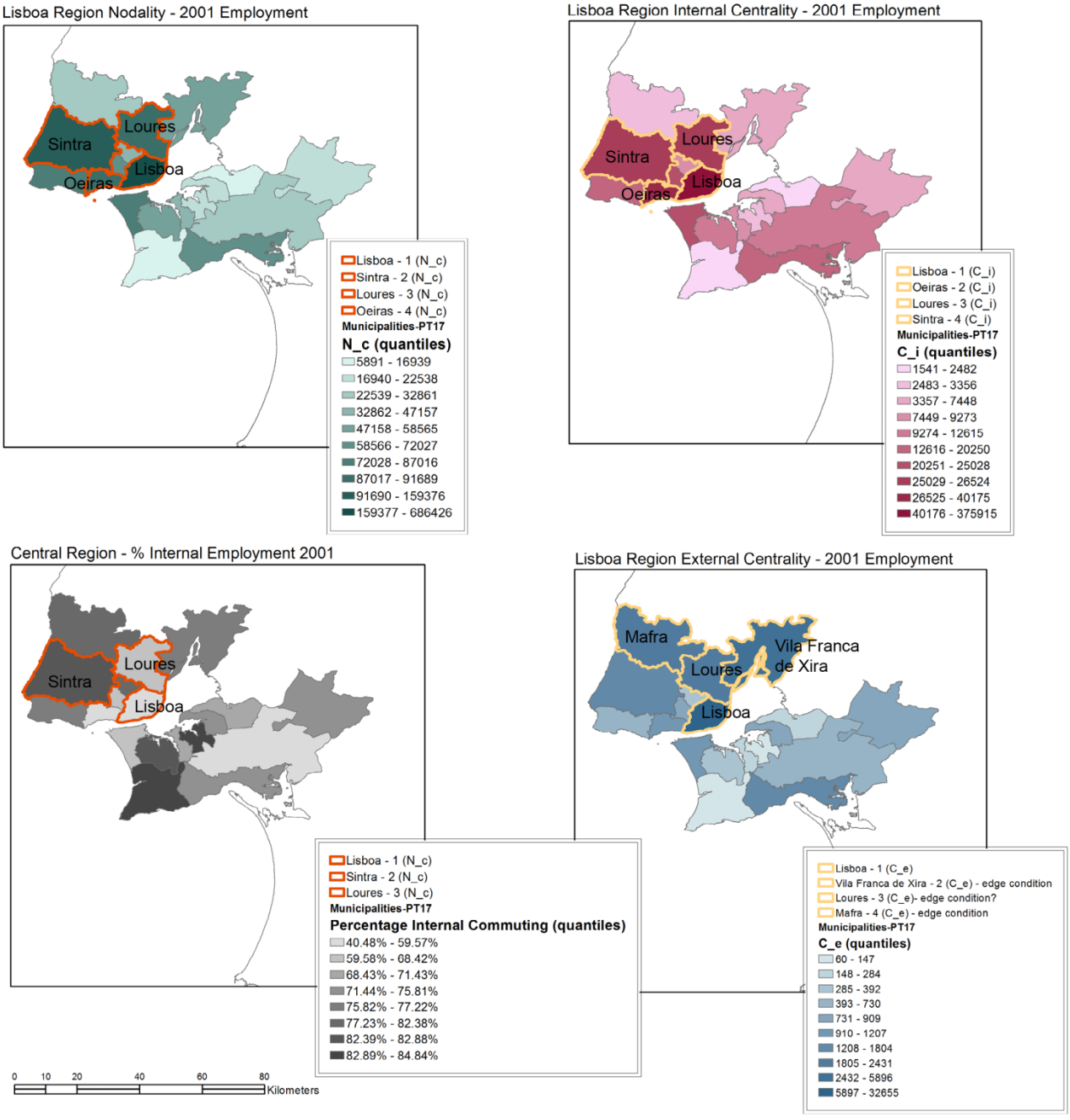

Figure A-5 Employment nodality and centrality in the Lisboa region, 2001 (Source: Author, data from 2001 Census, INE)