

**THE AGGLOMERATIVE ROLE OF TRANSPORTATION INVESTMENT:
A COMPARATIVE ANALYSIS OF PORTUGUESE AND AMERICAN HIGH-SPEED RAIL PROPOSALS**

by

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Abstract

This research uses a comparative analysis of High-Speed Rail (HSR) impacts from proposals in both Portugal and Illinois to understand the wider economic implications of these proposed transportation links and corollary improvements. Conceptualizing these HSR-linked regions as a string of interconnected cities, the research explores added accessibility in these linked cities and shows HSR time-space effects functionally move some cities into other cities' commuting areas.

Here, case studies of four different, but analogous, proposed HSR stops in two countries—Portugal and the United States—reveal various insights. The cities of Coimbra and Leiria in Portugal and Champaign-Urbana and Kankakee in Illinois, with new high-speed access to Lisbon and Chicago, respectively, are analyzed to further explore the potential effects HSR could have on such communities. The research presented takes a complex systems perspective, exploring striking parallels of population and distances between the case communities, and highlights opportunities for these communities afforded by new connections to the principal cities.

Ultimately, further understanding potential impacts on local communities involves multiple considerations and provides various transportation planning lessons. This work shows how particular investment will serve to reinforce and potentially accelerate the growth of regions, metropolitan areas, and create new micro-urban centers. Via further market integration into the principal metropolitan areas, economic development and quality of life shifts become possible. Using a conceptual methodological framework to quantitatively assess agglomerative benefits, the research shows that HSR improves the potential for agglomeration growth over the best existing travel mode by approximately 25% to 125% in Portugal and 15% to 150% in Illinois amongst the case communities.

Thesis Supervisor: Joseph M. Sussman

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Ryan Westrom
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Chapter 1

1 INTRODUCTION AND MOTIVATION

The "regional cities" of tomorrow will be nearly continuous complexes of homes, business centers, factories, shops and service places. Some will be strip or rim cities; some will be star-shaped or finger-shaped; others will be in concentric arcs or parallels; still others will be "satellite towns" around a nucleus core. They will be saved from traffic self-suffocation by high-speed transportation—perhaps monorails that provide luxurious nonstop service between the inner centers of the supercities—as well as links between the super-metropolises themselves.¹

-July 23, 1961, ...Closer Than We Think! comic strip

1.1 MOTIVATION

Throughout history, humankind has looked to the future with hope and aspiration. Many expect today's problems can be eliminated tomorrow. This has been especially true in the most human of innovations, our cities.² Formed by the networks of human movement and communication, they continue to evolve alongside humanity. But we have typically been poor at foreseeing the future. We have envisioned colonies on the moon or transportation from American coast to coast in 45 minutes. Visions of new infrastructure and warp speed transportation litter our cultural history, usually without realization.

Now, here we are living in the future of yesterday. Some things envisioned have happened—the over 50 years old prediction cast above sounds true in part. But many have not, and others unimagined are here. So how can we assess future innovations robustly? With knowledge of our own predictive limitations, but also recognizing that today's tools allow more data-driven approaches than available to past visionaries, what can today's context tell us about where society is going? And more pointedly to our purposes, how will transportation linkages continue to transform the cities of tomorrow?

Within this thesis research, we have determined that a focus on urban areas is appropriate. As we will explain further, it is within urban cores of metropolitan areas that society's leading trends seem to be emerging and where creativity and innovation are thriving.³ This is true especially as cities embrace digital technology and start to become so-called "smart cities."⁴ It is within certain settings, where an appropriate density of people with particular demographics, policy, and politics are in place, that we can most clearly illustrate and articulate the forthcoming trends. We are especially interested in the role high-speed rail plays in transforming a city's spatial geography. This altering effect has corollary impacts on a city's function, as well as further afield within its regional setting. And ultimately, as we will show, these effects are felt nationally or internationally. We will be examining two specific high-speed rail proposals, one in Portugal and the other in Illinois, to explore the implications of these major proposed

¹ Radebaugh, "...Closer Than We Think!". (for full comic illustration, see Appendix A)

² Glaeser, *Triumph of the City*.

³ Katz and Bradley, *The Metropolitan Revolution*.

⁴ Townsend, *Smart Cities*.

transportation links and corresponding improvements. The new systems will pass through communities not currently connected so closely to the principal metropolitan centers in their regions, allowing exploration of growth opportunities for outlying cities within growing regions of all types⁵ anchored by a principal center city.

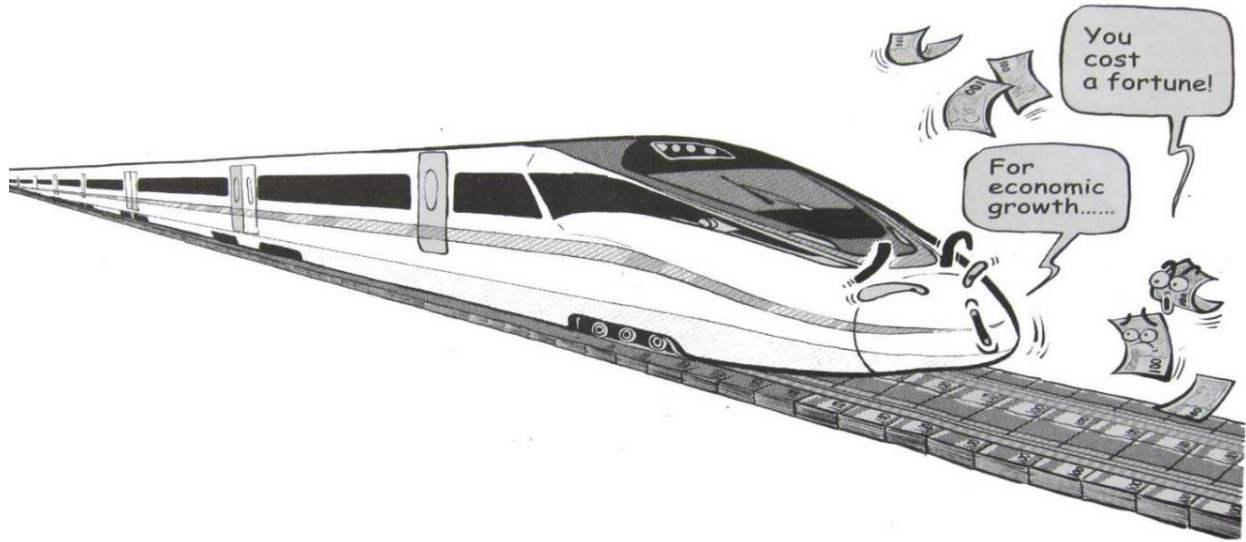


Figure 1.1. *The Value of HSR?* (Source: *China Daily*, June 20, 2011, by Pang Li)

High-speed rail is one of those transportation innovations that has been slow to materialize in some parts of the world, especially in the Americas, although they have gained rapid traction elsewhere.⁶ The benefit of investment in a system of its magnitude has often not been clear enough for advocates to win approval for projects. Drawing on a stream of past literature within our research group^{7 8} and globally, we believe the case for high-speed rail can be added to by the framework used in consideration of the systems we will examine. Quite simply, we are interested in bolstering understanding of continued high-speed rail investment, and will use the fundamentals offered in our analysis to elicit this result. Past literature observes, “Thus far, most of the debate around the HSR project[s]...has centered on the rail’s anticipated ridership, capital and operating costs, and fare structures. Less inquiry has focused on its potential economic development and spatial impacts.”⁹ It is into this gap we hope to step.

Here, study of four different proposed high-speed rail stops in two countries—two in Portugal and two in the United States—reveals a number of insights. Understanding further the potential impacts on local communities involves multiple considerations and provides various conceptual transportation planning lessons, ultimately showing how particular investment will serve to reinforce and potentially accelerate growth in metropolitan centers and megaregions, and create new micro-urban intermediate cities.

⁵ Various definitions provided by assorted outlines of regional hierarchy will be further discussed in Chapter 2.

⁶ Bradsher, “Speedy Trains Transform China”.

⁷ Stein, “Spatial Dimensions of High-Speed Rail”.

⁸ Melibaeva, “Development Impacts of High-Speed Rail”.

⁹ Loukaitou-Sideris et al., “Tracks to Change or Mixed Signals?”.

1.2 FUNDAMENTALS OF HIGH-SPEED RAIL CONSIDERATION

High-speed rail (hereafter HSR) is a mode of transportation that has been much studied, but on which most Americans have never traveled or have only experienced abroad. A concise overview of what we mean by HSR can be offered:

HSR is considered a passenger rail project where travel speeds are significantly higher than conventional passenger rail services. What speed is meant by HSR is variable depending on the jurisdiction proposing the project. However, typically, there are two types of projects encountered, regional HSR and express or international-quality HSR.¹⁰ First, express HSR travels at speeds above 150 mph, with few intermittent stops. Crossings are grade-separated and the track is typically on dedicated right-of-way (ROW). One can expand on this, noting that true international-quality high-speed rail is often meant to include trains with a maximum speed of at least 220 mph, which brings strong competitiveness with other transport modes in a range up to 500 miles. Second, regional, or higher speed (than conventional rail), HSR is sometimes considered. This intermediate service provides improved speed and reliability, but with speeds typically ranging between 80 mph and 150 mph. Some shared track or at-grade crossings may be seen on these lines. The Amtrak Acela route in the Northeast Corridor of the United States is considered the only HSR in the Americas, and it is a regional HSR service. In Portugal, the Alfa Pendular service operates as a regional HSR, connecting its major cities, but may not be considered true HSR by European standards. For the purposes of this thesis, we are almost exclusively considering installation of international-quality or express HSR. Table 1.1 provides an overview of these passenger rail types.

Table 1.1. Passenger Rail Service Characteristics (Source: author)

| <i>Passenger Rail Type</i> | <i>Typical Speed (mph)</i> | <i>Stops</i> | <i>Typical Configuration</i> |
|-------------------------------------|----------------------------|---------------|--|
| Conventional | 40-80 | Frequent | Shared track, at-grade crossings |
| Regional HSR | 80-150 | Less frequent | Split between dedicated and shared track, few at-grade crossings |
| International-quality (Express) HSR | >150 | Few | Dedicated track and ROW, completely grade-separated |

Additionally, some specific underlying concepts are important for the ongoing understanding of analyses in this thesis.

1.2.1 HSR as Transit

Historically, HSR has been considered an interurban form of transportation. Its competitors are seen as air and auto, and to some extent slower trains and buses.¹¹ However, as will soon become even clearer, we now can also consider HSR, especially the first portion extending from each connected city, as a form of “urban transit”. The functional role HSR plays in the transportation system varies depending on the trip taken by its user. The speed of HSR, along with its typical city-center to city-center routing, has served to blur the line between intercity and intra-city travel.

Intraurban transit is typically used largely for commuting purposes and other daily activities. And the amount of time people typically spend traveling to and from work each day is amazingly consistent,

¹⁰ This bipartite definition has been adopted by the United States Federal Railroad Administration (FRA). Globally, the first system considered true HSR is the 1964 Japanese Shinkansen Tokaido line between Tokyo and Osaka.

¹¹ Taylor, “Selling the Value of High-Speed Rail”.

across time and geography.¹² This constant travel-time budget¹³ suggests that people will commute up to approximately one hour in each direction, allotting time in their day for an uncannily constant portion spent commuting. While there are outliers, often referred to as *super-commuters*, this again remains surprisingly consistent across place and cultures. As transport ease and speed has increased, the distance people travel has also increased, while the time remains constant. With that being the case, one would suspect that, for HSR users, the potential for commuting on this new mode will be real within this one hour travel window. And indeed, Stein observes:

*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”.*¹⁴

Therefore, any city, regardless of its distance from a metropolitan area, can move into the commutable realm of a central city if the travel time resulting from a HSR improvement moves to below one hour. In our cases, this is true of all four cities we are examining, and in fact is one of the driving forces behind our selection of these communities.

Figure 1.2 depicts the transformed regions resulting from the development of HSR between particular metropolitan centers. As can be seen, a new commuting region is formed on the HSR line out to the reasonably commutable distance (again, measured by time).

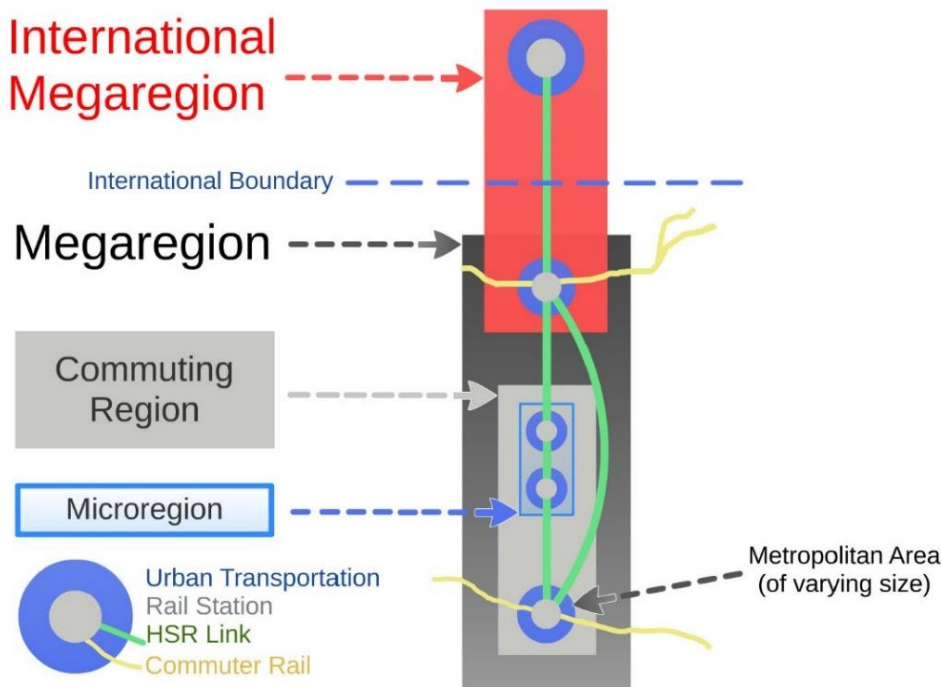


Figure 1.2. HSR and Regions (Source: developed jointly by Prof. Joseph M. Sussman, Andrés F. Archila, and the author)

It is within these newly formed commuting areas this thesis largely focuses effort, on providing a fuller picture of the impacts and magnitude of effects the new HSR line brings.

¹² Schafer and Victor, “The Past and Future of Global Mobility”.

¹³ Sometimes called Marchetti’s constant, after the work on this topic of Italian physicist Cesare Marchetti.

¹⁴ Stein, “Spatial Dimensions of High-Speed Rail”.

1.2.2 Wider Economic Benefits

When infrastructure projects of any magnitude are considered, it is typical for some form of project evaluation to occur by which the potential project's worthiness can be assessed. Often this takes the form of a comparison between project benefits and the cost of implementation and operation. Typically, a benefit/cost ratio is measured, which weighs all the project's benefits against its costs. Usually this value is monetized, and qualitative considerations are either assigned a dollar value or considered tangentially. Included are typical user or system benefits such as cost savings, travel time savings, congestion relief, and environmental factors. While this quantitative benefit/cost measure certainly still is valuable, decision makers have begun to also recognize that some of these qualitative considerations as well as additional project ramifications and economic effects should also be more closely considered, and in fact are potentially quite substantial. These wider considerations have recently begun to be studied far more closely. Coined wider economic benefits¹⁵, these considerations could be negative¹⁶, but are typically considered positive.

Wider economic benefits are those indirect benefits, not usually included in the benefit/cost analysis. These can include effects on regional productivity and economic output, agglomeration, labor markets, competition, land and property markets, and as well additional network and environmental considerations.¹⁷ ¹⁸ There is some debate as to the extent to which these effects should be considered in project evaluation, as some may only be redistributive, but consensus seems to be forming that infrastructure investment typically provides net positive contribution to the wider economy within which it operates.¹⁹ Benefits to the wider economy can be regional or relatively localized. Locally, significant increases in accessibility can increase the efficiency of connected city centers, while also impacting community equity throughout the system.²⁰ Regionally, the distribution of effects throughout the region varies, and social effects may also result.²¹

As evaluators assess whether the overall net project benefit outweighs costs, the wider economic benefits often do matter. Many transportation investments are quite sizable, and with large initial costs, downstream resulting economic development and added environmental and equity benefits are important considerations. That said, quantification of these remains a challenge. The magnitudes and even direction of various economic impacts can be considerably different²², continuing to make their inclusion in evaluation complicated. This thesis, building on past research in this realm²³, attempts to describe some of the wider economic benefits resulting to Illinois and Portugal, and the cities within, of the proposed HSR investment. A more focused word on one of these key wider economic concepts is worthwhile.

¹⁵ Also sometimes alternatively described as broader economic benefits or non-transport benefits, or more generally wider economic impacts, as effects could potentially move in either direction.

¹⁶ Negative externalities could include air pollution, noise, safety concerns, and sprawl.

¹⁷ Banister and Thurstain-Goodwin, "Quantification of the Non-Transport Benefits Resulting from Rail Investment".

¹⁸ *The Wider Economic Benefits of Transport*.

¹⁹ Vickerman, *Recent Evolution of Research into the Wider Economic Benefits of Transport Infrastructure Investments*.

²⁰ Monzón, Ortega, and López, "Efficiency and Spatial Equity Impacts of High-Speed Rail Extensions in Urban Areas".

²¹ Monzón, Ortega, and López, "Social Impacts of High Speed Rail Projects".

²² Lakshmanan, "The Broader Economic Consequences of Transport Infrastructure Investments".

²³ Vickerman and Ulid, "Chapter 5: Indirect and Wider Economic Impacts of High-Speed Rail".

1.2.3 Agglomeration Economies

Many of the wider impacts are related to an economic concept called agglomeration, the importance of which is continuing to gain traction within the transportation community.²⁴ Agglomeration in this context²⁵ refers to additional economies of scale or production wrought by density. In agglomeration economies, firms and people spatially concentrate, the basis for forming cities, creating dynamic collaborative environments within which members gain from the synergy produced by this community of participants. Firms and people mutually benefit from such surroundings for three main reasons: they learn from each other (knowledge spillovers), they share resources or costs (shared inputs), and they integrate their labor needs (labor market pooling). These ideas first arose in Adam Smith's work, which noted the propensity for people to cooperate by exchanging not only goods but assistance, favors, gifts, and ideas.²⁶ The three pillars of agglomeration are based on seminal economist Alfred Marshall's intuition²⁷ from late in the 19th century that ideas are "in the air" within neighborhoods of likeminded tradesmen, and expanded upon by economist Robert Lucas, who noted in the 1980s the importance of human capital concentration, and the resultant knowledge spillovers, for innovation.²⁸

All these benefits, deemed a type of externality, provide advantage to people operating in close quarters with other smart people, offering incentive for creative-minded and innovative people and industries to cluster. This trifold benefit of agglomerative communities allows members to be more productive and economically successful than expected were they not in such a symbiotic environment. Transportation thus plays a critical role in allowing access to such clusters.²⁹ By decreasing the friction of distance, the benefits of agglomeration are available to a greater circle of collaborators, in turn serving to positively reinforce the mutually beneficial dependency. And collocating reduces transportation costs for all in proximity to the agglomerative core. Cities themselves are a natural result of the success of agglomeration economies. This is indicated as we see economies of scale increase more than proportionately as cities grow in size.³⁰ ³¹ Put another way, "...cities exist to reduce transport costs for goods, ideas, and people."³² And we aim to further understand the effects on our subject cities of new transportation investment, and whether it does increase access to and from these communities to such agglomeration.

Ongoing work in the realm of economic geography explores the role of transport in agglomeration. A new extension of this work developed in the 1990s, called new economic geography, provides various new approaches to understanding the spatial underpinnings of economic output.³³ We will investigate further the resultant consideration of accessibility to such markets in Chapter 5. Now, however, we turn our focus to the linkages through which we will explore the reach of agglomeration, our proposed HSR systems.

²⁴ Graham, "Agglomeration, Productivity and Transport Investment".

²⁵ The term agglomeration is also often used to describe an urban settlement, especially in European academia.

²⁶ Smith, "The Two Faces of Adam Smith".

²⁷ Marshall, *Principles of Economics*.

²⁸ Harford, *The Logic of Life*.

²⁹ Chen and Hall, "The Impacts of High-Speed Trains on British Economic Geography".

³⁰ Batty, *The New Science of Cities*.

³¹ Hardesty, "Why Innovation Thrives in Cities".

³² Stein, "Spatial Dimensions of High-Speed Rail".

³³ Fujita, Krugman, and Venables, *The Spatial Economy*.

1.3 A SUMMARY OF THE HSR PROPOSALS IN PORTUGAL AND ILLINOIS

In both Portugal and Illinois, significant international-quality HSR systems are proposed. The new HSR systems we are focusing on are envisioned to move from each geography's major economic force, Lisbon and Chicago respectively, providing high-speed access ultimately to Porto and St. Louis (as well as potentially Indianapolis).

Lisbon and Chicago play special roles within their geography. Major metropolitan areas such as these are often given added significance as they are described as hubs or gateways. These descriptors hold important meaning in the realm of transportation. A *hub* is a city with central location in a transportation system such that it has better accessibility to all the other locations. A *gateway* is a city with an advantageous location such that most goods and people move in and out of the region through it.³⁴ Both Lisbon and Chicago are hubs for their geography; for Portugal and Illinois and the Midwest, respectively. And especially Chicago is a main gateway as well. Thus it is clear the significant role they each play in their locale and the potential a HSR connection could bring. Specifics on each of these HSR proposals are as follows:

1.3.1 Portugal's HSR Proposal

In Portugal, the capital and largest city of Lisbon is intended as the hub of a new set of HSR links. These systems would link Madrid, Spain to Lisbon, which would then be linked to Porto, Portugal's second largest city, with additional connections to the south of Portugal and north of Porto possible. Leiria and Coimbra fall on the proposed link between Lisbon and Porto, with both featuring substantially reduced travel times to either Lisbon or Porto.

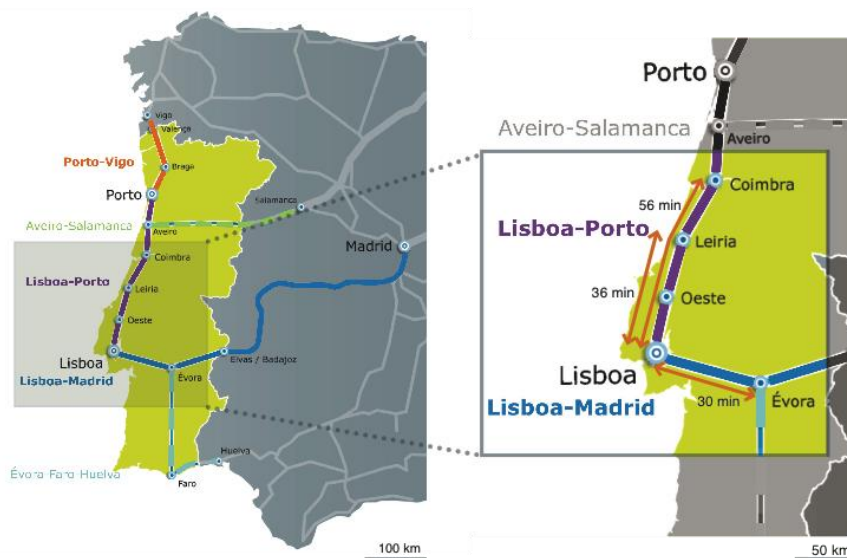


Figure 1.3. Portugal's Proposed HSR System (Source: Stein, 2013 from RAVE)

³⁴ Ottaviano, "Infrastructure and Economic Geography".

This major rail upgrade is part of an overall European plan called the Trans-European Transport Network (TEN-T) anticipated by European Union (EU) leadership.³⁵



Figure 1.4. European HSR Plan (Source: RAVE)

Historically, Portugal's railway system began on October 28, 1856, with the first line operating from Lisbon to Carregado. Its spread by the 20th century is shown in Figure 1.5. The network has grown to a length of 1,733 miles as of 2010, with a vast majority of the system wide gauge. Since 1975, the national freight and passenger operations have been the jurisdiction of a nationalized enterprise called Trains of Portugal (Comboios de Portugal) or CP. As of 2004, the rail network carried 133 million passengers and 9.5 million tons of freight annually.³⁶ Most of these are urban commuters, and as of 2012, CP carried 14.1 million long-distance and regional passengers.³⁷

Currently, Portugal does offer regional quality HSR, as well as conventional rail service to various cities. Their existing regional HSR is the Alfa Pendular service, which operates from Braga to Porto to Coimbra to Lisbon to Faro. It performs at top speeds of 220 km/h or nearly 140 mph. Between Lisbon and Porto, the Alfa Pendular service features 11 trains per day.³⁸ CP also maintains other long-distance intercity conventional rail routes (Intercidades) as well as regional services (Interregional and Regional) and suburban networks in Lisbon and Porto.

³⁵ Melibaeva, "Development Impacts of High-Speed Rail".

³⁶ Ibid.

³⁷ Source: CP

³⁸ Melibaeva, "Development Impacts of High-Speed Rail".

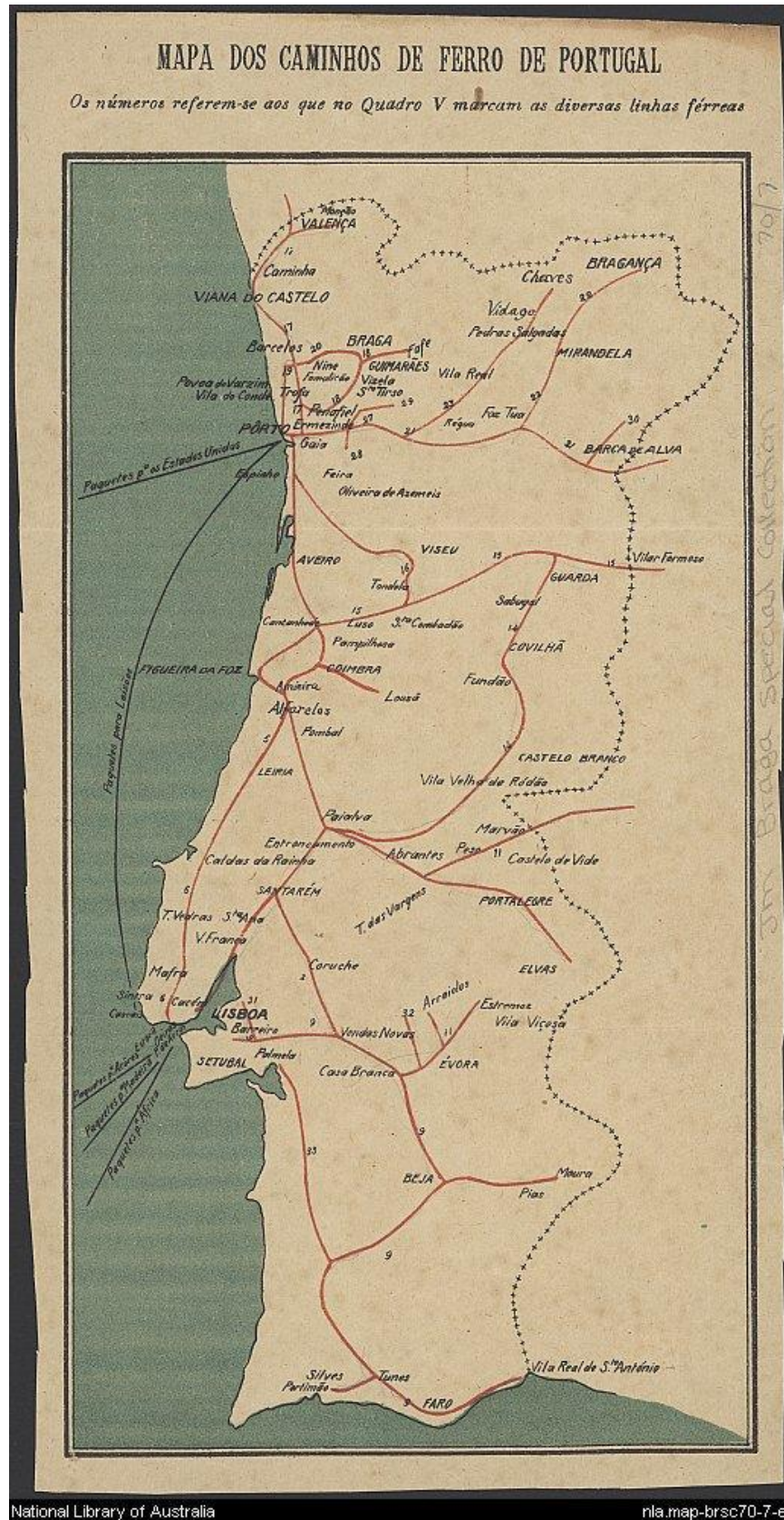


Figure 1.5. Railway Map of Portugal, circa early 20th Century (Source: National Library of Australia)

In 1997, management of railway infrastructure was transferred from CP to a new entity called the National Railway Network (Rede Ferroviária Nacional Empresa Publica) or REFER.³⁹ With prompting from European planners and national interest in closer linkage to Spain for economic purposes, the vision for this proposed HSR system was begun in the 1990s. In 2000, a separate company was created by the Portuguese government to develop HSR in Portugal called High-Speed Rail Network (Rede Ferroviária de Alta Velocidade) or RAVE. REFER owned 40% of RAVE and the Portuguese government 60%.⁴⁰ Initial priority was given to the Madrid-Lisbon line of greater interest to the EU, with the Lisbon-Porto link to follow. Detailed planning commenced, with complete plans for both lines developed by the end of the decade. However, just as they were moving to construction in 2010, implementation of these railways came into question due to the ongoing financial difficulties of the Portuguese economy and thus government. Facing a debt crisis, the government has moved into an austerity mode. In March of 2012, all HSR work was officially stopped and shared EU funding for the project was withdrawn. Despite ongoing efforts to renegotiate, especially on the Madrid line, the project remains suspended indefinitely. RAVE was reabsorbed by REFER and dissolved in 2012.⁴¹

Despite the unknown prospects for the proposed HSR project, examination of its potential impacts is useful as they can continue to inform the decision-making process as future implementation is considered. Furthermore, due to the relatively advanced plans for the project, communities along the way have anticipated the new HSR and planned accordingly. We can consider these efforts as we contemplate the proposal's potential. And part of this thesis' goal is to allow planners to more effectively consider the possible impacts of a significant transportation investment such as this prior to its accomplishment. That is exactly where this project's status remains. Thus, we examine more closely the details of the Lisbon to Porto proposal.

The Lisbon to Porto rail distance is 185 miles, which is an apt proposed HSR distance. Past literature has shown that, depending on the precise speed, HSR is the fastest city-center to city-center trip for distances ranging from approximately 200 miles to 500 miles. And within those distances, it will usually outcompete alternative modes such as auto, bus, and air.⁴² Major intermediate stops are found in Leiria and Coimbra. This Portuguese proposal will bring passengers from Lisbon to Leiria in 36 minutes, to Coimbra in 56 minutes, and Porto in 75 minutes. This compares extremely favorably to existing travel times via other modes, and would move Coimbra and Leiria within Lisbon's commuting region.

Table 1.2. Portugal HSR Travel Times (Source: as noted)

| Locale | Rail Distance (mi.) | Existing Highway Travel Time** | Existing Rail Travel Time*** | Existing Flight Travel Time**** | Proposed HSR Travel Time |
|---------------|----------------------------|---------------------------------------|-------------------------------------|--|---------------------------------|
| Lisbon | - | - | - | - | - |
| Leiria | 74.6 | 83 | 175 | - | 36 |
| Coimbra | 116.2 | 109 | 96 | - | 56 |
| Porto | 184.5 | 165 | 155 | 145 | 75 |

* All travel times in minutes
 ** Google estimated driving times were used for all routes
 *** Amtrak in Illinois, Fastest CP service in Portugal (Accessed 10/30/13)
 **** Assuming 1.5 hr. security/check-in/arrival time

³⁹ "REFER".

⁴⁰ Melibaeva, "Development Impacts of High-Speed Rail".

⁴¹ Stein, "Spatial Dimensions of High-Speed Rail".

⁴² Chen and Hall, "The Impacts of High-Speed Trains on British Economic Geography".

The proposed Portuguese HSR line from Lisbon to Porto is estimated to cost approximately \$6.1 billion dollars.⁴³ Portugal sees this potential investment as fulfilling several important strategic goals. Specifically it would:

- “Create a modern, sustainable and efficient transport system with the minimum environmental impact;
- Reduce the country’s peripheral position by improving rail links to Spain and to the rest of Europe;
- Contribute to the Atlantic southwest front competitiveness;
- Accelerate the country’s economical and technological development, including at the regional level;
- Contribute to a better modal distribution, both for passenger and freight, and encourage a modal shift to rail from air and road; and
- Increase mobility and competitiveness of the country’s port, airport and logistics systems.”⁴⁴

1.3.2 Illinois’ HSR Proposal

In Illinois, the third largest American city, Chicago, is slated to serve as the hub of a new set of HSR links branching out across the Midwest. These systems would connect Chicago at the origin with other cities including the Twin Cities via Milwaukee, Detroit and Cleveland, Indianapolis, and St. Louis. Our study cities of Kankakee and Champaign-Urbana fall on the proposed link between Chicago and St. Louis (slated to also potentially branch to Indianapolis), as shown in Figure 1.6, and would benefit from significant travel time reductions to either termini.

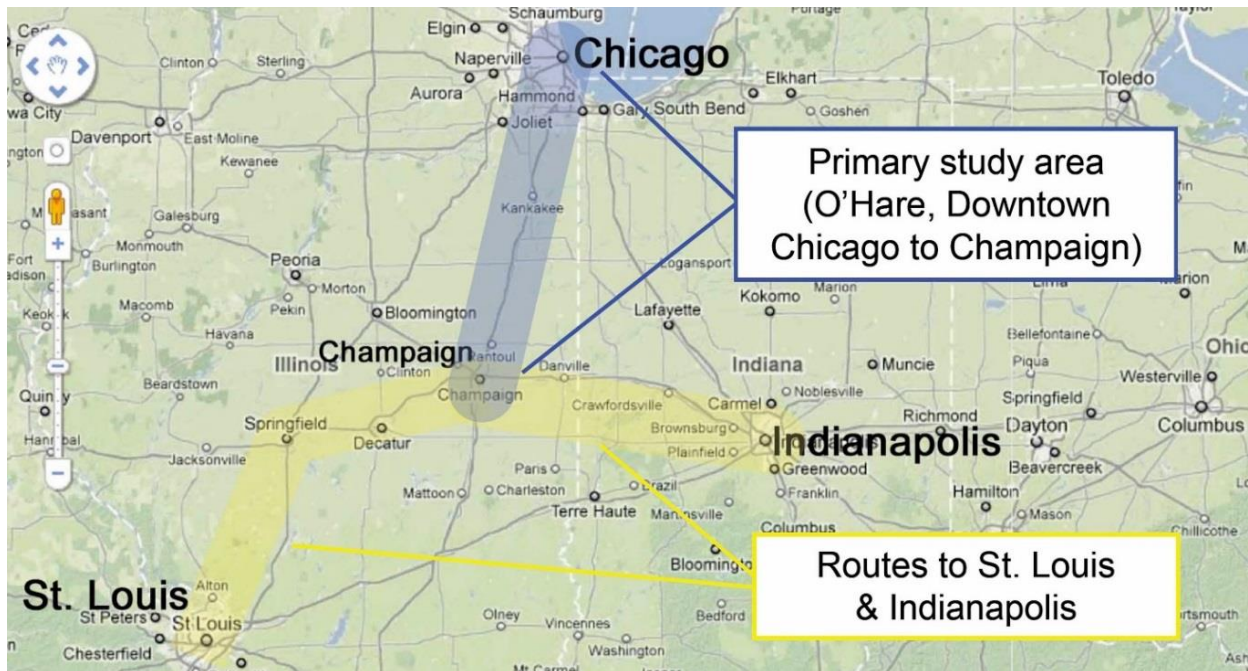


Figure 1.6. Illinois HSR System (Source: Illinois HSR Feasibility Study, 2013)

⁴³ 4.5 billion Euros (Source: Melibaeva, 2010)

⁴⁴ Melibaeva, “Development Impacts of High-Speed Rail”.

This rail upgrade is part of an overall American vision for a nationwide HSR system championed by the Obama administration, beginning in 2009. In the Midwest, this vision would feature the hub and spoke network outlined above, centered in Chicago.⁴⁵ This Midwest system is shown in Figure 1.7, while the overall national plan is shown in Figure 1.8. The U.S. DOT envisions state collaboration to help plan and develop the various corridors proposed nationwide.



Figure 1.7. American Midwest HSR Proposals (Source: Midwest High Speed Rail Association)

⁴⁵ AECOM and EDR Group, Inc., *The Economic Impacts of High Speed Rail: Transforming the Midwest*.



Figure 1.8. American High-Speed Rail Vision (Source: U.S. DOT)

Historically, Illinois' first railroad came into operation on November 8, 1838, when a railroad locomotive moved eight miles on a piece of track comprising part of Northern Cross Railroad (the future Wabash Railroad) west of Springfield, Illinois near the small town of Meredosia.⁴⁶ With passage in 1837 by the state legislature, which included Abraham Lincoln, an ardent rail proponent, of an infrastructure improvement plan focused on railroads, growth of railroads in Illinois occurred rapidly, as it did throughout the Midwest.⁴⁷ By 1860, nearly 5,000 miles of track existed in the Midwest.⁴⁸ Figure 1.9 depicts Illinois' railway network in that era. Growth nationwide had moved similarly rapidly, following opening of America's first commercial railroad, the Granite Railway in Massachusetts, in 1826. By 1860, nearly 30,000 miles of track existed nationwide.⁴⁹

Part of this growth in Illinois was track built for one of the earliest Class I railroads in the United States. After President Millard Fillmore signed the first land grant to a railroad in 1850, the Illinois Central Railroad was formed by the Illinois General Assembly on February 10, 1851 after Abraham Lincoln and

⁴⁶ Advertising and Public Relations Department of the Wabash Railroad Company, "Wabash Railroad History".

⁴⁷ McClellan McAndrew, "When the Railroad First Came to Springfield".

⁴⁸ 4,951 miles (Source: United States Census Bureau, Report on Transportation Business in the United States at the Eleventh Census 1890, pg. 4.)

⁴⁹ 28,920 miles (Source: United States Census Bureau, Report on Transportation Business in the United States at the Eleventh Census 1890, pg. 4.)

his political cohort Stephen Douglas lobbied for the charter. At its completion in 1856, the Illinois Central was the world's longest railroad, running from the southern tip of Illinois in Cairo to Galena in the northwest corner and to Chicago in the northeast (branching in Centralia).⁵⁰ This Chicago to Cairo line ultimately became one of the most famous railroad routes in America as part of the City of New Orleans route still operated today between Chicago and New Orleans.⁵¹ This same route, passing from Chicago through Kankakee and Champaign, is proposed as the HSR route today.

⁵⁰ "Illinois Central Railroad".

⁵¹ Made famous in part by the song of the same title by Steve Goodman, sung most notably by Arlo Guthrie in the early 1970s. Its initial lyrics read:

City of New Orleans

*Riding on the City of New Orleans,
Illinois Central Monday morning rail
Fifteen cars and fifteen restless riders,
Three conductors and twenty-five sacks of mail.
All along the southbound odyssey
The train pulls out at Kankakee
Rolls along past houses, farms and fields.
Passin' trains that have no names,
Freight yards full of old black men
And the graveyards of the rusted automobiles.*

[Chorus]

*Good morning America how are you?
Don't you know me I'm your native son,
I'm the train they call The City of New Orleans,
I'll be gone five hundred miles when the day is done.*



Figure 1.9. Map of Illinois Railways, 1854 (Source: Illinois Digital Archives)

Current intercity passenger rail operations in the United States are provided by the for-profit government agency Amtrak. Formed in 1971, it operates routes nationwide, with several extending from Chicago and in Illinois. In fiscal 2013, Amtrak carried 31.6 million passengers nationally, with 5.2 million in Illinois.⁵² Five current routes serve the market proposed for future HSR operation, with three of these serving Kankakee and Champaign.⁵³ These include:

- City of New Orleans: daily service between Chicago and New Orleans, LA via Carbondale, IL
- Illini Service: daily service between Chicago and Carbondale, IL
- Saluki: daily service between Chicago and Carbondale, IL
- Lincoln Service: daily service between Chicago and St. Louis, MO
- Texas Eagle: daily service between Chicago and San Antonio, TX via St. Louis, MO

In addition to these routes, the State of Illinois, in conjunction with the U.S. DOT, is working to bring 110-mph regional HSR service to Illinois on the route from Chicago to St. Louis. This service is expected to be operational from Alton, IL (just outside St. Louis) to Joliet, IL (just outside Chicago) by 2017.

Now, the State of Illinois seeks to further develop HSR in Illinois and is currently analyzing the feasibility of potential 220 mph HSR service in Illinois. This proposal would originate at O'Hare International Airport, pass through downtown Chicago, and continue south to Champaign-Urbana and on to St. Louis and/or Indianapolis. This corridor was chosen to supplement the current regional HSR to St. Louis, which passes through Bloomington-Normal.^{54 55} Both routes are shown on the map of proposed Midwest HSR shown in Figure 1.7, and are part of the entire Midwest system foreseen.⁵⁶ A recent report completed by the Illinois Department of Transportation deems this proposal as feasible, and next steps would include further study, including a federally-required Environmental Impact Study (EIS).⁵⁷ However, its long-term prognosis remains unclear as funding is not assured.⁵⁸ As is the case in Portugal, it will be helpful to further assess the impacts this proposed HSR service may have on newly connected communities such as Champaign-Urbana and Kankakee.

The Chicago to St. Louis rail distance along this proposed route is 314 miles, which again provides an ideal HSR distance. Major intermediate stops are found in Kankakee, Champaign-Urbana, Decatur, and Springfield. Additionally, exploration of a second branch HSR line from Champaign-Urbana to Indianapolis is being investigated. This Illinois proposal will bring passengers from Chicago to Kankakee in 30 minutes, to Champaign-Urbana in 55 minutes, and to St. Louis in 127 minutes. This again compares favorably to existing travel times via other modes, with Kankakee and Champaign-Urbana moving within the commuting region of Chicago.

⁵² "Amtrak Record Ridership - FY13".

⁵³ "Illinois Train Services - Chicago - Quincy/St. Louis/Carbondale | Amtrak".

⁵⁴ TranSystems, *Chicago to St. Louis 220 Mph High Speed Rail Alternative Corridor Study: Volume 1- Infrastructure & Cost*.

⁵⁵ TranSystems, *Chicago to St. Louis 220 Mph High Speed Rail Alternative Corridor Study: Volume 2- Ridership & Benefits*.

⁵⁶ AECOM and EDR Group, Inc., *The Economic Impacts of High Speed Rail: Transforming the Midwest*.

⁵⁷ University of Illinois at Urbana-Champaign and University of Illinois at Chicago, *220 MPH High Speed Rail Preliminary Feasibility Study Executive Report*.

⁵⁸ Witcher, "Years after Initial Funding, Illinois Struggles to Develop High-Speed Rail".

Table 1.3. Illinois HSR Travel Times (Source: as noted)

| Locale | Rail Distance (mi.) | Existing Highway Travel Time** | Existing Rail Travel Time*** | Existing Flight Travel Time**** | Proposed HSR Travel Time |
|------------------|----------------------------|---------------------------------------|-------------------------------------|--|---------------------------------|
| Chicago | - | - | - | - | - |
| Kankakee | 56 | 61 | 73 | - | 30 |
| Champaign-Urbana | 129 | 129 | 130 | 135 | 55 |
| St. Louis | 314 | 267 | 320 | 155 | 127 |

* All travel times in minutes
 ** Google estimated driving times were used for all routes
 *** Amtrak in Illinois, Fastest CP service in Portugal (Accessed 10/30/13)
 **** Assuming 1.5 hr. security/check-in/arrival time

The proposed Illinois HSR line from Chicago to St. Louis is estimated to cost approximately \$23 billion dollars.⁵⁹ Illinois sees this potential investment as bringing new connectivity between the main university in the state, the University of Illinois at Urbana-Champaign, and its principal metropolitan area, Chicago. Further, this link is a vital component of the overall Midwest HSR network, which could then provide service via Chicago to most of the major Midwestern cities.

In summary, the proposed HSR systems in Portugal and Illinois represent very similar investments in new regional connectivity. They will bring various effects to the geography served, and represent a tremendous opportunity to examine the potential impacts of large-scale transportation investment.

Table 1.4. HSR Project Costs (Source: author based on Melibaeva, 2010 and University of Illinois, 2013)

| HSR Route | Rail Distance (mi.) | Total Project Construction Cost (\$ billions) | Project Construction Cost (\$ millions) per mile |
|---------------------|----------------------------|--|---|
| Lisbon - Porto | 184.5 | \$6.1 | \$33.1 |
| Chicago - St. Louis | 314 | \$23.0 | \$73.2 |

1.4 AN OVERVIEW OF THE FEATURED CITIES

For this thesis, we have chosen to focus on four communities along the proposed HSR systems, two in Portugal and two in Illinois. The genesis of our focus on these communities arises, as aforementioned, due to their movement from outside commuting distance of the principal metropolitan area in their geography to being within the commuter shed for these cities via the reduced travel time brought by HSR. The effects of this transition are an area worth further study, and offer the potential to illustrate additional wider benefits of the proposed projects.

In Portugal, Coimbra is the country's fourth largest metropolitan area. Home to an esteemed university, University of Coimbra, and the country's best hospitals, it is an intellectual center, and a picturesque river city. Leiria is smaller, more centered on manufacturing and light industry, and the second most important proposed stop between Lisbon and Porto. In Illinois, Champaign and Urbana are twin communities that are home to the state's most important university, University of Illinois, and the area is a significant state intellectual influence. Kankakee is smaller and grew as an industrial river town, and is the only substantial town between Champaign-Urbana and the Chicago metropolitan region. Lisbon and Chicago are the main economic and political centers of Portugal and Illinois, respectively (despite

⁵⁹ University of Illinois at Urbana-Champaign and University of Illinois at Chicago, *220 MPH High Speed Rail Preliminary Feasibility Study Executive Report*.

Chicago not being the state capital). As significant metropolitan areas, they bring influence that stretches far past their own geographic boundaries, with substantial gravitational pull over the entire Iberian Peninsula and Midwest, respectively.

Additional demographic information for each of the jurisdictions can be found in Table 1.5. Here, we can see the respective populations and relative prosperity for each entity.

Table 1.5. Demographic Information (Source: as noted)

| Locale | City Population | Metropolitan Population | GDP[#] (in billions) | GDP/capita | Unemployment Rate[^] (%) |
|------------------|------------------------|--------------------------------|--------------------------------------|-------------------|--|
| Chicago | 2,695,598 | 9,461,105 | \$ 571.0 | \$ 60,352.36 | 8.9 |
| Kankakee | 27,537 | 113,449 | \$ 3.5 | \$ 30,674.58 | 10.8 |
| Champaign-Urbana | 122,305 | 231,891 | \$ 9.5 | \$ 40,967.52 | 7.5 |
| St. Louis | 319,294 | 2,787,701 | \$ 136.7 | \$ 49,026.06 | 7.2 |
| <i>Illinois</i> | 12,830,632 | | \$ 695.2 | \$ 54,182.83 | 9.1 |
| Lisbon | 547,361 | 3,035,000 | \$ 95.2 | \$ 31,367.38 | 11.7 |
| Leiria | 50,200 | 126,879 | \$ 2.3 | \$ 18,113.00 | 10.7 |
| Coimbra | 102,455 | 435,900 | \$ 7.8 | \$ 17,926.00 | 12.4 |
| Porto | 237,591 | 1,817,172 | \$ 41.6 | \$ 22,892.71 | 16.5 |
| <i>Portugal</i> | 10,562,178 | | \$ 237.6 | \$ 22,495.36 | 12.3 |

*Populations are 2010 for U.S. and 2011 for Portugal; Source: National Censuses

**For Portugal, city populations were typically used in lieu of municipal area ones

***Indianapolis 2010 population=829,718 (MSA=1,887,877)

2012; Sources: U.S. Govt. Revenue and Brookings Institution

[^] Aug. 2013 for Illinois; 2011 for Portugal; Sources: U.S. BoL and WTIP

1.5 A THESIS FRAMEWORK

With this backdrop of new commuting cities, in this case intermediate cities on a through HSR line, we introduce our analysis. This thesis focuses on the question of what happens when the effective geography of a region is transformed by new transportation connections. With such proposed connections, we aim to provide additional tools to quantitatively assess their potential. We explore two communities in Portugal and two in Illinois who will possibly see new HSR service. Analysis of these communities will allow us to glean lessons as to the impacts that flow from transportation investments such as these. This analysis will include a quantitative measurement of accessibility changes brought by the HSR system, which draws on burgeoning literature in the field. We conclude with parting thoughts as to the types of communities that will see the synergy possible with these linkages.

Chapter 1 has provided background on the landscape and HSR systems serving as the backdrop for our discussion as well as the motivation for this exploration. In Chapter 2, we provide additional background on understanding of cities and regions imparted by academicians in the past several years. Then, in Chapter 3, we provide a full assessment via a complex systems analysis framework of our focus cities. Based on our added comprehension, we will then compare and contrast our cities and systems in Chapter 4. In Chapter 5, we present our original quantitative methodology to assist in predicting impacts of the HSR. Finally, in Chapter 6, we provide concluding remarks, considerations for the focus communities, and suggestions for future work.

Chapter 2

2 CITIES AND REGIONS

*...Cities are devices that enable us to communicate. In doing so, we are able to use them to increase our prosperity by providing environments in which we can work together, innovate together, and generally share the fruits of our labors. Until quite recently, most of this sharing took place in individual cities, but increasingly our technologies enable us to share and communicate at a distance.*⁶⁰

-Michael Batty

2.1 THE CITY AS AN INTEGRAL PART OF A REGION

The Earth as a whole is urbanizing rapidly, with the globe recently passing the threshold of more than 50% of people living in urban areas. In the 18th century, only approximately 5% of people lived in cities. It is estimated that by 2050 more than 75% of the world's population will be urbanized.⁶¹ By 2025, nearly 50% of the world population will live in cities of greater than 1 million people. Coupled with ongoing rapid overall population growth, this urbanization has led to the rapid growth of cities and eventual formation of megaregions where major cities begin to come together forming adjoining developed urban areas.

The trend towards megaregions has become clear in the last few decades. Historically, the identification of megaregions was largely begun when, in 1957, Jean Gottman coined the term "megalopolis".⁶² By the 1990s, some researchers argued that the nation-state was no longer the central economic unit of the global economy, but that it was "region states," made up of large cities.⁶³ Megaregions are thus "composed of multiple overlapping metropolitan areas."⁶⁴ Note that the term megaregion is not necessarily synonymous with other similar categorizations. Megacities, alternatively, are very large cities with populations greater than ten million, and will rise from 23 in 2011 to 37 by 2025.⁶⁵ Megaregions may contain megacities, but that is not necessarily so. An additional hierarchical term is sometimes used—megapolitan—which we expand on shortly. Also based on Gottman's coinage, it refers to an in-between categorization of a string of connected metropolitan areas, though not quite at the megaregional scale.⁶⁶ So what will be the role of cities, mega- or not, in these megapolitan regions and megaregions? Researchers have now begun to further understand the powerful role cities have in driving a region's and even a nation's economy. As goes the city, so goes its region and nation. And thus, with the world urbanizing quickly, so will go the world.

⁶⁰ Batty, *The New Science of Cities*.

⁶¹ Wakefield, "Tomorrow's Cities: Do You Want to Live in a Smart City?"

⁶² He was referring to the Northeast Corridor (NEC) or the Boston to New York City to Washington, DC megaregion.

⁶³ Florida, Gulden, and Mellander, "The Rise of the Mega Region".

⁶⁴ Nelson and Lang, *Megapolitan America*.

⁶⁵ Ross, *Megaregions*.

⁶⁶ Nelson and Lang, *Megapolitan America*.

These varying layers of geographic hierarchy could sometimes lead to confusion. In Portugal, the Lisbon to Porto region is discussed as an emerging megaregion.⁶⁷ And the various regional tentacles extending from Chicago to cities such as the Twin Cities, St. Louis, Indianapolis, and Detroit is considered one of 11 emerging megaregions in the United States, the Great Lakes Megaregion.⁶⁸ Globally, approximately 40 megaregions have been identified.⁶⁹

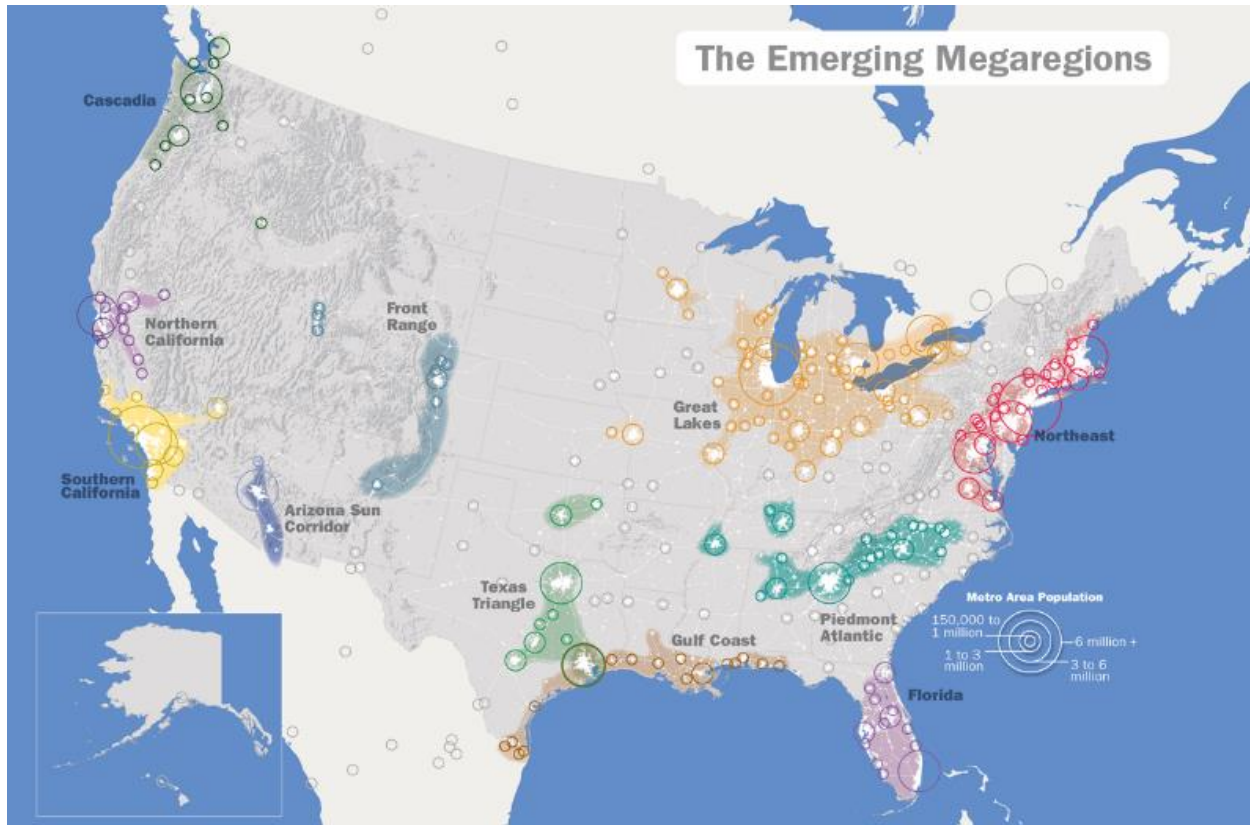


Figure 2.1. *The Emerging American Megaregions* (Source: Regional Plan Association)

The scale of one HSR line is often smaller than the megaregional scale. For the purposes of this thesis, and for the sake of clarity since these boundaries are sometimes ambiguous, we will refer to these varying levels of geographic hierarchy as outlined in Table 2.1. The effects at both the megapolitan and megaregional scales can be considered regional in nature. Obviously there may be some dialogue as to a specific location's categorization, but for the purposes of this research each of our case cities are considered part of a metropolitan area and their linkage creates a megapolitan region within a megaregion.⁷⁰ Within metropolitan areas, there are obviously also a range of city sizes. For this work, we also sometimes differentiate between the major metropolitan centers and smaller ones. Chicago and Lisbon are the principal, or focal, cities in their region. These principal metropolitan cities serve as

⁶⁷ Pagliara et al., "Megacities and High Speed Rail Systems: Which Comes First?"

⁶⁸ Nelson and Lang, *Megapolitan America*.

⁶⁹ Florida, "The Dozen Regional Powerhouses Driving the U.S. Economy".

⁷⁰ The difference between a megapolitan area or region and megaregion is notably fuzzy. There could be some overlap, especially where expansion past what we are terming a megapolitan region is less easy for political or geographic reasons (as in Portugal). Thus, while we are also comfortable with the notion of an overall Portuguese megaregion, we denote the Lisbon-Porto tandem as megapolitan. Nevertheless, many effects apply to both.

transportation hubs and/or gateways, as outlined in Section 1.3, and operate at a larger scale than do our other four case communities of Coimbra and Leiria in Portugal and Champaign-Urbana and Kankakee in Illinois.

Table 2.1. The Evolving Regional Hierarchy (Source: author and Nelson and Lang, 2011)

| Type | Description | Example(s) |
|--------------------|--|---|
| Micropolitan Area | An “urban area” with a population between 10,000 and 50,000 people | Lincoln, IL Micropolitan Area |
| Metropolitan Area | An “urban area” with at least 50,000 people | Coimbra Metropolitan Area Chicago, IL Metropolitan Area |
| Megapolitan Region | A cluster of economically joined metropolitan and/or micropolitan areas | Lisbon-Porto Megapolitan Region Chicago-St. Louis Megapolitan Region |
| Megaregion | Broad, often multi-state, set of economically joined megapolitan regions and/or metropolitan areas | Great Lakes Megaregion |

With the potential for new HSR lines running from Lisbon and Chicago, intermediate cities such as Coimbra and Champaign-Urbana within these regions have the potential to serve as the “middle metropolis” in a prospective growing region. These intermediate cities are placed along a string of linked cities⁷¹ with similar opportunity for growth, which together can propel the region’s ascendance. With HSR implementation around the world, we have an opportunity to see additional such transformations globally as HSR, uniquely suited to intercity regional connections, serves to reinforce and potentially accelerate the growth of megapolitan regions and their megaregions. How can we parse the influence of HSR on these newly connected cities and their metropolitan areas, and thus on the megapolitan region and megaregion? We aim to begin answering these questions through the examination of Coimbra and Leiria and Champaign-Urbana and Kankakee.

We must proceed by exploring the layered system we aim to examine. For our purposes we will largely focus on an overall system of a city and its metropolitan area embedded in a megapolitan region and/or megaregion in a nation. Graphically, this system of interactive players could be represented as an onion, as shown in Figure 2.2.

To assist our research, we will use the CLIOS (complex, large-scale, interconnected, open, sociotechnical system) process framework, outlined further in Chapter 3, established to study engineering systems.⁷² Past CLIOS



Figure 2.2. Geographic Layers (Source: author)

⁷¹ Consider, as connoted by the image in Figure 2.1, a ‘string of pearls’, with the string comprised of a HSR line and each city a pearl. This phrase, referring to a necklace of pearls, was also popularized by a song—the 1941 hit “A String of Pearls” by Glenn Miller and His Orchestra.

⁷² Sussman et al., *The “CLIOS Process”: A User’s Guide*.

representation work has largely focused at the regional level. However, recent research has begun to illustrate the outsized importance of the relatively smaller entity, the city. Thus, a CLIOS representation of this smaller system within a system, with greater focus on the local attributes that drive the system as a whole, potentially all the way down to the micro level of analysis, is worthwhile. Chapter 3 is devoted to this systems analysis. First, though, we must further understand the role of cities in megapolitan regions and megaregions.

It is becoming ever more apparent that society is centered in cities, where a density of technology and people connect to evolve our culture, more than ever before. The application of connected devices plied by urban dwellers in a connected-city environment is emerging as the center of this digital society trend. A mix of young and old, these urban beacons of the future are following an age-old trend in setting the course for our future from the heart of the bustling city. The value of urban core agglomeration is becoming clearer, with positive overflows of creativity, productivity, and financial return. What does this tell us about the future of our cities, and how has this culture making mechanism arisen?

2.2 INCREASING URBANIZATION

The rate of urbanization is accelerating, and this has real implications for how we design tomorrow's developments. While globally, many cities are growing anew, in the United States, this is illustrated by a return to the urban core, or very center of principal cities.⁷³ Central urban business districts are newly resurgent here as young people, as well as the retired, are increasingly interested in urban living.⁷⁴ Rather than "Location, location, location," the new mantra seems to be "Proximity, proximity, proximity."⁷⁵ These trends have revitalized downtown cores and together with the urbanization trend emphasize the importance of the city for our future. Figure 2.3 shows the American urban-rural population split over the last 110 years, while Figure 2.4 shows the projected global trends.

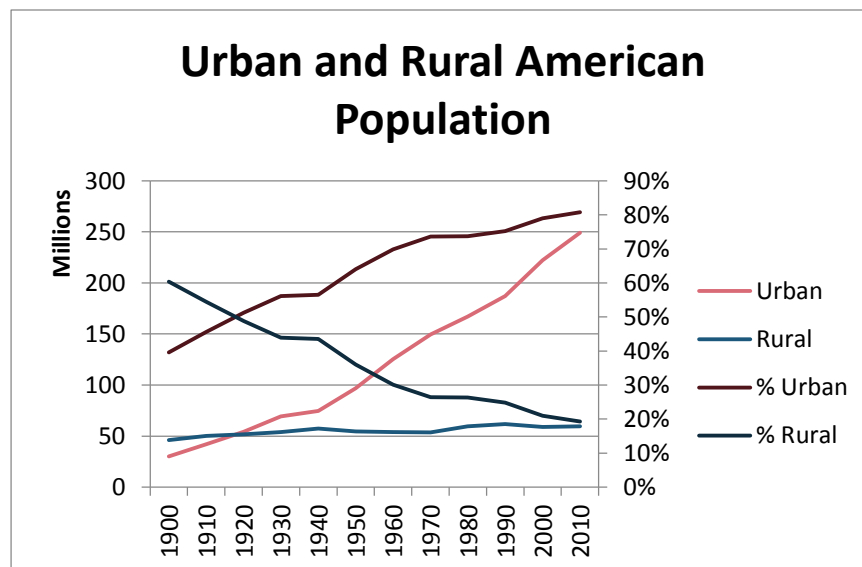


Figure 2.3. Urban and Rural American Population (Source: U.S. Census Bureau)

⁷³ Ehrenhalt, *The Great Inversion and the Future of the American City*.

⁷⁴ Freed, "Get Away From the Sprawl".

⁷⁵ Wilson, "Picking the 'Right Home' Is Easier than You Think".

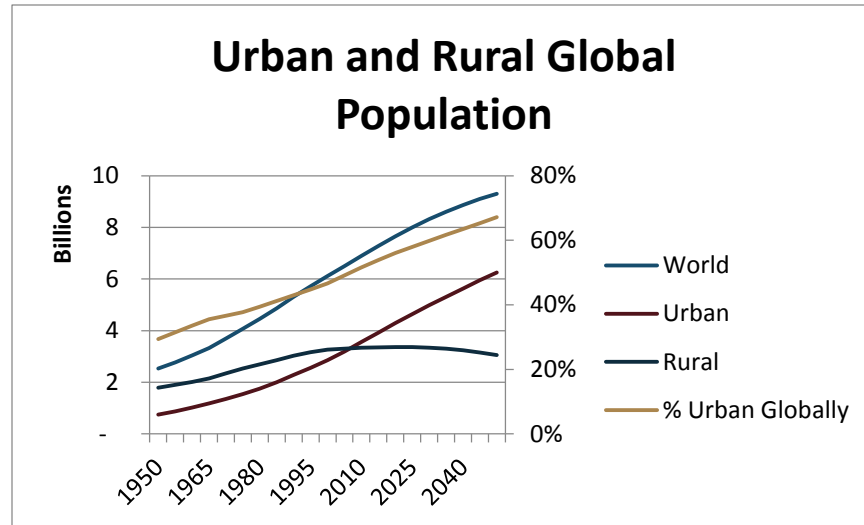


Figure 2.4. *Urban and Rural Global Population* (Source: UN)

Along with this return to center is a corollary increasing rise of additional areas of density within and outside metropolitan regions, away from the urban core. These new urban districts contribute to polycentric regions, or in other words, a multi-centered region. These trends may not contradict each other, and in fact perhaps point to a turn to a more urban lifestyle, which is the overarching trend. This development will thus form around various gravitational centers. Past literature has outlined the growing interest in polycentric development, with Europe especially taking interest.⁷⁶ Transportation linkages will prove key if development does indeed trend towards separated dense urban agglomerations of varying size. These linked networks of cities will more than ever before function as megapolitan regions or megaregions. Stein observes, “HSR technology is seen as a way to further enable metropolitan areas to be integrated into polycentric mega-city regions.”⁷⁷ In essence, densification is occurring at the very nodes HSR would serve to connect. The contribution of complex urban centers towards economic productivity, innovation, and human creativity is becoming increasingly obvious. At the same time, there has been a large-scale and rapid urban over rural reordering in global society as urbanization has accelerated. Some background on how this has come to be the case is useful.

2.2.1 The Rise of Urbanization

Cities formed to allow collaborative benefits to society. Quantification of these has recently been shown more robustly than ever before possible. Meanwhile, urbanization globally has continued in various ebbs and flows. Looking at the United States, specifically, after a half-century of spreading, there is a return to the central core underway.

Historically, villages grew up around wells, and then grew to the size a 20-minute walk to the well would allow. Thus, they were typically about one mile apart.⁷⁸ Villages at transportation crossroads grew further to become cities. Cities continued to grow around vital marketplaces where agricultural products could be traded. Cities served as gathering places, centers of government, and protected havens. Then industrialization came, which brought the advent of networks, from social to transportation to utilities. And with it came the incentive for cities to grow. All of a sudden, agglomerative benefits of resource

⁷⁶ Stein, “Spatial Dimensions of High-Speed Rail”.

⁷⁷ Ibid.

⁷⁸ Larson, “Brilliant Designs to Fit More People in Every City”.

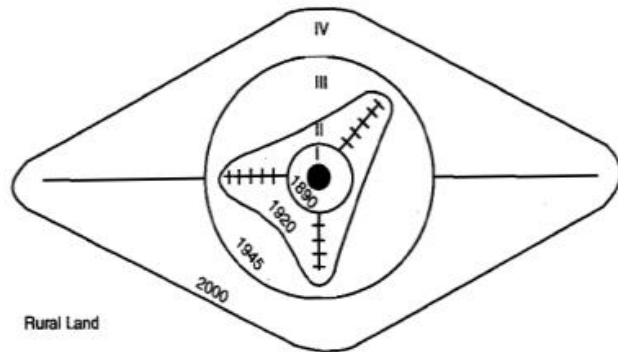
sharing and knowledge spillovers were accrued by residents. And there was a growing division of labor as well.⁷⁹ Cities have changed significantly and rapidly since that point. Populations exploded and the labor force began to shift from being agriculturally-based to factory-based. Urban economies have become closely correlated with national prosperity.

Transportation began to transform the urban form, as new technologies allowed expansion. Beginning in the 1830s, railroads were built to transport people and goods. First came horsecars, animal-powered streetcars, in the 1830s, then cable cars in the 1870s, and electric trolleys and transit lines by the 1880s when electrical power spread through urban areas. Ultimately, transportation largely transitioned to automobiles by the 1920s, and by the 1950s, most trolleys transitioned to buses. Only heavy transit typically remained of the prior rail-based urban transportation networks. Following the advent of autos, the form of American cities especially became bifurcated along development date lines, with an inner zone matching the boundaries of the

old industrial city and farther out areas developed and designed with the automobile in mind. This ever-changing pattern of metropolitan growth can be categorized into eras of changing urban form. Muller captures these intraurban transport eras and metropolitan growth patterns in Figure 2.5, further dividing the automobile era and highlighting the “freeway era” that has dominated

American development since the 1960s.⁸⁰ Locally, neighborhood forms match the move through these eras as one moves from the urban core to its fringe. And many regard the growth of automobile use in America as having led to a successful “suburban experiment.”⁸¹ Therefore, cities have grown in area significantly and into metropolitan regions, with densities of development generally declining.

Mieszkowski & Mills observed⁸² that as cities grew to sprawling metropolitan regions, much of this growth was a natural evolution as people grew to desire less density but also a “flight from blight.” They further assert that, “If suburbanization is largely the result of natural evolution, and technologically- and income-induced changes in the demand for land, then it is appropriate for the public sector to accommodate these demands.” Advocates such as Joel Kotkin applaud the spread of cities, as just such a natural evolution.⁸³ Recently, however, even in areas previously suburbanizing, there has been the noted return towards center-centric growth, and areas around the world are relearning the importance of city core business districts.



Intraurban transport eras and metropolitan growth patterns: (I) Walking-Horsecar Era, (II) Electric Streetcar Era, (III) Recreational Auto Era, and (IV) Freeway Era. Source: Adams (1970, p. 56). Copyright 1970 by The Association of American Geographers. Adapted by permission.

Figure 2.5. Intraurban Transport and Metropolitan Growth
(Source: Muller, 2004)

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⁷⁹ Glaeser, “Why Humanity Loves, and Needs, Cities”.

⁸⁰ Muller, “Chapter 3: Transportation and Urban Form”.

⁸¹ Hall, *Cities of Tomorrow*.

⁸² Mieszkowski and Mills, “The Causes of Metropolitan Suburbanization”.

⁸³ Kotkin, “The Triumph of Suburbia”.

2.2.2 Why Urbanization Continues

Some adherents have questioned whether the return to urban centers will continue, observing that the most recent return to urban core living coincides with a global economic recession, and may have only delayed many people's desired move outwards. Further, Kotkin asserts that much of the evidence for revitalized city centers is delivered as propaganda promoting urban living. He claims that Americans continue to aspire to single-family homes and lower densities. He sees jobs becoming more dispersed throughout metropolitan regions, and residents having led and followed them there. And he observes this evolution of city form towards sprawling metropolitan areas as just another variation of the constantly evolving form cities take.⁸⁴

Others observe, however, that it is now becoming clear that evidence seems to point toward cities—and here by city, we mean the urban core of the overall metropolitan area, regardless of where the “city” boundary falls—as the center for growth. Thus, as goes the central city, so goes the region's and even the nation's economy.⁸⁵ It thus follows that if this pursuit of expanse championed by some does lead to central city blight as it did in America, it may be undesirable. If that is the case, building highways and accommodations for cars, spreading cities in the pursuit of suburban utopia along their fringes, and otherwise moving away from the historical form of city that has proved most resilient through millennia, cannot simply follow such “demand.” That classic quote from Lewis Mumford reminds us: “Adding highway lanes to deal with traffic congestion is like loosening your belt to cure obesity.”⁸⁶ So, as our society considers its own plans for growth, we must determine whether this notion rings true: Are central cities vital to the future?

“The city itself is the central organizing unit of our time,” notes Richard Florida.⁸⁷ While cities are messy, complicated, and multilayered, they are engines of growth—the economic innovation centers of their country. Bruce Katz observes, “Metropolitan areas ... really concentrate all the assets that drive prosperity and will drive [the economy].”⁸⁸ It is the cities of the world that have made strides towards a more sustainable planet, and which hold hope for our sustainable future. And specifically, it would appear that the strength of cities lies in their dense urban core, a place where their very design, including transportation and land use systems, is fundamental to the success achieved.

Katz goes on to observe, “... major metros ... make the country thrive. Why? When cities collect networks of entrepreneurial firms, smart people, universities and other supporting institutions in close proximity, incredible things happen. People engage. Specializations converge. Ideas collide and flourish. New inventions and processes emerge in research labs and on factory floors. New products and companies follow. As Henry Cisneros, former United States Secretary of Housing and Urban Development, likes to say, ‘Cities are places where two plus two equals five.’”⁸⁹ And that observation is just what economists and sociologists studying urban areas have found.⁹⁰

Despite repetitive predictions of the declining importance of place in a society where mobility and communication are being revolutionized, today's economic factors are increasingly becoming more

⁸⁴ Ibid.

⁸⁵ Katz and Bradley, *The Metropolitan Revolution*.

⁸⁶ Halton, “Lewis Mumford: A Brief Biography”.

⁸⁷ Florida, *The Rise of the Creative Class*.

⁸⁸ Katz, “Revitalizing America's Metropolitan Areas”.

⁸⁹ Katz, “City-Centered”.

⁹⁰ Hardesty, “Why Innovation Thrives in Cities”.

consolidated in specific locations—global cities.⁹¹ With the ongoing urbanization aforementioned, there are indications that urban areas are indeed gaining value and adding agglomerative effects. Economist Tim Harford observes that, “... cities allow people to learn from one another ...” and “When people are in cities, they are getting smarter quickly because they are learning from one another.” And this is because, “The ‘death of distance’ doesn’t make the world flatter, it makes it spikier.” In fact, “The technology has increased the benefit of being in [cities], not reduced it.”⁹² While new technology and the Internet allow connectivity, face-to-face contact remains important.⁹³

Harford based some of his conclusions on the work of economist Edward Glaeser. Glaeser notes “... the city creates productivity advantages that offset [its] costs.” He goes on to state that, “Cities ... are the nodes that connect our increasingly globalized world. Urban areas ... have always played this role, but as the world becomes ever more tightly knit, cities are becoming even more important.” Innovation and creation in society flow outwards from cities, making them vital centers of society. Harford asserts, “... new ideas of any kind are, ultimately, what cities produce.” and “... vibrant cities [are] the ultimate source of innovation and progress, fundamental to civilization.” Glaeser declares, “Cities enable collaboration, especially the joint production of knowledge that is mankind’s most important creation.”⁹⁴ And theologian Tim Keller goes so far as to say, “Cities are culture forming wombs. You are thrown together with people who are like you, but also with people who are not like you. This leads to massive creativity ... [And] this creative tension always births new culture People who live in large urban cultural centers, occupying jobs in the arts, business, academia, publishing, the helping professions, and the media, tend to have a disproportionate impact on how things are done in our culture.”⁹⁵

In summary, most now seem to consider it the more compelling case that our cities are our economic engines, innovative centers, culture-making hubs, creative cores, and intellectual and governance leaders. And the ongoing demographic trends seem to be supporting this growing understanding.

2.3 METROPOLITAN INFLUENCES

Describing the layers of interaction amongst these overlapping urban networks becomes important.⁹⁶ Our assessment of the metropolitan influences focuses on the directionality of these effects. And most of these effects are felt within the region in which a metropolitan area lies. The influence within the regions we are assessing are trifold:

- Center city to outlying ones
- Outlying cities to center one
- Outlying cities to each other

Together, these influences work to create the regional dynamics in place. And with each of these potential influences, we will aim to understand the role HSR could take in propelling these effects.

⁹¹ Florida, “Why Big Cities Matter in the Developing World”.

⁹² Harford, *The Logic of Life*.

⁹³ Storper and Venables, “Buzz”.

⁹⁴ Glaeser, *Triumph of the City*.

⁹⁵ Keller, “Why Cities Matter”.

⁹⁶ Batty, *The New Science of Cities*.

A helpful way of understanding these is to consider the overall regional economy. As we have seen with cities, the importance of place still matters immensely. But the forces of globalization are acting in crosscutting fashion. While the search for cheaper real estate and logistics has indeed moved many manufacturing or light industry jobs to suburbs, exurban areas, or mid-sized cities, if not abroad, the interdependency of companies has pulled many more businesses together. These dueling forces have contributed towards a rising regional polycentrism at the same time as agglomerative benefits have led to clustering.

The new economy resulting from the trends of globalization and technology today involves transformation via knowledge dependent, entrepreneurial, global, entrenched in information technology, and innovative companies and government.⁹⁷ Firms must be aware of the network of institutions and collaborators present within their place and market. And these innovation and knowledge based jobs, which produce global value via added trade and production and jobs are just those for which proximity is important. Thus, we are seeing specific types of firms clustering in distinct places. The term cluster in the context of businesses and industry was coined most actively by Michael Porter. He observes, “Paradoxically, the enduring competitive advantages in a global economy lie increasingly in local things –knowledge, relationships, and motivation that distant rivals cannot match.” Thus we see clusters, or geographic concentrations, of institutions and companies that are interlinked and work together. Clusters can form around specialized suppliers, complementary manufacturers, or knowledgeable information providers.⁹⁸ Therefore, the networks supporting and connecting these clusters are extremely important, and a region’s wellbeing can come to ride on these networks.

Why does this perspective on the regional economy matter? Because as local cities, regions, and even states or nations work to build their economic productivity, the methods they use must mesh with this layout. Their institutional influence works to create jobs, strengthen communities, and build the wellbeing of their residents. As shown in Figure 2.6, past literature has divided the influencing components into three categories: economic development, workforce development, and community development.⁹⁹

Transportation improvements may traditionally have been thought of as an area of community development, but its purpose is often economic or workforce development. As cities and regions compete for their future vitality, infrastructure is a key tool through which they can do so. Thus, a city and region’s infrastructure becomes key to its success. And the influence a city has on the rest of its region and vice versa is directly dependent on the ease of mobility within. This leads to a simple inference. Countries, by using urban and regional planning in a transformational way, will allow urban cores to generate the agglomeration possible, and to grow in such a way as to encourage this collaboration and not to squelch it. As Katherine Sierra concludes, “While many of the problems facing cities and towns may be global, the solutions will, in large measure, be local and unique to the specific circumstances on the ground. Good solutions will result from a smooth collaboration amongst various levels of government that is crafted pragmatically to get results.”¹⁰⁰

⁹⁷ Blakely and Leigh, “Chapter 1: The Enduring Argument for Local Economic Development Planning”.

⁹⁸ Porter, “Clusters and the New Economics of Competition”.

⁹⁹ Siegel and Seidman, *The Economic Development and Workforce Development Systems*.

¹⁰⁰ United Cities and Local Governments, *Decentralization and Local Democracy in the World*.

The Regional Economy

Simple model of how the regional economy works. In reality, the model is more circular. While we consider building all assets as part of economic development, in the field activity has been segmented into three categories of policy and program activity.

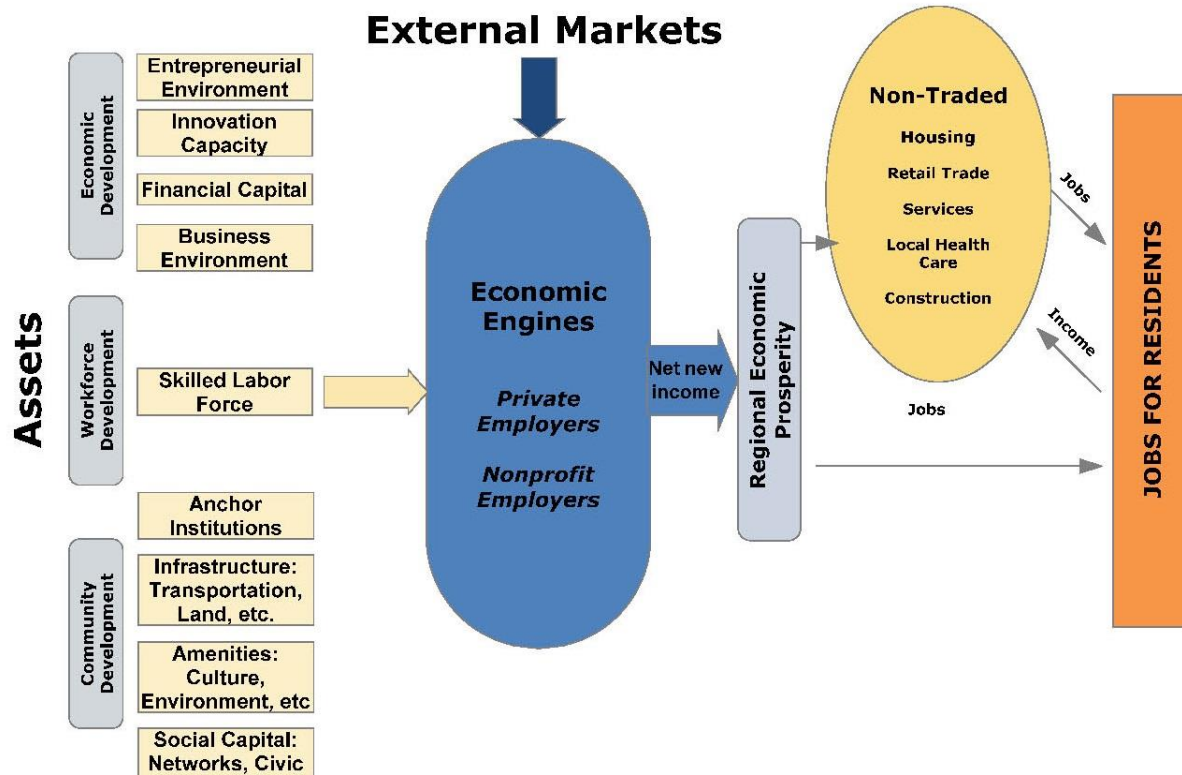


Figure 2.6. *The Regional Economy* (Source: Siegel and Seidman, 2009)

Yet, even as understandings of city and regional interactions continue to grow, so does our realization of how complex these are. As John Fullerton of the Capital Institute observes, “We are constantly told that we live in a competitive global economy, and it’s true. But it’s not the whole truth. We actually live in a complex global-regional-local economic web with often opposing pressures and objectives. The interplays inside this web are far more nuanced than conventional economic wisdom suggests.”¹⁰¹ This global-national-regional-local interplay is exactly the nuanced set of interactions we hope to provide more insight on.

2.4 EXAMINING OUR REGIONAL CITIES

Cities have become ever more complex and dynamic. They are a system of systems, with subsystems for transport, energy, communications, safety, buildings, public services, and utilities embedded in a sometimes dense institutional sphere, a CLIOS term for the stakeholding institutions with jurisdiction. Connections between initiatives in these various elements are key. And all of this is nested in a regional system. Research has shown the surprising complexity of cities, as a “science of cities”¹⁰² has grown,

¹⁰¹ “Capital Institute | The Future of Finance”.

¹⁰² Batty, *The New Science of Cities*.

revealing them to be an impressive man-made kind of complex system: part social reactor, part network.¹⁰³

This overarching trend presents both challenges and opportunities; these complex, innovative, denser cities can be more productive than ever before, but governing and planning them can be extraordinarily complex and challenging. While creativity and productivity thrive, congestion and pollution rise. There are new, growing needs to manage waste production, environmental considerations, crime, noise, and efficiency. And cities aim to be globally competitive among a connected world of growing cities—all aspiring to become intelligent and livable in an ongoing pursuit of optimal city form. As technology evolves and includes smart city elements, what will the city of tomorrow look like? We must continue to consider the dimensions that such a city should contain. Lynch offers five elements of city performance: vitality, sense, fit, access, and control. He also adds two “meta-criteria”: efficiency and justice.¹⁰⁴ Cities of tomorrow will contain these components and perhaps more.

Furthermore, these cities of tomorrow will comprise the megaregions where most people will live. Connected cities will compete, but often function together in agglomerative ways. This merging will, in large part, be made possible by transportation linkages existing and new. And along these linkages, every station or stopping place will have new opportunity to become part of this larger network, while also contributing. And so, we thus turn to the exploration of what impacts we might see in such intermediate communities. Specifically, for communities that functionally are moved within commuting distance of a principal metropolitan city and major hub, as our four (Coimbra, Leiria, Champaign-Urbana, and Kankakee) are, how are they affected?

Describing the existing circumstances—attempting to represent the complex networks that are cities and regions today—is where we turn next in Chapter 3, before ultimately returning to what impacts may be. Thinking of cities as “sets of actions, interactions, and transactions” instead of only spaces, places, and locations¹⁰⁵, here we will focus on the communities we are explicitly examining. We will thus complete a CLIOS-based analysis of their physical domains, embedded in their institutional spheres, to help assess these cities.

¹⁰³ Bettencourt, “The Origins of Scaling in Cities”.

¹⁰⁴ Lynch, *Good City Form*.

¹⁰⁵ Batty, *The New Science of Cities*.

Chapter 3

3 A CLIOS REPRESENTATION OF THE CASE COMMUNITIES

*The characteristic of the innovator is the ability to envisage as a system what to others are unrelated, separate elements.*¹⁰⁶

-Peter Drucker

3.1 INTRODUCTION TO THE CLIOS PROCESS

A CLIOS system (complex, large-scale, interconnected, open, sociotechnical system) is a class of engineering systems with wide-ranging social and environmental impacts, and important technological components. The CLIOS Process is a methodology to study CLIOS systems developed over the past decade.¹⁰⁷ It can be used as an organizing mechanism for understanding a CLIOS system’s underlying structure and behavior, identifying and deploying strategic alternatives for improving the system’s performance, and monitoring the performance of those strategic alternatives. The ability to describe and begin to understand a complex system is a step towards ultimately improving it.

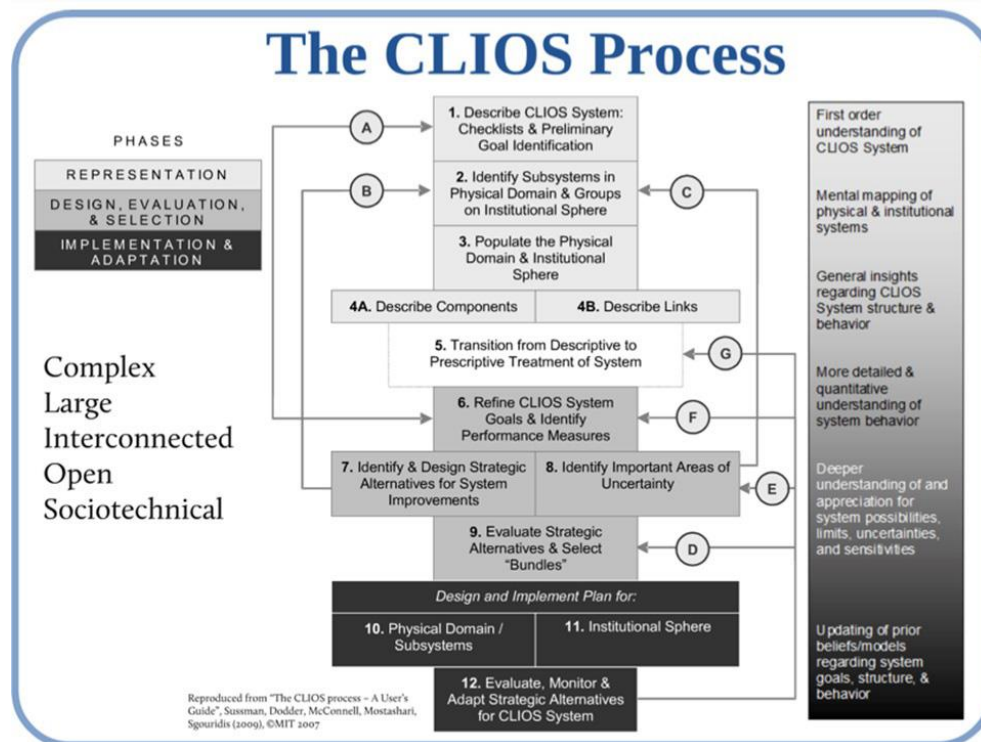


Figure 3.1. The CLIOS Process (Source: Sussman et al, 2009)

The first stage of the CLIOS process involves creating a system representation of the study subject. This representation includes a physical domain composed of subsystems (such as the transportation subsystem or the land use subsystem, for example) nested within an institutional sphere containing

¹⁰⁶ Drucker, *Innovation and Entrepreneurship*.

¹⁰⁷ Sussman et al., *The "CLIOS Process": A User's Guide*.

actors that can influence or be influenced by the physical domain.¹⁰⁸ Ultimately, these components are analyzed and the linkages among them described.

A common challenge encountered in outlining a systems representation is attempting to define the boundaries of the system. Boundary definition is key to CLIOS representation, which then allows one to present and summarize the initial representations of the physical subsystems. In the case of a city, the boundary is a key consideration. Whether one is considering the urban core only, the city proper, or the metropolitan area, stakeholders vary. Here we will fully assess the appropriate boundaries for a CLIOS examination of our cities. Finally, a description of some of the key institutional actors is presented.

One final note—the CLIOS process is iterative. Inherent in a complex system such as a city are evolving systems, constantly interacting with one another, and changing the system as a whole. As we showed in Chapter 2, cities have become ever more complex and dynamic as they have grown and added technology. Luis Bettencourt has observed that, “Ultimately, cities achieve something very special as they grow. They balance the creation of larger and denser social webs that encourage people to learn, specialize, and depend on each other in new and deeper ways, with an increase in the extent and quality of infrastructure.”¹⁰⁹ Others note, “Cities have always been the most complex artifacts in any civilization. Currently, complexity is increasing as our cities grow in size, connect to a global economy, and face trans-boundary issues...”¹¹⁰ They are a system of systems, with subsystems for transport, energy, communications, safety, buildings, public services, and utilities embedded in a usually dense institutional sphere. Connections between initiatives in these various elements are key.

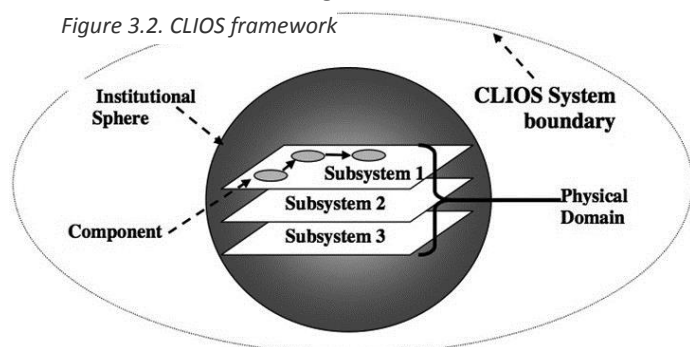
With an eye towards further understanding the complex system of the cities we are examining, we turn our eye to assessing the existing communities, Coimbra, Leiria, Champaign-Urbana, and Kankakee, to be linked via proposed HSR to the Lisbon and Chicago metropolitan areas, respectively. For background material, we draw extensively from encyclopedia information, as cited in the overviews, unless otherwise noted.

3.2 COIMBRA, PORTUGAL

3.2.1 Boundaries of the CLIOS Representation

As noted, one of the challenges associated with creating the CLIOS representation is determining the system boundaries. When looking at cities such as those we are examining, we must determine to what geographic boundary we should extend the analysis, as well as what subsystems are present that must be captured.

In beginning our examination of Coimbra, we have assessed the area context. This background information is useful in understanding the local setting, which serves as necessary backdrop to the framework we are developing.



(Sources: Sussman et al. 2009, Schwartz 1996, McConnell 2007)

¹⁰⁸ Ibid.

¹⁰⁹ Bettencourt, “The Origins of Scaling in Cities”.

¹¹⁰ Moffatt, Suzuki, and Iizuka, *Eco2 Cities Guide: Ecological Cities as Economic Cities*.

Table 3.1 provides a broad overview of Coimbra, the details of which are explained subsequently.

Table 3.1. Coimbra Overview ¹¹¹

COIMBRA

HISTORY AND CONTEXT

State/Province: Centro, Baixo Mondego subregion, Coimbra District, Greater Metropolitan Area of Coimbra

Country: Portugal

Köppen Classification: Dry-summer subtropical or Mediterranean (Csb)

Location: 40°13'31.69"N 8°27'8.24"W

Land Area: 319.4 km² (municipality), 3,272 km² (metropolitan)

Spatial Adjacencies: Located near midway between Portugal's two largest cities (Lisbon and Porto), the city of Coimbra is one of the most important urban centers in Portugal, playing a central role in the northern-central littoral and interior of the country. It is the main center in the Centro region within the Baixo Mondego subregion, on the Mondego River.

City Population: 102,455

Municipality Population: 143,396

Metropolitan Population: 435,900

Municipal Population Density: 449.0/ km²

Metropolitan Population Density: 133.2/km²

Racial Distribution: largely Portuguese; some Brazilians

Language: Portuguese

Demonym: Conimbricense

City Inception/Incorporation Date: 456

POLICIES AND ORGANIZATION

Current Strategic Plan: Municipal level planning, based on national land use plans; PDM (municipal-level zones); PROT (regional planning); 31 civil parishes

Spatial Planning in Portugal: driven by Agenda 21

Municipal Mayor: João Paulo Barbosa de Melo

ECONOMICS

Largest Industry of Employment: University and Academia; Health care

GDP/capita: Baixo Mondego –\$17,926 in constant 2000 International dollars (lowest quartile internationally)

Competitiveness by city (all Portugal district capitals):

Ranking:

1. Évora: 7,293 (index value)
2. Lisbon: 6,454
3. Coimbra: 6,042

Shipping:

Port: nearest is in Figueira da Foz at the mouth of the Mondego River

Air: Aeródromo Municipal Bissaya Barreto (Cernache)

Based on these findings, drawing the CLIOS boundary at the municipal level makes sense. It is at this level that local planning is conducted, and the political leader of the area is the municipal mayor. That said, it is clear certain systems will not be municipal-wide or will extend past municipal boundaries into the metropolitan area and even beyond. These tendrils are to be expected in a complex system.

¹¹¹ "Coimbra".

In assessing the systems present and to capture within the physical domain and associated institutional sphere, the following categories were identified:

- Physical domain
 - Transportation subsystem,
 - Energy / environmental subsystem,
 - Land use subsystem,
 - Economic activity subsystem,
- Institutional sphere
 - Government (various layers)
 - Universities
 - Hospitals
 - Transportation

These system components serve as the elements within which we will look for additional connections and linkages by which we can describe the complex system that is Coimbra. These components will be kept consistent as possible for all the communities examined to allow comparison.

3.2.2 Coimbra's Physical Domain

Coimbra's physical domain is described via a group of subsystems that serve to make up the overall Coimbra city system. The function of the subsystems in our CLIOS model is to help us understand the dynamics of the Physical Domain. A key challenge of the CLIOS process is to simplify the system, such that it replicates the original dynamics, and yet provides a manageable representation. As aforementioned, we have divided the physical domain into four main subsystems. In assessing Coimbra, these are the subsystems that together described best the city in the context of this research.

3.2.2.1 Transportation subsystem

Coimbra's transportation system has evolved to revolve around the personal vehicle over the past few decades. Portugal's vehicle ownership rate is 548 vehicles per 1,000 people (as compared to the United States' 797), and is rising.¹¹² Coimbra itself has developed along roadway expansions, as it lacks a developed rail transit system. Coimbra is located on the A1 Lisbon to Porto highway, which serves as an important link for intra-nation travel.

Coimbra is also served by local transit in the form of a trolley bus system. Over 140 buses carried 28 million passengers in 2011.¹¹³ Additionally, some private buses operate in the city. Further transit has been long discussed, and two iterations were in various phases of planning. A subway plan, Ramal da Lousã, is now defunct, and a commuter rail plan, Metro Mondego, has now also been halted. The commuter rail network, for which studies and planning had until recently been in process, would have had two lines and would have reached three municipalities: Coimbra, Miranda do Corvo, and Lousã.

Coimbra is well-served by regional rail, with three railway stations. Coimbra-A is on a small spur from the main line to the city center. Coimbra-B is on the main railway line between Lisbon and Porto approximately a mile from the historic city center and is served by the Alfa Pendular train, with speeds up to over 130 mph, and the standard speed Intercidades train. Travel time to Lisbon is approximately

¹¹² "List of Countries by Vehicles per Capita".

¹¹³ Santos and da Vinha, "One City, One System: Integrating Public Transportation in Coimbra".

1h 30m via the higher speed train or 2h driving or on the lower speed train. Coimbra Parque is found at the southern edge of the city center, and serves a local commuter rail line running to Miranda do Corvo, Lousã and Serpins. And of course, new HSR service is planned to Coimbra at a new station location, sometimes called Coimbra-C, on the proposed line between Lisbon and Porto, which will cut access times to Porto and Lisbon further.

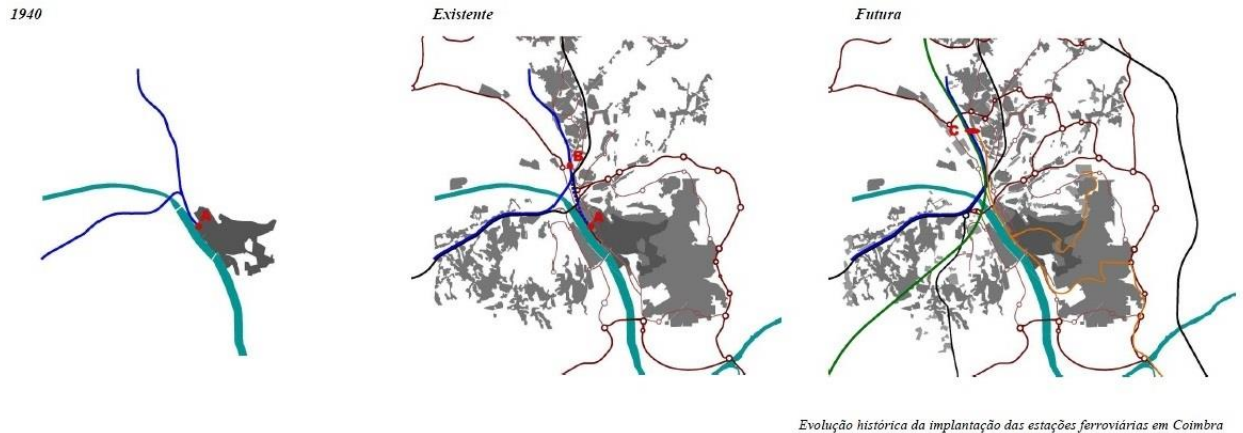


Figure 3.3. Historic Development Around Coimbra's Railway Stations (Source: Stein, 2013 and RAVE)

Around the planned station location a new, approximately 250-acre, urbanization plan creating a contemporary city gateway is planned. This land use and transportation master plan for the currently undeveloped area would provide high development potential in the station area, and could help alleviate demand for housing near the downtown area.¹¹⁴

Additionally, Coimbra is served by a small airport, the Aeródromo Municipal Bissaya Barreto in the Cernache district. The nearest port is in Figueira da Foz at the mouth of the Mondego River on the Atlantic Ocean, approximately 30 miles away. Most freight is via trucks; however there are some freight rail operations as well. This services the Pampilhosa yard, some industries (north and south), the Figueira port, and the Soporcel paper industry at Louriçal, also near Figueira.

The transportation development patterns seen in Coimbra are quite familiar, and mirror similar patterns seen throughout much of the Western world.

3.2.2.2 Energy/environmental subsystem

In terms of its energy use, Coimbra is now largely served (as is much of Portugal) by natural gas. Portugal as a whole has recently moved past more than 50% of its electric generation from renewable sources.¹¹⁵ The Coimbra region is home to wind farms, which generate some of the area's electricity.

Environmentally, central to Coimbra's locale is the Mondego River. Passing through the heart of town, its ultimate destination is the port at the river's mouth in Figueira da Foz. Coimbra's Köppen Classification is Dry-summer subtropical or Mediterranean (Csb). Its average temperature is 15.73 C, and it is quite hilly with its highest elevation at 489m and lowest at 16m.

¹¹⁴ Stein, "Spatial Dimensions of High-Speed Rail".

¹¹⁵ Rosenthal, "Beyond Fossil Fuels - Portugal Makes the Leap to Renewable Energy".

3.2.2.3 Land use subsystem

Coimbra's organization and development is now driven by its zoning and planning. Although it is an old city, with an historic central downtown, new development activity along its fringes is especially governed by the planning codes. Overall, spatial planning in Portugal is driven by the UN's Agenda 21 directives¹¹⁶, derived from the European Spatial Development Perspective agreed upon in 1999¹¹⁷. Municipal level planning is paramount in Coimbra. They have a form-based code, which is based on national land use plans. Figure 3.4 shows the layout of Coimbra.

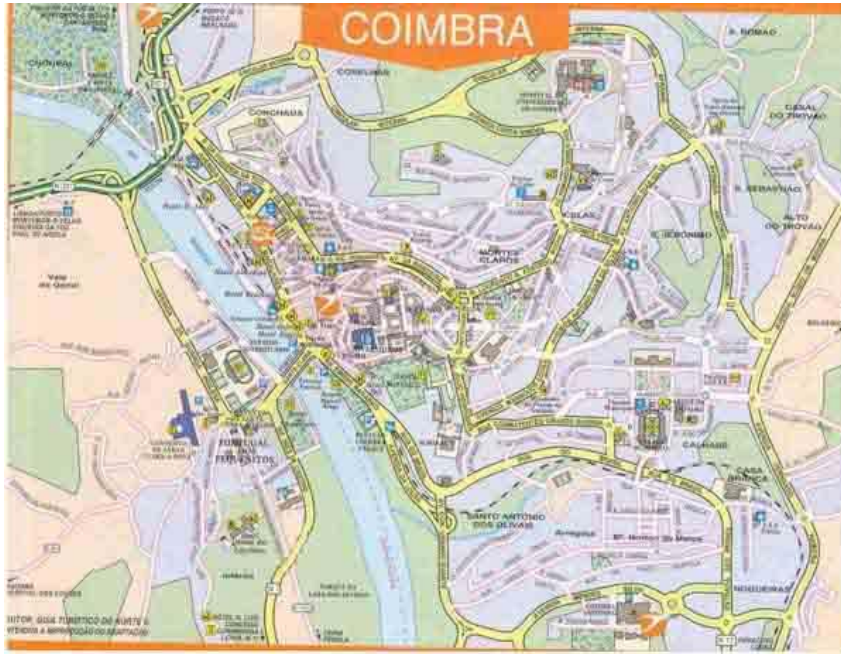


Figure 3.4. Coimbra and Vicinity (Source: Portugal Hotels)

Municipal level zones (PDM) are the main zoning, with areas defined as agricultural, ecological, forests, or by urban density and/or type. This layer of zones is in turn part of the regional planning areas (PROT), which all must subscribe to the national spatial plan laid forth by the federal government. Additionally, Coimbra is home to 31 civil parishes, all which have local interests. With multiple layers of governance, and complicated interconnections, understanding the development requirements and guidelines is difficult, but it seems clear that the municipal government, which controls the municipal level zoning is the key power holder here.

3.2.2.4 Economic activity subsystem

Coimbra's economy is largely supported by two major industries: academic institutions and hospitals. Coimbra has a notable university, well-known hospitals, a wide range of services, important technological-based companies, and diverse cultural attractions. But paramount are the University of Coimbra, the oldest and amongst the largest universities in Portugal with 20,000 students, and other schools, as well as the Centro Hospitalar Universitário de Coimbra, an important healthcare destination, again along with other hospitals. Driven by these white collar sources of income, Coimbra's local

¹¹⁶ "United Nations Sustainable Development: Agenda 21".

¹¹⁷ "European Spatial Development Perspective".

economy is more stable than the country's as a whole. Other economic outputs are supported by technology (e.g. the iParque entrepreneurial center), cement, and commerce.

Coimbra has also been ranked one of the three most economically competitive district capital cities in Portugal based on recent Portuguese research.¹¹⁸ This study, based on business competitiveness, the available labor market, demographics, and the overall business climate created a unitless index of competitiveness, which ranks the district capital cities across these four subcategories based on World Economic Forum methodology. This could be an indicator for the ability to compete amongst Portuguese cities, indicating Coimbra is well positioned to compete in this market. The GDP for the Baixo Mondego subregion, where Coimbra is found, is only \$17,926, however.¹¹⁹ This reflects the overall less productive Portuguese economy.

3.2.2.5 Links in the Physical Domain

Having identified the main aspects and subsystems of Coimbra's physical domain, we must ask: How do all these subsystems link together? Links between various elements of the physical domain are classified as Class 1 links in the CLIOS framework. Thus, we want to identify which Class 1 links drive the behavior of the Coimbra urban system. Figure 3.5 illustrates the major linkages seen.

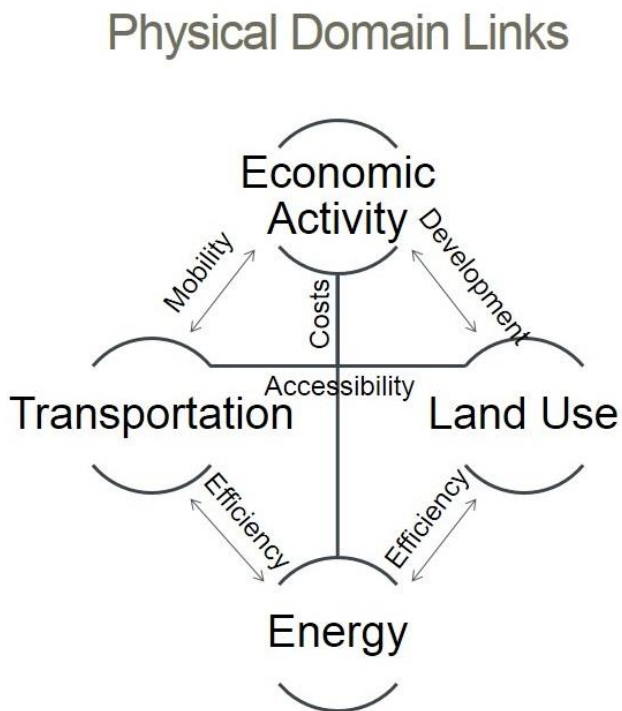


Figure 3.5. Physical Domain Links (Source: author)

The final output Coimbra's government is concerned with is obviously their economic activity or productivity. That economic activity is dependent on both transportation and land use, which in turn are driven by the energy sector. Types of linkages are listed on the connections between nodes.

¹¹⁸ Mourão and Barbosa, "La Competitividad de Las Ciudades Portuguesas. El Caso de Las Capitales de Distrito".

¹¹⁹ "List of OECD Regions by GDP (PPP) per Capita".

Energy is needed for both transportation and to support the various uses of land in the community. But it is a two-way linkage, as the types of transportation used and the way land is used impact how much energy is used. This means that how transportation and land use are actualized in the community impacts how efficient from an energy perspective the community as a whole is. Transportation and land use are also linked, with their connection determining how accessible to the residents the rest of the city is. Both influence one another directly and indirectly.

Moving up the diagram, we see that transportation provides the mobility necessary for citizens to reach the activities that drive the local economy. Additionally, any new development that might drive the local economy rests within the land use subsystem. Further, if the economy goes well, investments will be made in both transportation and developments that further show the connection. Lastly, we must note that all of the other subsystems have associated costs which balance the returns from the local economy. Whether the economic activity provides a net benefit past the costs of the other supporting subsystems and social equity is maintained determines in large part whether Coimbra is successful.

3.2.3 Coimbra's Institutional Sphere

The next part of the CLIOS representation involves describing the actors in the institutional sphere. As was the case for the physical domain, we have identified four institutional realms that have main influence on Coimbra. These institutional groups drive the city's direction.

3.2.3.1 Government

Coimbra is part of the Centro region, Baixo Mondego subregion, Coimbra District, and Greater Metropolitan Area of Coimbra. The Coimbra Mayor is João Paulo Barbosa de Melo.

The governance of Coimbra filters through multiple layers, with confusing boundary overlaps. For instance, the Coimbra District and Metropolitan Area cover almost the exact same area, but the boundaries differ slightly. As is the case with land use, the authority with most local control is the municipal government. In Portugal, regional or district control is relatively weak, despite recent efforts to strengthen it. This includes a 2008 law establishing official metropolitan governance for Lisbon and Porto, and some political push to expand these to other areas.¹²⁰ The national government exerts control influencing national policies that local municipalities must live within, but municipal authorities seem to hold most control over the day-to-day reality of the city. Recent observers note, "The country's model of metropolitan governance remains loosely coordinated constituent municipal activities, with few and fragmented metropolitan administrative powers, subsidiarity to municipal governments, and a lack of public finance autonomy."¹²¹

In considering the levels of government that would have influence in terms of the prospective high-speed rail, there are several levels of transportation authorities. At the EU level, the TEN-T system plan aims to establish an efficient trans-European transport network. Portuguese national implementation comes through the Ministério das Obras Públicas, Transportes e Comunicações (Ministry of Public Works, Transport and Communications). At the regional level, CCDRs, in this case the *comissao de coordenacao e desenvolvimento regional do centro*¹²², influence infrastructure planning, although this influence from the CCDRs or any regional entity is weak. Recognizing this regional weakness, a 2009 law

¹²⁰ Zegras et al., "Fiscal Federalism and Prospects for Metropolitan Transportation Authorities in Portugal".

¹²¹ Ibid.

¹²² "Comissao de Coordenacao E Desenvolvimento Regional Do Centro".

established metropolitan transportation authorities in Lisbon and Porto. But oddly, these entities are separate from the metropolitan governance established in 2008, and their fiscal structure is unclear without dedicated funding sources identified.¹²³ Furthermore, there is no such body in Coimbra.

At the more local level, the Coimbra Metropolitan area contains 16 municipalities, with Coimbra the largest. The population of the Coimbra area is shown in Table 3.2, and has remained relatively constant since 1991.¹²⁴

Table 3.2. Coimbra Metropolitan Area Population (Source: Portugal Instituto Nacional de Estatística, 2011)

| Population Statistics | | | |
|--|-----------------|-----------------|-----------------|
| <i>Grande Área Metropolitana de Coimbra Greater Metropolitan Area of Coimbra</i> | | | |
| Municipality | 1991 Population | 2001 Population | 2011 Population |
| Arganil | | 13,623 | 12,145 |
| Cantanhede | | 37,910 | 36,595 |
| Coimbra | 139,052 | 148,443 | 143,396 |
| City | 96,142 | 101,069 | 102,455 |
| Condeixa-a-Nova | | 15,340 | 17,078 |
| Figueira da Foz | | 62,601 | 62,125 |
| Góis | | 4,861 | 4,260 |
| Lousã | | 15,753 | 17,604 |
| Mealhada | | 20,751 | 20,428 |
| Mira | | 12,872 | 12,465 |
| Miranda do Corvo | | 13,069 | 13,098 |
| Montemor-o-Velho | | 25,478 | 26,171 |
| Mortágua | | 10,379 | 9,607 |
| Oliveira do Hospital | | 22,112 | 20,855 |
| Pampilhosa da Serra | | 5,220 | 4,481 |
| Penacova | | 16,725 | 15,251 |
| Penela | | 6,594 | 5,983 |
| Soure | | 20,940 | 19,245 |
| Tábua | | 12,602 | 12,071 |
| Vila Nova de Poiares | | 7,061 | 7,281 |
| Total Metropolitan | | 430,845 | 435,900 |
| Total District | | 441,204 | 430,104 |
| <i>Portugal</i> | 9,862,540 | 10,356,117 | 10,562,178 |

= Metropolitan only
= District only

To summarize the role of governance, the influence of the various layers of government can be seen in Figure 3.6.

¹²³ Zegras et al., “Fiscal Federalism and Prospects for Metropolitan Transportation Authorities in Portugal”.

¹²⁴ “Instituto Nacional de Estatística, Censos 2011”.

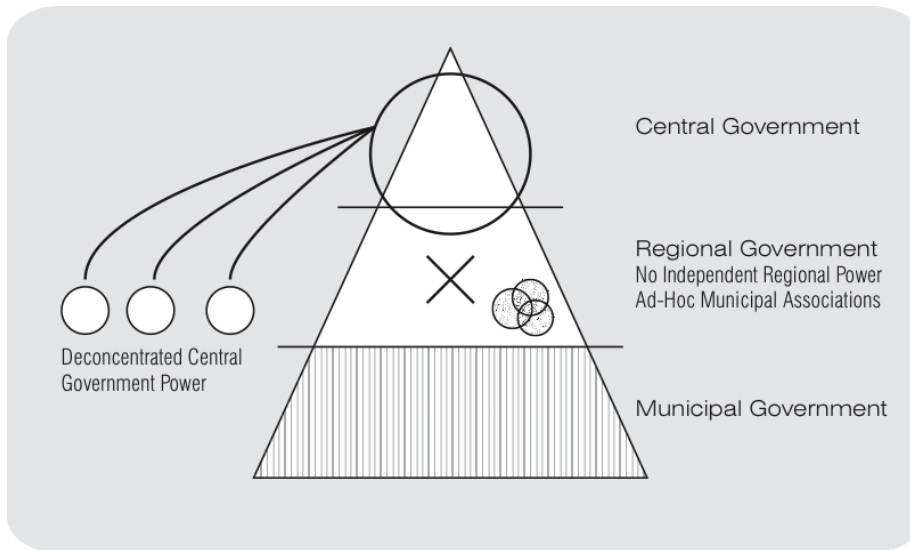


Figure 3.6. Portugal's Governance Layers (Source: Stein, 2013)

We see that regional government is relatively weak, with deconcentrated central government power helping guide a strong municipal government. In other words, “Similar to many other countries, metropolitan governance in Portugal remains a challenge. In Lisbon and Porto [and beyond], metropolitan governance is a mix of occasional, ad-hoc, and limited voluntary cooperation among municipalities and a few special-purpose bodies.”¹²⁵

3.2.3.2 Universities

As noted in the economic subsystem, Coimbra is a university town. The largest of these universities exert significant influence and control throughout the community. The University of Coimbra is the oldest and amongst the largest universities in Portugal with 20,000 students. It is a continentally important research university, with a prominent reputation, especially throughout the nation.

Also in Coimbra are the Instituto Politécnico de Coimbra, a public polytechnic institute, the Escola Superior de Enfermagem de Coimbra, a public nursing school, and some private higher education institutions: the Instituto Superior Miguel Torga, the Instituto Superior Bissaya Barreto, the Escola Universitária Vasco da Gama, and the Escola Universitária das Artes de Coimbra, an art school.

The magnitude of the university presence, via students and faculty/staff, institutional presence, and knowledge and intellectual output are clear influences in Coimbra.

3.2.3.3 Hospitals

Similar to the universities, another important institution is the hospital community in Coimbra. The Centro Hospitalar Universitário de Coimbra has been formed from a merger of the Hospitais da Universidade de Coimbra, associated with the University of Coimbra, and the Centro Hospitalar de Coimbra. It is regarded by many as the preeminent hospital for all of Portugal and draws patients from throughout the country. A major employer and medical innovator, it and other hospitals also exert strong municipal influence.

Also in Coimbra are the Instituto Português de Oncologia and the Hospital pediátrico de Coimbra.

¹²⁵ Zegras et al., “Fiscal Federalism and Prospects for Metropolitan Transportation Authorities in Portugal”.

3.2.3.4 Transportation

There are multiple agencies and institutions with influence within the transportation domain in Coimbra. Some of these lie as well in the governmental realm, and were outlined in the governance group. Other entities are typically modally associated.

In terms of railroad institutions, the infrastructure owner is REFER, the national Portuguese railroad infrastructure owner. The operations are conducted by CP, the national railroad operator. The HSR venture was to be conducted by RAVE, an organization now defunct.

Public transit in Coimbra is largely run by the SMTUC, or the Municipal Urban Transportation Services of Coimbra. This municipal public transportation operator was founded in 1908, and boasts over 400 employees, approximately 300 of whom are bus drivers. They operate a fleet of over 140 buses, with 28 million passengers carried in 2011.¹²⁶

Additional transport operators in the city include private bus companies, the airport, roadway agencies, companies involved in the commuter rail and subway endeavors, and freight and shipping companies.

3.2.3.5 Links from the Institutional Sphere

So now, how do these institutional players impact and interact with the physical domain we have outlined? Links between institutional actors and various elements of the physical domain are classified as Class 2 links in the CLIOS framework. Figure 3.7 begins to paint that picture.

Coimbra's Institutional Sphere Links

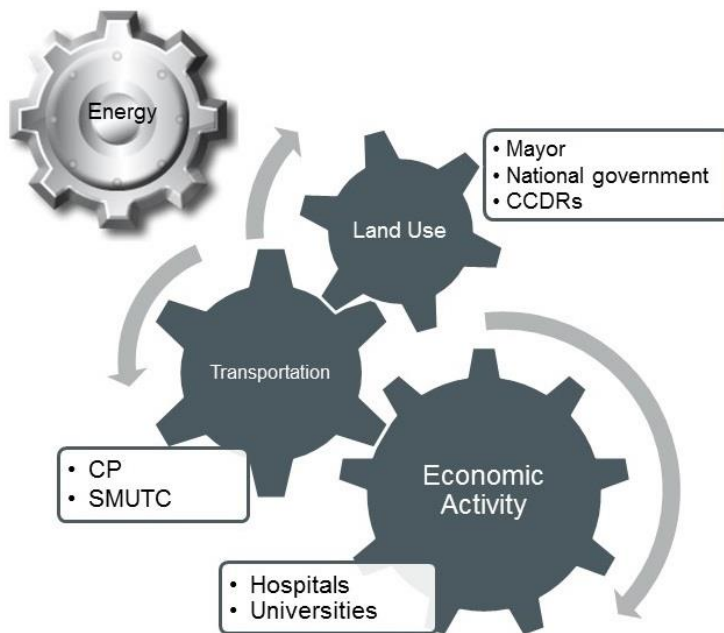


Figure 3.7. Coimbra's Institutional Sphere Links (Source: author)

Now we see the total picture a CLIOS representation illustrates of Coimbra. The various physical domain subsystems that guide Coimbra are connected to the key institutional actors present in the community.

¹²⁶ Santos and da Vinha, "One City, One System: Integrating Public Transportation in Coimbra".

The crucial links present are noted, with CP, the rail operator, and SMUTC, the public transit operator, as major contributors to the transportation subsystem. The mayor, who controls zoning, as well as the national and regional bodies of governance, interact directly with the land use subsystem. And main industries, in the hospitals and universities, directly and indirectly impact the economic activity exhibited by Coimbra. Via policy levers and investment these agents act on the city to control both supportively and negatively the economic potential for the community. Crucially, we see that Coimbra's success relies on a cooperative effort between Coimbra's authorities and the national government. However, with the regional authorities holding only light influence, one wonders whether the metropolitan interest is being represented well.

Specifically, we see overlapping layers of geography, with the district and metropolitan area nearly synchronous, but not identical. And Coimbra itself is within the Baixo Mondego subregion while much of its metropolitan area is not. Specific regional interests such as coordinated planning and regional development considerations may not be met given this municipal level of control.

3.2.4 What is Coimbra?

Thus, we see that Coimbra is a key intermediate city between Lisbon and Porto. Located near midway between these principal cities, the city of Coimbra is one of the most important urban centers in Portugal, playing a central role in the interior of the country. It is an intellectual center, with a significant university and healthcare presence, markers of an increasingly important knowledge economy. And it functions based on municipal leadership. It is a key transportation hub, with key linkages to Lisbon and Porto.



Figure 3.8. Coimbra at a glance (Source: <http://www.map-of-portugal.co.uk/>; University of Coimbra; <http://pinkalarmclockpt.com/coimbra/>)

3.3 LEIRIA, PORTUGAL

3.3.1 Boundaries of the CLIOS Representation

As in Coimbra, we draw the CLIOS boundary at the municipal level. Table 3.3 provides a broad overview of Leiria, the details of which are outlined subsequently.

Table 3.3. *Leiria Overview* ¹²⁷

LEIRIA

HISTORY AND CONTEXT

State/Province: Centro, Pinhal Litoral subregion, Leiria District

Country: Portugal

Köppen Classification: Dry-summer subtropical or Mediterranean (Csb)

Location: 39°44'37"N 8°48'25"W

Land Area: 565 km² (municipality)

Spatial Adjacencies: Located less than 50 miles south of Coimbra, between Portugal's principal cities (Lisbon and Porto), the city of Leiria is a historic urban center in Portugal. Center of the Pinhal Litoral subregion, the city spreads locally between the national monument Leiria Castle hill and the river Lis.

City Population: 50,200

Municipality Population: 126,879

Municipal Population Density: 228.0/ km²

Racial Distribution: largely Portuguese

Language: Portuguese

Demonym: Leirian

City Inception/Incorporation Date: 1142

POLICIES AND ORGANIZATION

Current Strategic Plan: Municipal level planning, based on national land use plans; PDM (municipal-level zones); PROT (regional planning); 29 civil parishes

Spatial Planning in Portugal: driven by Agenda 21

Municipal Mayor: Raúl Miguel de Castro

ECONOMICS

Largest Industry of Employment: Manufacturing, light industry, services

GDP/capita: Pinhal Litoral – \$18,113 in constant 2000 International dollars (lowest quartile internationally)

Competitiveness by city: (all Portugal district capitals)

Ranking:

1. Évora: 7,293 (index value)
2. Lisbon: 6,454
3. Coimbra: 6,042
4. Beja: 5,660
5. Leiria: 5,609

Air: Aérodromo de Leiria

In assessing the systems present in Leiria and to capture within the physical domain and associated institutional sphere, the following categories were identified:

¹²⁷ "Leiria".

- Physical domain
 - Transportation subsystem,
 - Energy / environmental subsystem,
 - Land use subsystem,
 - Economic activity subsystem,
- Institutional sphere
 - Government
 - Universities
 - Tourism
 - Transportation

These system components serve as the elements within which we will look for additional connections and linkages by which we can describe the system that is Leiria.

3.3.2 Leiria's Physical Domain

Leiria's physical domain is also described via a group of subsystems that make up the overall Leiria city system. As with Coimbra, we have divided the physical domain into four main subsystems. In assessing Leiria, these subsystems together describe best the city in the context of this research.

3.3.2.1 Transportation subsystem

Leiria's transportation system is largely centered on the personal vehicle, with internal transit only via bus and relatively little transit connectivity outside the city aside from bus service. As noted in Coimbra's case, Portugal's vehicle ownership rate is rising although still well below the United States rate. Leiria is located centrally between the two main north-south highways running through Portugal. It is near the A1 Lisbon to Porto highway, as well as A8 and A17, which provide link between Lisbon and Aveiro. A8 circles around the south side of Leiria, connecting up to A1 as well. Additionally, A19 extends south from Leiria, putting it at the hub of a highway network. This highway network can be seen in Figure 3.10. As would be expected, Leiria has developed outward along the roadway network.

Leiria's local transit service is provided by the Mobilis bus system. Mobilis is comprised of two routes, which serve major commercial and recreational destinations and the bus station is in the city center. It was organized by the Leiria City Council, the Polytechnic Institute of Leiria's School of Technology and Management, and external consultants.¹²⁸



Figure 3.9. Northern Portugal Infrastructure (Source: RAVE)
[orange=proposed HSR, red=existing rail, gray=highways]

¹²⁸ "Mobilis - Circular Urbana de Leiria".

Leiria has regional rail access on the Linha do Oeste (West Line) via a station several kilometers west from the city center, but service is relatively limited. Connections to either Coimbra or Lisbon, the closest substantial cities, are lengthy and inconvenient. Travel time to Lisbon is approximately 2h 55m via the train. Thus, the HSR service planned to Leiria on the proposed line between Lisbon and Porto would provide a dramatic upgrade. It would be accessed at a planned intermodal station, Leiria-AV, west of the city. This station, between Leiria and Marinha Grande in the Barosa industrial zone, would provide integrated access to the major local roadways and multiple communities.¹²⁹ Most current higher-volume regional service is by bus, with multiple companies offering service, especially to/from the Lisbon airport, which is a trip of approximately 1h 20m. The Lisbon to Leiria trip is dominated by bus and personal vehicles due to the current uncompetitive state of rail. Figure 3.9 shows the infrastructure linking Leiria.



Figure 3.10. Leiria Area Highways (Source: Portugal Hostel Bookers)

Additionally, Leiria is served by a small airport, the Aeródromo de Leiria, largely used for sports and recreation purposes. The nearest port is in Nazaré approximately 24 miles away. As in Coimbra, the transportation development patterns seen in Leiria are quite familiar, and mirror similar patterns seen throughout much of the Western world.

3.3.2.2 Energy/environmental subsystem

In terms of its energy use, Leiria, like Coimbra and most of Portugal, is largely served by natural gas. Central to Leiria's locale is the Lis River. The historic downtown portion of Leiria extends between the 12th century Leiria Castle and the Lis.

Leiria's Köppen Classification is also Dry-summer subtropical or Mediterranean (Csb). It is quite hilly as well with a listed elevation at 44m. Much of the land surrounding the area is used for agricultural purposes, with Portugal's main agricultural products including beef, cheese, fruits, pork, wine, and wood. An important feature is the Pinhal de Leiria (Leiria National Forest) between the city of Leiria and the beaches on the Atlantic Ocean, which was largely planted by Dom Dinis, a Portuguese king, in the 14th century. These point to the significant role forestry and logging have played in Portuguese history

¹²⁹ Arsenio, Tao, and Ferreira, "How to Promote Sustainable Land-Use Changes through Developing Intermodal High-Speed Railway Stations: A Case Study in Portugal".

(contributing to their success as shipbuilders and explorers), and which are still an important industry today.

3.3.2.3 Land use subsystem

Leiria's organization and development is also driven by its zoning and planning. Although it is also an old city, with an historic central downtown, new development activity along its fringes is just as active as in Coimbra. Stein observes, "Past trends in ... Leiria and Coimbra demonstrate that the country is becoming more connected, with expanding commuter sheds and increasing inter-municipal commuting. That change, however, is ... accompanied by increased motorization and sprawling land use patterns."¹³⁰ In these areas, growth is especially governed by the planning codes. Municipal level planning is again paramount in Leiria. They have a land use code based on municipal level zones, which is based on national land use plans. Leiria's layout is shown in Figure 3.11.



Figure 3.11. Leiria and Vicinity (Source: Portugal Hotels)

Leiria is home to 29 civil parishes, and thus also features multiple layers of governance, with complicated interconnections. As with most of Portugal, it seems clear that the municipal government, which controls the municipal level zoning is the key power holder here.

¹³⁰ Stein, "Spatial Dimensions of High-Speed Rail".

3.3.2.4 Economic activity subsystem

Leiria's economy is built on light industries and services. Various types of manufacturing or industry are found in Leiria, with main products including plastics and molds and glass. Additional industries include agricultural trade, cement production, construction, and milling. Figure 3.12 highlights several of the industry clusters located in proximity to Leiria. Interestingly, Leiria was the site of the Western world's first water paper mill in 1411, where there is a museum today (Museu do moinho do papel). This highlights another major component of Leiria's economy, which is tourism. Within and surrounding Leiria are several popular tourist attractions, including the eponymous Leiria Castle situated at the top of

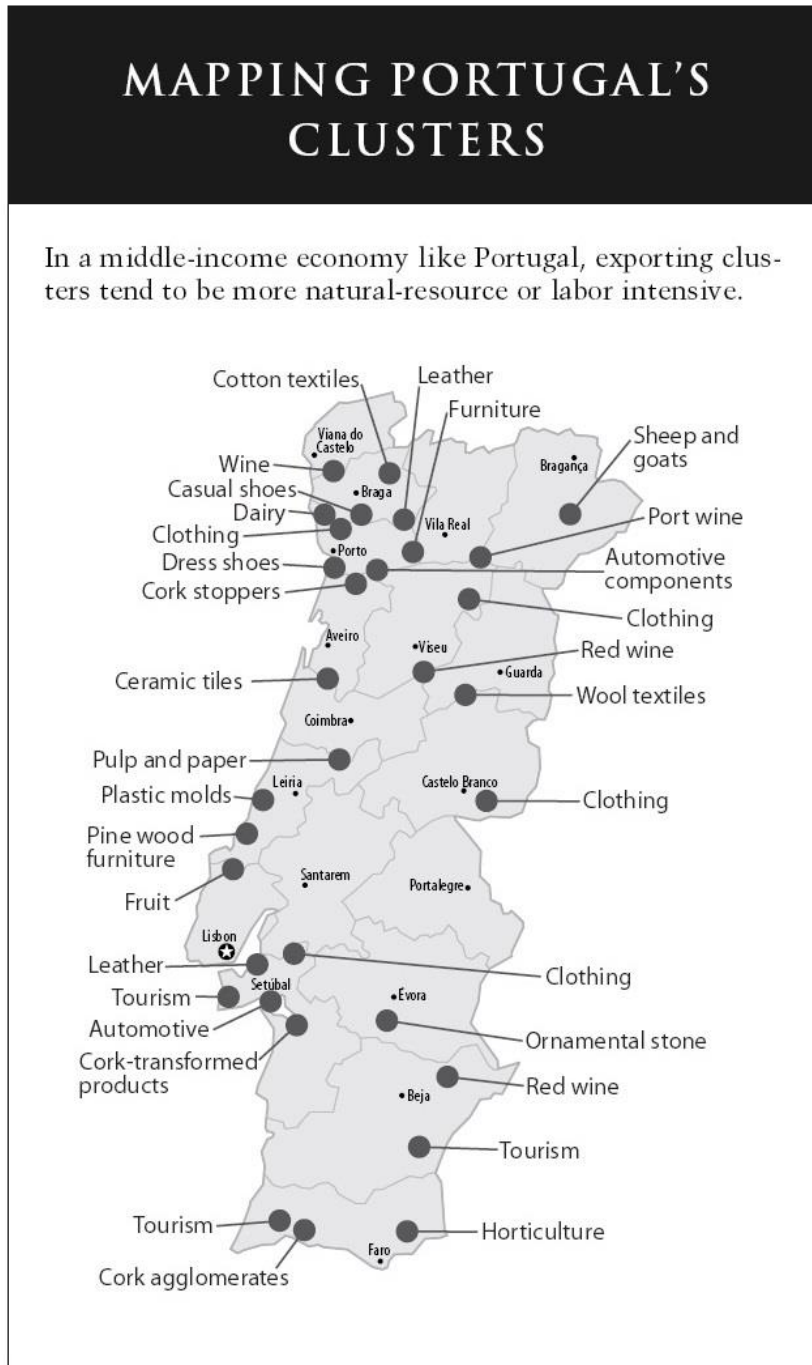


Figure 3.12. Portuguese Industrial Clusters (Source: Porter, 1998)

the hill overlooking the city center. Other nearby medieval castles include the Ourem and Porto de Mos. Additionally, the Alcobaça and Batalha Monasteries are designated UNESCO World Heritage sites.

Leiria is also home to academic institutions and hospitals. The district's regional hospital, Hospital de Santo André is in Leiria. Much of Leiria's work force is blue collar, with white collar occupations also playing a role. The GDP for the Pinhal Litoral subregion, where Leiria lies, is \$18,113/capita.¹³¹ Leiria has also, like Coimbra, been ranked one of the five most economically competitive cities in Portugal in the Portuguese study based on its available labor market, demographics, and the overall business climate.¹³²

3.3.2.5 Links in the Physical Domain

Just as we saw in Coimbra, the links between the physical domain elements are key. To support its overall economic productivity, the city uses its transportation and land use subsystems, powered by the present energy and natural resources. As in Coimbra, whether the economic activity provides a net benefit past the costs of the other supporting subsystems determines in large part whether Leiria is successful.

3.3.3 Leiria's Institutional Sphere

Here, as part of the CLIOS representation, we turn to describing the actors in the institutional sphere. As was the case for the physical domain, we have identified four institutional realms that have main influence on Leiria. These institutional groups drive the city's direction.

3.3.3.1 Government

Leiria is part of the Centro region, Pinhal Litoral subregion, and Leiria District. The Leiria Mayor is Raúl Miguel de Castro.

The governance of Leiria, as in Coimbra, filters through multiple layers. And, as is the case with land use, the authority with most local control is the municipal government. Like Coimbra, EU spatial planning would trickle down through the Portuguese national government to Leiria's municipality. Within that municipality are smaller parishes, including the city of Leiria.

The population of the Leiria area is shown in Table 3.4, which shows moderate growth.¹³³

Table 3.4. Leiria Municipal Population (Source: Portugal Instituto Nacional de Estatística, 2011)

| Population Statistics | | | |
|---|-----------------|-----------------|-----------------|
| Concelho de Leiria Municipality of Leiria | | | |
| Municipality | 1991 Population | 2001 Population | 2011 Population |
| Leiria | 102,762 | 119,847 | 126,879 |
| City | | | 50,200 |
| Total Metropolitan | | | N/A |
| Total District | | 459,426 | 470,930 |
| Portugal | 9,862,540 | 10,356,117 | 10,562,178 |

¹³¹ "List of OECD Regions by GDP (PPP) per Capita".

¹³² Mourão and Barbosa, "La Competitividad de Las Ciudades Portuguesas. El Caso de Las Capitales de Distrito".

¹³³ "Instituto Nacional de Estatística, Censos 2011".

The diagram illustrating the relative importance of Portuguese governance layers applies here as well (Figure 3.6, shown within Coimbra section 3.2.3). As outlined, regional government is relatively weak, with deconcentrated central government power helping guide a strong municipal government.

3.3.3.2 *Universities*

As noted in the economic subsystem, Leiria is home to a decently sizable university population. Leiria's most noteworthy university is the Polytechnic Institute of Leiria, which includes a School of Education and Social Sciences, the engineering-focused School of Technology and Management, and a School of Health Sciences. 11,500 students overall call Leiria home. In a community this size, the university presence is clearly felt, via students and faculty/staff.

3.3.3.3 *Tourism*

An important industry and presence in Leiria is the tourism traffic in the community, as indicated by the various tourist sites in and near Leiria. The leaders of this important regional element are headquartered in Leiria. The Regional Tourist Office of Leiria/Fátima, which is responsible for Leiria area tourism as well as that of neighboring Fátima, home to one of Europe's main Catholic pilgrimage destinations, is the foremost presence.¹³⁴ This tourism board, as well as the countless businesses who rely on tourism, are key institutions present in Leiria. Any municipal decisions are undoubtedly weighed in light of the crucial place tourism holds in the community's economy.

3.3.3.4 *Transportation*

Although not as many as in Coimbra, there are multiple agencies and institutions with influence within the transportation domain in Leiria. Several of these lie as well in the governmental realm, matching the hierarchy outlined for Coimbra. Other entities are typically modally associated.

In terms of railroads, the infrastructure owner is REFER, the national Portuguese railroad infrastructure owner. The operations are conducted by CP, the national railroad operator. The HSR venture was to be conducted by RAVE, an organization now defunct. However, due to the lesser presence of passenger rail in Leiria, these agencies hold less weight than the local transit.

The Mobilis bus system public transit in Leiria was established by the Estudo de Mobilidade e Transportes do Concelho de Leiria (EMTCL) or Leiria Mobility and Transport Study in 2005.¹³⁵ Additional transport operators in the city include private bus companies, the airport, roadway agencies, construction companies, and freight and shipping companies.

Furthermore, with recent greater interest in regional cooperation, Leiria authorities have considered cooperating with neighboring Marinha Grande to form a joint inter-municipal transit and transportation plan.¹³⁶

¹³⁴ "Portal Do Turismo de Leiria-Fátima".

¹³⁵ "Mobilis - Circular Urbana de Leiria".

¹³⁶ Stein, "Spatial Dimensions of High-Speed Rail".

3.3.3.5 Links from the Institutional Sphere

So now, how do these institutional players impact and interact with the physical domain we have outlined? Again, links between institutional actors and various elements of the physical domain are classified as Class 2 links in the CLIOS framework. Figure 3.13 begins to paint that picture for Leiria.

Leiria's Institutional Sphere Links

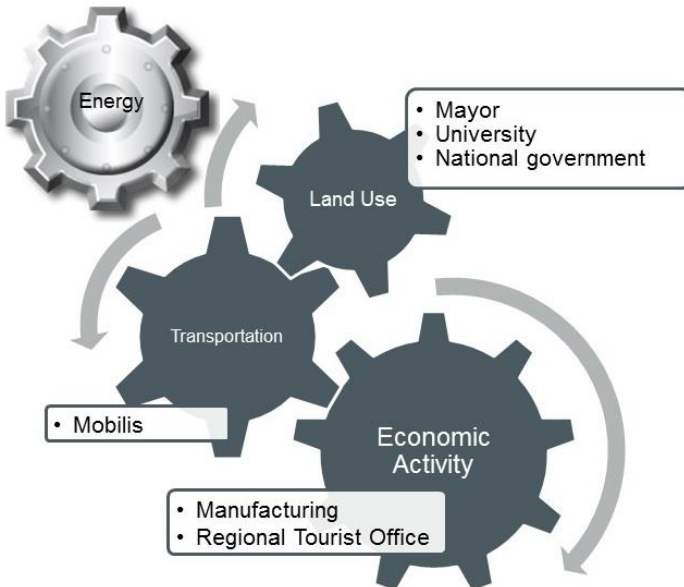


Figure 3.13. Leiria's Institutional Sphere Links (Source: author)

Now we can see the total picture the CLIOS representation illustrates of Leiria. The various physical domain subsystems that guide Leiria are connected to the key institutional actors present in the community.

The crucial links present are noted, with Mobilis, the public transit operator, as key contributor to the transportation subsystem. The mayor, who ostensibly controls zoning, as well as the national government and perhaps the university, interact directly with the land use subsystem. And the major industries, in the manufacturing and tourism realms, directly and indirectly impact the economic activity exhibited by Leiria. Crucially, we see that Leiria's success also relies on a cooperative effort between Leiria's authorities and the national government.

3.3.4 What is Leiria?

Leiria is a town of multiple foci. A manufacturing center, it is also seeking to continue positioning itself as a key tourist destination. Located less than 50 miles south of Coimbra, between Portugal's principal cities (Lisbon and Porto), the city of Leiria is a historic urban center in Portugal. A local university provides intellectual presence, but many residents are blue collar. Heavily reliant on highway access, it is less isolated since the growth of automobile use following World War II. But rail access is limited, making it feel less connected to Lisbon. Led municipally, it is more similar in size to its neighboring communities, and the leadership hierarchy for the district is more egalitarian. A new HSR connection would be a key differentiator as well as providing profoundly different access to the main metropolitan areas in Portugal.



Figure 3.14. Leiria at a glance (Source: www.mapscd.com; www.panoramio.com; Wikipedia)

3.4 CHAMPAIGN-URBANA, ILLINOIS

3.4.1 Boundaries of the CLIOS Representation

In the United States, the boundaries for each city follow different patterns than in Portugal. Here, each municipality has a city boundary, with the adjacent cities combining to form a metropolitan area. The economic impact of an area is dependent on its metropolitan characteristics, but an area's character is shaped by its main city.

In Champaign-Urbana's case, there are two twin cities at the metropolitan center, which together anchor and lead the metropolitan area. Therefore, we draw the CLIOS boundary at the city level, and will represent the networks of systems for Champaign and Urbana together. Table 3.5 provides a broad overview of Champaign-Urbana, the details of which are outlined subsequently.

Table 3.5. Champaign-Urbana Overview ¹³⁷

CHAMPAIGN-URBANA

HISTORY AND CONTEXT

State/Province: Illinois, Champaign County

Country: United States

Köppen Classification: humid continental climate (Dfa)

Location: 40.109665°N 88.204247°W

Land Area: 58.2 km² (Champaign) 30.0 km² (Urbana)

Spatial Adjacencies: The Champaign and Urbana twin cities are at an interstate highway crossroads in the heart of Illinois farmland. Just over two hours south of Chicago, they are still influenced by that metropolitan region more than any other. But the area is similar distance from St. Louis, MO and Indianapolis, IN, serving as a midway stop on many journeys between these destinations.

City Population: 81,055 (Champaign), 41,250 (Urbana), 122,305 (combined)

City Population Density: 1,535/ km² (Champaign) 1,339/ km² (Urbana)

Metropolitan Population: 231,891

Racial Distribution: 67.5% white, 15.2% black, 11.8% Asian, 5.4% Hispanic

Language: English

Demonym: Champaignite or Urbanan

City Inception/Incorporation Date: 1855 (Champaign) 1833 (Urbana)

POLICIES AND ORGANIZATION

Current Strategic Plan: Champaign Urbana Urbanized Area Transportation Study (CUUATS) is the transportation entity of the Champaign County Regional Planning Commission (CCRPC), which is the Metropolitan Planning Organization (MPO) responsible for administering the federally mandated transportation planning process. The *Choices in 2035* Long-Range Transportation Plan and local land use plans govern development decisions.

City Mayor: Don Gerard (D), Champaign; Laurel Prussing (D), Urbana

ECONOMICS

Largest Industry of Employment: University and Academia; Technology; Health care

GDP: \$9.5 million | \$40,967.52/capita

Air: University of Illinois Willard Airport (CMI)

¹³⁷ "Champaign–Urbana Metropolitan Area".

In assessing the systems present in Champaign-Urbana and to capture within the physical domain and associated institutional sphere, the following categories were identified:

- Physical domain
 - Transportation subsystem,
 - Energy / environmental subsystem,
 - Land use subsystem,
 - Economic activity subsystem,
- Institutional sphere
 - Government
 - Universities
 - Arts/Culture
 - Transportation

These system components serve as the elements within which we will look for additional connections and linkages by which we can describe the complex system that is Champaign-Urbana.

3.4.2 Champaign-Urbana's Physical Domain

Champaign-Urbana's physical domain is again described via a group of subsystems that serve to make up the overall Champaign-Urbana city system. As with the Portuguese cities, we have divided the physical domain into four main subsystems. In assessing Champaign-Urbana, these subsystems combine together to describe the city as it is today.

3.4.2.1 *Transportation subsystem*

As with most of the United States, Champaign-Urbana's transportation system is largely centered on the personal vehicle. Between the 1960s and 1990s, the United States developed a national system of interstate highways to facilitate interstate (and intrastate) traffic of goods and people. Historically, many of these interstate highways were developed along existing railroad lines or prior traditional highways. Champaign and Urbana are at an interstate highway crossroads in east central Illinois, as shown in Figure 3.15. The north-south highway, I-57, is an interstate highway running from Chicago to Illinois' southern tip. The main east-west highway, I-74, is an interstate highway running from the Quad Cities¹³⁸ to Cincinnati. An additional east-west highway, I-72, runs from Missouri through Springfield to Champaign.

¹³⁸ Straddling the Mississippi River are Davenport and Bettendorf in Iowa, with Rock Island and Moline in Illinois.



Figure 3.15. Champaign County Location Map (Source: PGAV Urban Consulting)

For an auto-centric culture, Champaign-Urbana does have a surprising number of alternative mode options. Their local public transit is operated by the Champaign-Urbana Mass Transit District. It serves the communities with an extensive public bus system, and is considered one of the nation’s best small transit operators.¹³⁹ Intercity bus service is also offered, with various companies such as Greyhound and Megabus along with smaller local operators offering service from Champaign to intermediate and major cities.

Champaign-Urbana has regional passenger rail access on the north-south former Illinois Central rail line discussed in Chapter 1. This is the main line between Chicago and New Orleans. Passenger service is offered by Amtrak, with three trains in each direction daily. The station is located in downtown Champaign at the Illinois Terminal, built in 1999, which also serves as transit hub for the Mass Transit District making it a key intermodal transfer facility.¹⁴⁰ Rail travel offers direct access to downtown Chicago, but most trips between Champaign and Chicago are via auto. Freight railroad traffic is high, especially in comparison to Portugal and Europe. Railroad is a much more predominant mode for freight traffic in the United States, and in the heart of agricultural land as Champaign-Urbana is, much traffic

¹³⁹ “About Us | Champaign-Urbana Mass Transit District”.

¹⁴⁰ “Champaign, Illinois”.

exists transporting agricultural goods. Champaign-Urbana is also home to a rail intersection, with the north-south route (on which Amtrak operates) owned by CN and the east-west route owned by NS.

Additionally, Champaign-Urbana is served by a regional airport, the Willard University of Illinois Airport. This is a full service airport, with daily flights operated by American Eagle Airlines to Chicago and Dallas with some charter flights to Mexico. It is also used by private entities and serves the University of Illinois, who is its operator, closely.

3.4.2.2 *Energy/environmental subsystem*

In terms of its energy use, Champaign-Urbana, like Portugal, is served by natural gas for heat. Electricity, however, is generated largely by coal-burning power plants. The local utility for both is Amaren.

Environmentally, Champaign-Urbana's locale is flat prairie. Most surrounding land is agricultural, and towns formed around road or rail intersections or river crossings. The main agricultural products are corn and soybeans.

Champaign-Urbana's Köppen Classification is humid continental climate (Dfa). Summers are relatively humid and hot while winters are relatively cold. The listed elevation is 738 feet.

3.4.2.3 *Land use subsystem*

In the United States, any metropolitan area that seeks federal funding for transportation must have a Metropolitan Planning Organization (MPO). The United States government requires any urbanized area greater than 50,000 to have such a group. These organizations are established to create a comprehensive plan for their communities, and the federal government seeks to see that transportation investment is in keeping with a mandated plan for long-term transportation investment. Most such organizations create a comprehensive land use plan and parallel long-range transportation plan. These plans are important as they provide guidance for the metropolitan area's development. But they are not the ultimate authority on local land use. Each local municipality has control over their own community. The community layout is seen in Figure 3.16, with Champaign shown in yellow, Urbana in beige, and the university area in blue. Suburbs or nearby communities include Rantoul, Mahomet, Monticello, St. Joseph, Savoy, and Tolono, none of which are more than 15,000 people.

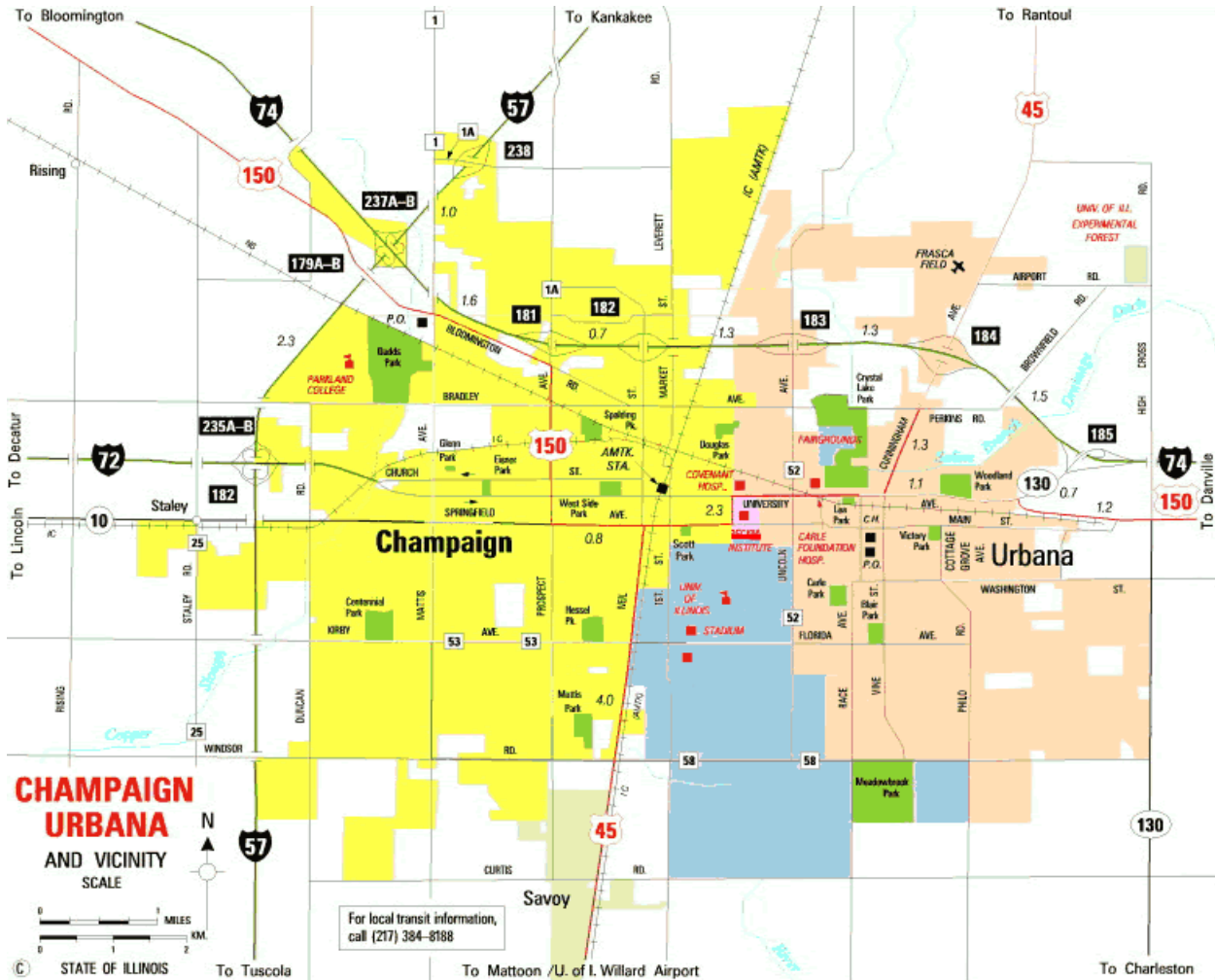


Figure 3.16. Champaign-Urbana and Vicinity (Source: University of Illinois)

Land use is typically controlled via zoning. Zoning is common in the United States, and is mandated by the local town who has municipal jurisdiction. Many communities aim to coordinate with their metropolitan area, but many make independent decisions that may not be in sync with the overall goals of the region. Larger communities will usually have their own planning department that manages zoning regulation, with the ultimate authority being the city’s government.

Champaign-Urbana’s organization and development are driven by its zoning and planning. Both Champaign and Urbana have their own planning departments, while the metropolitan area as a whole has an MPO as part of the Champaign County Regional Planning Commission. There are thus both area-wide and local decision makers.

Like the Portuguese cities, Champaign and Urbana have experienced a shift in development form since the advent of autos. Both have historic grid-based downtowns, but along the outer fringes of the town and in adjacent towns, development is more sprawling, and very similar to suburban development. However, overall the Champaign-Urbana community is relatively compact. In fact, it is the fifth least

sprawling metropolitan area in the country¹⁴¹, exhibiting relatively dense development, a mix of land uses, clustered activities, and beneficial street interconnectivity.¹⁴²

3.4.2.4 *Economic activity subsystem*

Champaign-Urbana's economy is built on the local universities and academic research. Additionally, significant presences include technology and healthcare, as well as some light industry and agriculture-related firms. Its technology presence is such that it is sometimes referred to as part of the "Silicon Prairie", and multiple Fortune 500 firms have offices in the area. The metropolitan area's top employer is the University of Illinois¹⁴³, the main campus of the state land-grant university. Home to numerous students, many of the other companies are involved with the university. Most of the technology firms are located in a research park created by the University of Illinois. Another university in town is Parkland College, a sizable community college.

The main resource-based economic driver is agriculture, with almost all the land surrounding the community devoted entirely to agricultural use. Though relatively few in number, local farmers produce very lucrative harvests, and the Midwest as a whole is one of America's and the world's most important centers of agricultural production.

Another significant employer is the healthcare industry. Champaign-Urbana is home to two large hospitals, the Carle Foundation Hospital and the Provena Covenant Medical Center run by Presence Health. Additionally, it is home to multiple branches of Christie Clinic, a multi-specialty group medical practice. Due to the sizable university and healthcare presences, a substantial portion of Champaign-Urbana's urbanized workforce could be classified as white collar.

The Champaign-Urbana metropolitan GDP is \$9.5 million or \$40,967.52/capita.¹⁴⁴

3.4.2.5 *Links in the Physical Domain*

Just as we saw in the Portuguese communities, the links between the physical domain elements are key. With matching subsystems, the linkages are similar to Portugal even if the components making up these subsystems differ. To support its overall economic productivity, the city uses its transportation and land use subsystems, powered by the present energy and natural resources. As in Coimbra and Leiria, whether the economic activity provides a net benefit past the costs of the other supporting subsystems determines in large part whether Champaign and Urbana are successful.

3.4.3 Champaign-Urbana's Institutional Sphere

Here, as part of the CLIOS representation, we turn to describing the actors in the institutional sphere. As was the case for the physical domain, we have identified four institutional realms that have main influence on Champaign-Urbana. These institutional groups drive the cities' direction.

3.4.3.1 *Government*

Champaign-Urbana is located in Champaign County in the State of Illinois. As previously mentioned, they make up the center of the local metropolitan statistical area, although there is not direct governance associated with this categorization. In the United States, states are the most powerful non-federal layer

¹⁴¹ Behind the New York City, San Francisco, Atlantic City, and Santa Barbara metropolitan areas.

¹⁴² *Measuring Sprawl 2014*.

¹⁴³ "Champaign County, Illinois Community Profile".

¹⁴⁴ 2012 GDP (Source: U.S. Government Revenue)

of government. Within each state, the municipalities tend to control their local domain with county governments only controlling unincorporated areas. Counties are also subdivided into Townships, which sometimes have their own governance, but it is typically weak. Thus, here in Champaign-Urbana, the main governmental influences are the United States national government (federal), Illinois state government (state), and City of Champaign and City of Urbana (local). Urbana is also the Champaign County seat.

The Champaign Mayor is Don Gerard (D), and Laurel Prussing (D) is the Urbana Mayor. The authority with most local control are the city governments, with both state and federal regulations affecting various policies.

The population of the Champaign-Urbana area is shown in Table 3.6, where we see relatively high growth in the past decade.¹⁴⁵

Table 3.6. Champaign-Urbana Metropolitan Population (Source: U.S. Census Bureau, 2010)

| Population Statistics | | | |
|--|-----------------|-----------------|-----------------|
| Champaign-Urbana Metropolitan Statistical Area | | | |
| Municipality | 1990 Population | 2000 Population | 2010 Population |
| Champaign | 63,502 | 67,518 | 81,055 |
| Urbana | 36,344 | 36,395 | 41,250 |
| Total Metropolitan | | 210,299 | 231,891 |
| <i>Illinois</i> | 11,430,602 | 12,419,293 | 12,830,632 |
| <i>USA</i> | 248,709,873 | 281,421,906 | 307,745,538 |

3.4.3.2 Universities

As noted in the economic subsystem, Champaign-Urbana is home to a significant university presence. The University of Illinois at Urbana-Champaign is the University of Illinois' flagship campus (other locations are in Chicago and Springfield), and is located at the center of the communities in both Champaign and Urbana. Established in 1867, it is one of the largest universities in the United States with nearly 45,000 students on this campus. It is a highly-ranked academic institution, ranked the 41st best national university by *U.S. News & World Report* and in the top 15 public universities. Its academic strengths include engineering, where it is ranked the fifth best engineering school in the country.¹⁴⁶ This has led to frequent collaboration in the technology realm with university professors and graduates.

The other college in town is Parkland College, a community college with approximately 18,000 students located in west Champaign. Thus, between the two schools, there are more than 60,000 college students in the community. A significant portion of the twin cities' economy is based on the university with a sizable share of its population directly related to university work.

3.4.3.3 Arts and Culture

As home to so many university-related residents, the value of art and culture within the community is high. Champaign-Urbana is home to several theaters and music venues, as well as museums.

¹⁴⁵ "Census.gov".

¹⁴⁶ "National University Rankings".

Additionally, the area, as a home to so many college students, has served as the origin for many music groups.¹⁴⁷ Institutions in this realm include the University of Illinois and each of the cities, who all control various venues or destinations. Additionally, numerous commercial media companies operate print outlets (i.e. *Champaign-Urbana News-Gazette*), radio stations, or TV stations, all with a vested stake in the community.

Furthermore, the significant role intercollegiate sports play in American culture means the University of Illinois sports teams are a large media (and economic) presence in the community. The “Fighting Illini” participate at the NCAA Division I level, and offer 21 varsity teams. The most media and fan attention is devoted to football and men’s basketball, both of which have large venues and a fierce fan base.

3.4.3.4 Transportation

Both local and outside institutions control various elements of Champaign-Urbana’s transportation network. The local transit operator is the Champaign-Urbana Mass Transit District. The District first operated in 1971, taking over for the failing private Champaign-Urbana City Lines bus service. Providing over 11 million rides annually, and a key mode for many local university students who receive discounted passes, it is an important local travel option.

Intercity rail travel is provided by Amtrak, with three daily services—the City of New Orleans, the Illini Service, and the Saluki—providing access north and south. Intercity bus service provides approximately 18 daily trip options between Champaign and Chicago, with other regional destinations also frequented. Operators include Greyhound, Megabus, Illini Shuttle, and Peoria Charter Coach Company.

The two main freight rail operators in the area are CN and NS as the facility owners. A significant freight trucking presence is also felt due to the interstate highways intersecting here. The interstate highways and several other state-owned roadways throughout are managed by the Illinois Department of Transportation. They distribute both state and federal dollars to the local roadways in the area. Locally controlled roads in Champaign and Urbana are managed by the Champaign Public Works Department and the Urbana Public Works Department respectively.

The local airport, the University of Illinois Willard Airport (CMI), named for past University of Illinois president Arthur Willard, is owned and operated by the University of Illinois. Public commercial service is currently only provided by American Eagle airlines, but with a jet-sized runway it is also frequently used for charter services.

Local transportation planning efforts are led by the Champaign Urbana Urbanized Area Transportation Study (CUUATS), part of the Champaign County Regional Planning Commission, and the metropolitan area’s designated MPO.¹⁴⁸

3.4.3.5 Links from the Institutional Sphere

How do these institutional players impact and interact with the physical domain we have outlined? Again, links between institutional actors and various elements of the physical domain are classified as Class 2 links in the CLIOS framework. Figure 3.17 begins to paint that picture for Champaign-Urbana.

¹⁴⁷ More geographically-named songs are worth noting here. *Champaign, Illinois* was co-written by Bob Dylan and Carl Perkins and released by Perkins on his 1969 album *On Top*. The band *Old 97’s* also released a song of the same name also co-written by Dylan (though unrelated to the first) in 2010 on their *The Grand Theatre* album.

¹⁴⁸ “Transportation (CUUATS)”.

Champaign-Urbana's Institutional Sphere Links

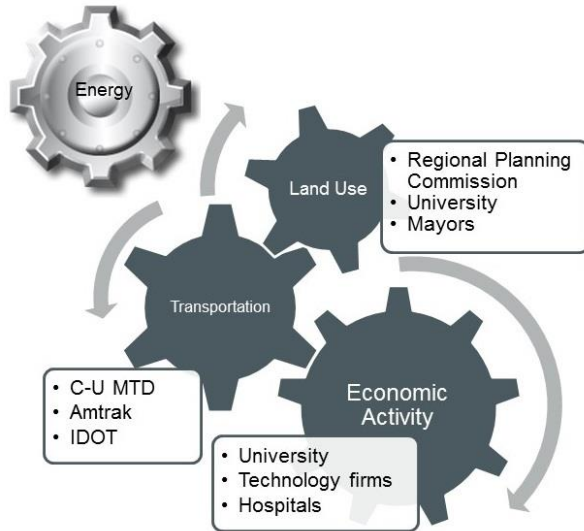


Figure 3.17. Champaign-Urbana's Institutional Sphere Links (Source: author)

Now we can see the total picture the CLIOS representation illustrates of Champaign-Urbana. The various physical domain subsystems that guide Champaign-Urbana are connected to the key institutional actors present in the community.

The crucial links present are noted, with various important contributors to the transportation subsystem. The cities, who control zoning, Regional Planning Commission, as well as the primary industry in the university, interact directly with the land use subsystem. And the key local businesses in the universities and health and tech sectors directly and indirectly impact the economic activity exhibited by Champaign-Urbana. Crucially, we see that Champaign-Urbana's success also relies on a cooperative effort between Champaign-Urbana's authorities and the State and University.

3.4.4 What is Champaign-Urbana?

The Champaign and Urbana twin cities are at an interstate highway crossroads in the heart of Illinois farmland. Just over two hours south of Chicago by car, they are still influenced by that metropolitan region more than any other. But the area is similar distance from St. Louis, MO and Indianapolis, IN, serving as a midway stop on many journeys between these destinations.

The local economy and culture are dominated by the presence of the University of Illinois. With technology and healthcare also significant presences, the research- and information-based economy drives the communities. But as well, the community is rooted in the nation's heartland, with agriculture providing a steady propulsion.

Due to the academic and technological heft of the metropolitan area, this is the main knowledge center outside Chicago in Illinois.

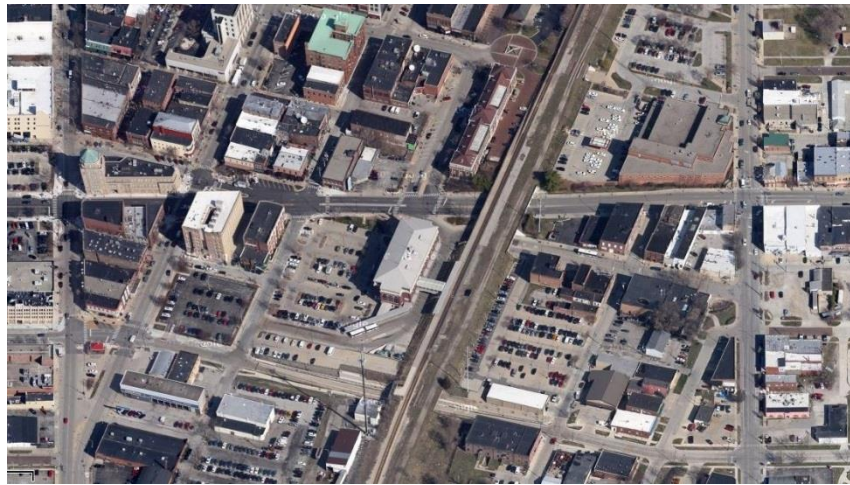


Figure 3.18. Champaign-Urbana at a glance (Source: University of Illinois; Google; www.panoramio.com)

3.5 KANKAKEE, ILLINOIS

3.5.1 Boundaries of the CLIOS Representation

As for in Champaign-Urbana, in the Kankakee area, each municipality has a city boundary, with the adjacent cities combining to form a metropolitan area. The economic impact of an area is dependent on its metropolitan characteristics, but an area's character is usually shaped by its main city.

In Kankakee's case, the metropolitan center is Kankakee, with several other communities nearby contributing to the metropolitan presence. Therefore, we draw the CLIOS boundary at the city level, and will represent the network of systems for Kankakee and its surrounding communities together. Table 3.7 provides a broad overview of Kankakee, the details of which are outlined subsequently.

Table 3.7. Kankakee Overview ¹⁴⁹

KANKAKEE

HISTORY AND CONTEXT

State/Province: Illinois, Kankakee County

Country: United States

Köppen Classification: humid continental climate (Dfa)

Location: 41°7'12"N 87°51'36"W

Land Area: 37.9 km² (municipality)

Spatial Adjacencies: Located almost exactly one hour or 60 miles from Chicago, Kankakee is a small regional city. Heavily influenced by the Chicago metropolitan region, the Kankakee area serves as the far outer limit for commuters to Chicago. Historically a river town, it is located at the original railroad and Kankakee River crossing.

City Population: 27,537

City Population Density: 730/ km²

Metropolitan Population: 113,449

Racial Distribution: 50.9% white, 41.1% black, 9.3% Hispanic, 0.3% Asian

Language: English

Demonym: Kankakeean

City Inception/Incorporation Date: 1853

POLICIES AND ORGANIZATION

Current Strategic Plan: The Kankakee County Planning Department staffs the local metropolitan planning organization (MPO), Kankakee Area Transportation Study (KATS), with the 2040 Long-Range Transportation Plan and local land use plans governing development decisions.

City Mayor: Nina Epstein (R)

ECONOMICS

Largest Industry of Employment: Manufacturing, light industry, healthcare, colleges

GDP: \$3.48 million | \$30,674.58/capita

Air:

Greater Kankakee Airport (IKK)

In assessing the systems present in Kankakee and to capture within the physical domain and associated institutional sphere, the following categories were identified:

¹⁴⁹ "Kankakee, Illinois".

- Physical domain
 - Transportation subsystem,
 - Energy / environmental subsystem,
 - Land use subsystem,
 - Economic activity subsystem,
- Institutional sphere
 - Government
 - Universities
 - Transportation

These system components serve as the elements within which we will look for additional connections and linkages by which we can describe the complex system that is Kankakee.

3.5.2 Kankakee's Physical Domain

Kankakee's physical domain is also described via a group of subsystems that serve to define the overall Kankakee city system. As with the prior cities, we have divided the physical domain into four main subsystems. In assessing Kankakee, these subsystems combine together to describe the city today.

3.5.2.1 *Transportation subsystem*

Like Champaign-Urbana, Kankakee's transportation system is now largely centered on the personal vehicle. Kankakee is located along the same interstate highway running from Chicago to Champaign. This north-south highway, I-57, is an interstate highway running from Chicago to Illinois' southern tip. I-57 largely bypasses Kankakee, with multiple exits to access the community. The area lies at the very outer limits of the Chicago commuting shed.

Kankakee also has some alternative mode options, but at a lesser level due to their smaller size. Their local public bus transit is operated by the River Valley Metro Mass Transit District. It serves the communities with a small public bus system, with service in much of Kankakee along with the nearby cities of Aroma Park, Bradley, Bourbonnais, and Manteno. Local bus service is housed at the Chestnut & North Schuyler Transfer Station. Intercity bus service is also offered, with some of the same companies serving Champaign, such as Greyhound, offering service from and to mainly Chicago or Champaign.

Kankakee has regional passenger rail access on the same Amtrak service as Champaign-Urbana, with three trains in each direction daily. The first stop for all Amtrak trains once they depart the Chicagoland area is Kankakee¹⁵⁰, with the next major stop in Champaign. Its historical presence as an initial stop outside Chicago is seen on Figure 3.19. The rail station is located in downtown Kankakee at the Kankakee Train Station and Railroad Museum, built in 1898, a beautiful historic building listed on the National Register of Historic Places. The museum features model train displays and railroad memorabilia. Rail travel offers direct access to downtown Chicago, but a vast majority of trips between Kankakee and Chicago are via auto. Freight railroad traffic is high here as well, with intermodal transfer facilities in neighboring Will County. Kankakee is also home to a rail intersection, with the same CN north-south route (on which Amtrak operates) passing through and another east-west route owned by NS. As well, it is the hub of the remaining Kankakee, Beaverville and Southern R.R. Co.

Additionally, Kankakee is served by a small private service airport, the Greater Kankakee Airport.

¹⁵⁰ Immortalized in the *City of New Orleans* song noted in Chapter 1.

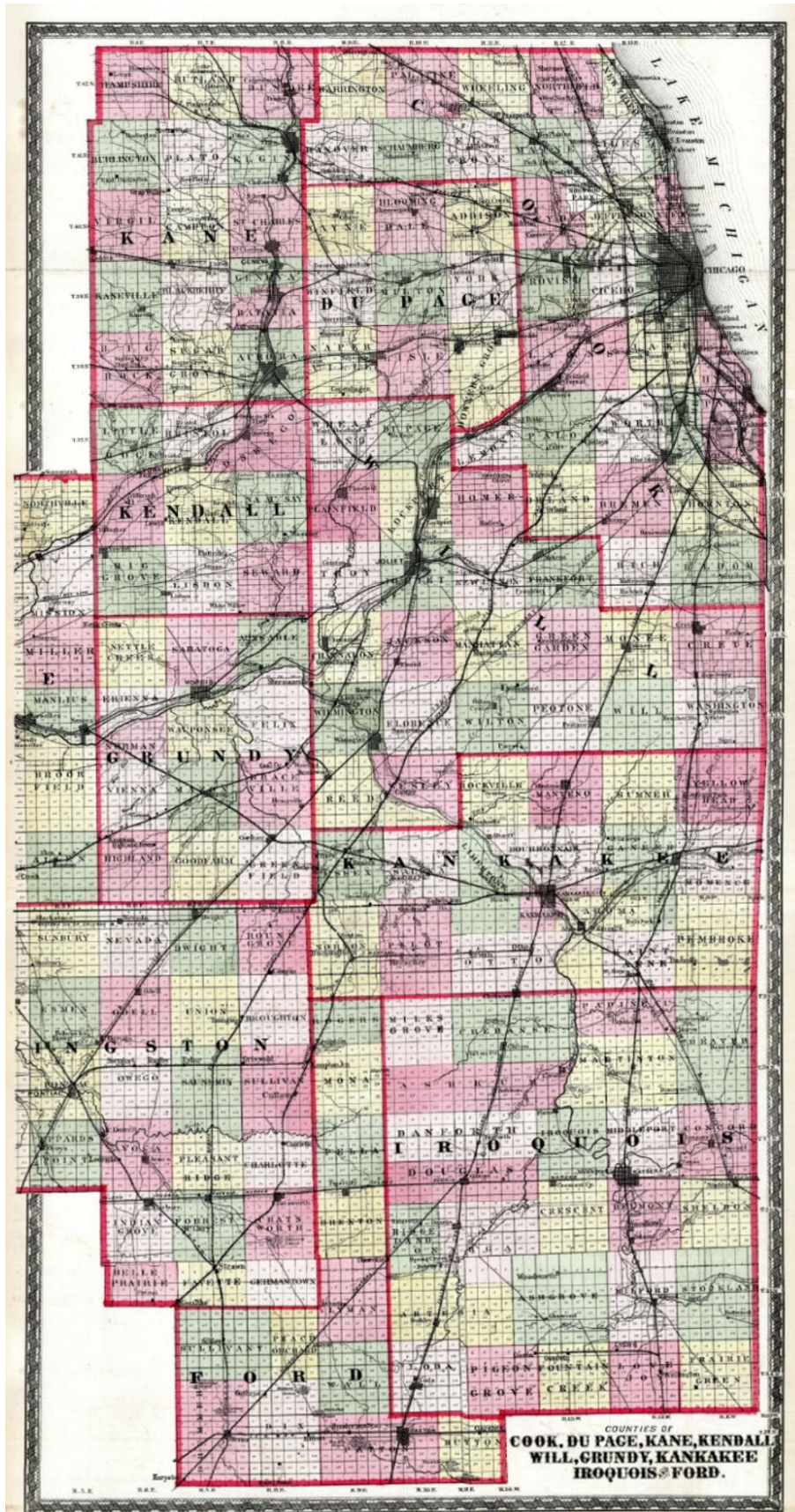


Figure 3.19. Northeast Illinois circa 1883 (Source: J. H. Beers & Co.)

3.5.2.2 Energy/environmental subsystem

Kankakee, like the other cities, is served by natural gas for heat. Electricity is generated largely by coal-burning power plants, like in Champaign-Urbana. The local utility for gas is the Northern Illinois Gas Co. (*nicor*), with electricity provided by Commonwealth Edison (ComEd), an Exelon company.

Environmentally, Kankakee’s locale like Champaign and most of Central Illinois is flat prairie. Most surrounding land is agricultural, with the main agricultural products corn and soybeans.

Central to Kankakee’s locale is the Kankakee River. Passing through the heart of town, it flows towards the northwest and ultimately joins the Des Plaines River to form the Illinois River, which is tributary to the Mississippi River. Just southeast of Kankakee, the tributary Iroquois River joins the Kankakee River. The river served as a historic magnet for industry and the City of Kankakee has largely grown around the railroad crossing of this river. A small dam is located in Kankakee parallel and adjacent to the Illinois Central railroad crossing. The Kankakee River State Park is located just northwest of Kankakee.

Kankakee’s Köppen Classification is also humid continental climate (Dfa). The listed elevation is 656 feet.

3.5.2.3 Land use subsystem

Like in Champaign-Urbana, Kankakee features a local MPO, since the Kankakee area is considered a metropolitan area by the United States government. This organization works with the City of Kankakee and neighboring towns to plan the area’s development. The Kankakee area is shown in Figure 3.20.

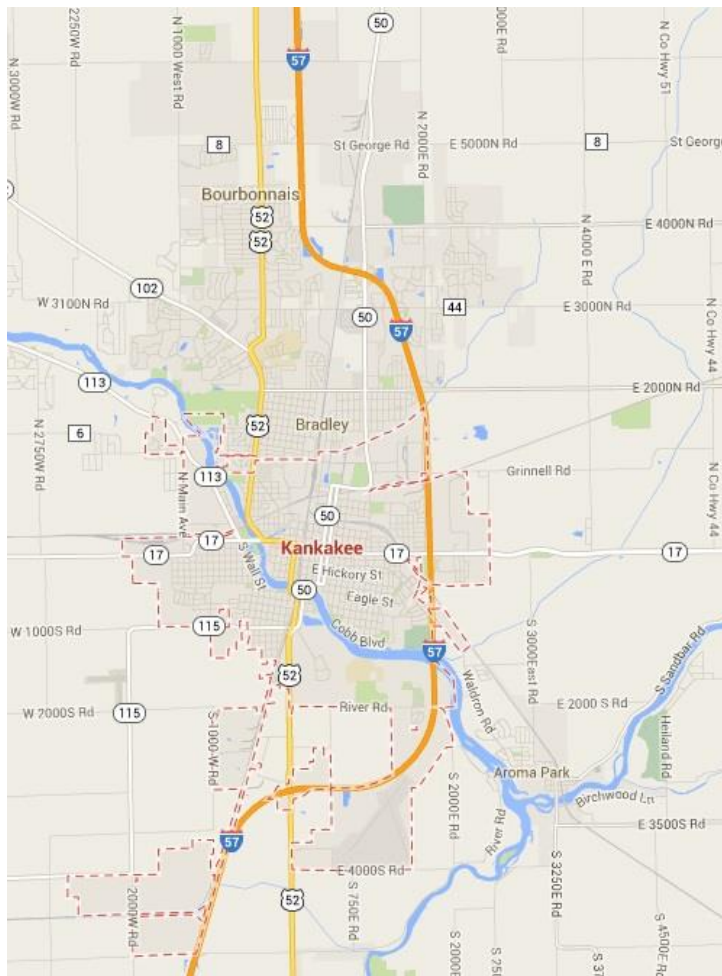


Figure 3.20. Kankakee and Vicinity (Source: Google)

Each local municipality has control over their own community. Suburbs or nearby communities of Kankakee include the Villages of Aroma Park, Bradley, and Bourbonnais, with Bradley and Bourbonnais each over 50% of Kankakee's size. It is worth noting that these neighboring bedroom communities are significantly less diverse than the City of Kankakee proper, and are where most recent housing development has occurred. They are also more sprawling. As in much of America, the development that has occurred in the past 40 years has been less dense than the historic Kankakee development. This has especially occurred in these communities like Bradley and Bourbonnais north of Kankakee.

Like most of the United States, Kankakee's organization and development is driven by its zoning and planning. The main local planning department, the Kankakee County Planning Department, is housed within the County government, which also functions as the local MPO. The City of Kankakee also has a Department of Planning and Zoning.

3.5.2.4 Economic activity subsystem

Kankakee's economy is broadly based. The main economic presences include manufacturing, light industry, healthcare, as well as some colleges. Various types of manufacturing, including agriculture and food manufacturing, metal, machinery and auto manufacturing, and miscellaneous manufacturing (i.e. biotech and plastics), are targeted industries for the community.¹⁵¹ Some such firms in the community are Fortune 500 firms.

Universities in the area include Olivet Nazarene University and the Kankakee Community College, a Christian private school in Bourbonnais and junior college in Kankakee, respectively. The main resource-based economic driver is also agriculture here, with almost all the land surrounding the community again devoted nearly entirely to agricultural use.

Another major employer is the healthcare industry. Kankakee is home to two hospitals, the Riverside Medical Center and the Provena Presence St. Mary's Hospital run by Presence Health. Additionally, it is home to a Cigna Healthcare clinic and the Shapiro Development Center, a state mental illness center.

The Kankakee metropolitan GDP is \$3.48 billion or \$30,674.58/capita.¹⁵²

3.5.2.5 Links in the Physical Domain

With matching subsystems, the linkages are similar to our prior cities even if the components making up these subsystems differ. To support its overall economic productivity, the city uses its transportation and land use subsystems, powered by the present energy and natural resources. As in Portugal and Champaign-Urbana, whether the economic activity provides a net benefit beyond the costs of the other supporting subsystems determines in large part whether Kankakee is successful.

3.5.3 Kankakee's Institutional Sphere

Here, as part of the CLIOS representation, we turn to describing the actors in the institutional sphere. As was the case for the physical domain, we have identified four institutional realms that have main influence on Kankakee. These institutional groups drive the cities' direction.

¹⁵¹ "Kankakee County Community Profile".

¹⁵² 2012 GDP (Source: U.S. Government Revenue)

3.5.3.1 Government

Kankakee is the county seat and center of Kankakee County in the State of Illinois. Here, Kankakee along with Bradley and Bourbonnais, are the main governmental influences along with the United States national government (federal), Illinois state government (state), and Kankakee County (regional).

The Kankakee Mayor is Nina Epstein (R), and again, the authority with most local control are the city governments, with both state and federal regulations affecting various policies.

The population of the Kankakee area is shown in Table 3.8, which shows relatively flat population in the city with moderate metropolitan growth.¹⁵³

Table 3.8. Kankakee Metropolitan Population (Source: U.S. Census Bureau, 2010)

| Population Statistics Kankakee Metropolitan Statistical Area | | | |
|---|-----------------|-----------------|-----------------|
| Municipality | 1990 Population | 2000 Population | 2010 Population |
| Kankakee | 27,575 | 27,491 | 27,537 |
| Total Metropolitan | | 103,833 | 113,449 |
| Illinois | 11,430,602 | 12,419,293 | 12,830,632 |
| USA | 248,709,873 | 281,421,906 | 307,745,538 |

3.5.3.2 Universities

As noted in the economic subsystem, the Kankakee area is home to two local universities. Olivet Nazarene University is an NCAA Division III private Christian school founded in 1907 by the Church of the Nazarene. It is home to nearly 5,000 students.

The other college in town is Kankakee Community College, a junior college that serves over 6,000 students located in southern Kankakee adjacent to the Kankakee River. Thus, between the two schools, there are more than 10,000 college students in the community.

3.5.3.3 Transportation

Most of the transportation influences in Kankakee come from outside the community. The local interstate highway is controlled by the Illinois Department of Transportation. They also control the other local major highways, US 45, US 52, IL 50, and IL 17. Local roads are managed by the municipality or County or Township. The City of Kankakee’s are managed within the City Engineer office and the County’s at the Kankakee County Highway Department.

Intercity rail travel is provided by Amtrak, again with the same three services—the City of New Orleans, the Illini Service, and the Saluki—providing access north and south as in Champaign. Intercity bus service by Greyhound provides approximately three daily trip options between Kankakee and Chicago or Champaign, with other regional destinations also frequented. The two main freight rail operators in the area are again CN and NS as the facility owners.

¹⁵³ “Census.gov”.

The local transit operator is the River Valley Metro Mass Transit District established in 1998. The small public bus system it operates carries nearly one million riders annually, and operates 12 daylong bus routes and three commuter ones.

The local airport, the Greater Kankakee Airport (IKK), provides general aviation service. It is owned and operated by the Kankakee Valley Airport Authority.

Local transportation planning efforts are led by the Kankakee County Planning Department, and specifically the Kankakee Area Transportation Study (KATS) that is the metropolitan area’s designated MPO.¹⁵⁴

3.5.3.4 Links from the Institutional Sphere

How do these institutional players impact and interact with the physical domain we have outlined? Again, links between institutional actors and various elements of the physical domain are classified as Class 2 links in the CLIOS framework. Figure 3.21 begins to paint that picture for Kankakee.

Kankakee’s Institutional Sphere Links

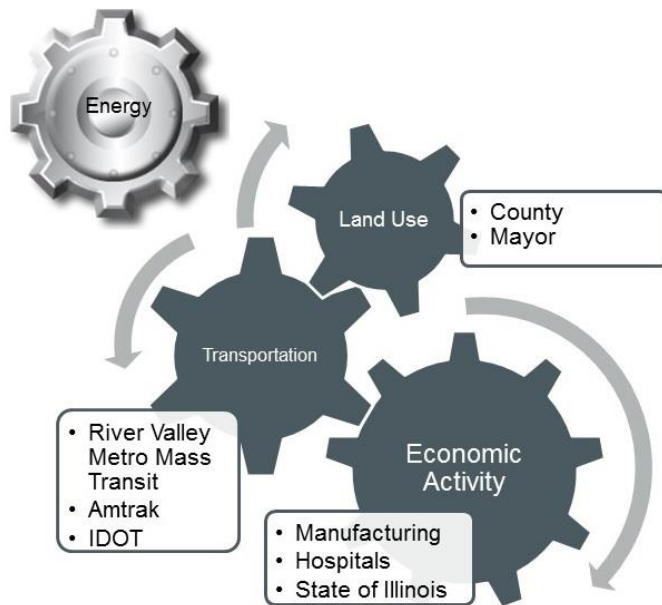


Figure 3.21. Kankakee's Institutional Sphere Links (Source: author)

Now we can see the total picture the CLIOS representation illustrates of Kankakee. The various physical domain subsystems that guide Kankakee are connected to the key institutional actors present in the community.

The crucial links present are noted, with various significant contributors to the transportation subsystem. The County, as well as the local authorities, interact directly with the land use subsystem. And the key local industries as well as the State directly and indirectly impact the economic activity exhibited by Kankakee. Crucially, we see that Kankakee’s success also relies on a cooperative effort between the City and County of Kankakee, its neighboring towns, and the State.

¹⁵⁴ "Transportation".

3.5.4 What is Kankakee?

Located almost exactly one hour or 60 miles from Chicago, Kankakee is a small regional city. Heavily influenced by the Chicago metropolitan region, the Kankakee area serves as the far outer limit for commuters to Chicago. Historically a river town, it is located at the original railroad and Kankakee River crossing.

Today, Kankakee is caught between its industrial past and its increasing residential spread into the neighboring villages. It faces challenges in revitalizing but also sports a solid manufacturing base, which is the major presence in its local economy. Largely blue collar, the potential to become a greater commuter residential home for Chicago and Champaign workers could significantly change the community.

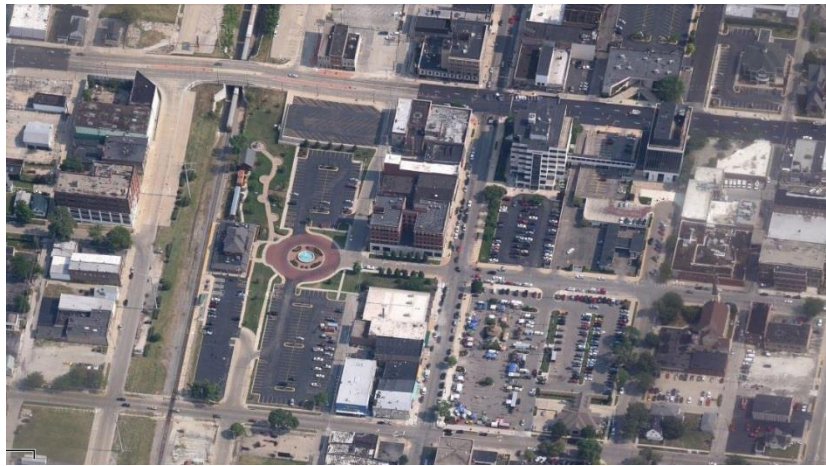


Figure 3.22. Kankakee at a glance (Source: Wikipedia; Google; Amtrak)

3.6 DERIVING UNDERSTANDING FROM THE CLIOS PROCESS

Having represented each subject city as a CLIOS system, we can turn to assessing what our representation indicates about these places. A complete CLIOS process would continue to identification of refinements that can be made in each represented system and ultimately implementation.

3.6.1 A Closer Look at the Subsystems

A closer look at the subsystems we have chosen to explore within each community will add greater depth to our exploration. In exploring the physical domains of each of our case cities, the following categories were identified:

- Physical domain
 - Transportation subsystem,
 - Energy / environmental subsystem,
 - Land use subsystem,
 - Economic activity subsystem.

Each of these subsystems were examined to help us further understand the physical domain in each of these places. Together they described best the cities being explored in the context of this research. But each of these subsystems is a collection of components and their links, which can be depicted graphically to further understanding.¹⁵⁵ Considering these components and links as we consider the subsystems' manifestations in each case community is valuable. Figures 3.23 through 3.26 outline generic CLIOS representations of these subsystems. All components may not be present in each of the case cities, but the links and feedback cycles within these dynamic systems can begin to be seen.

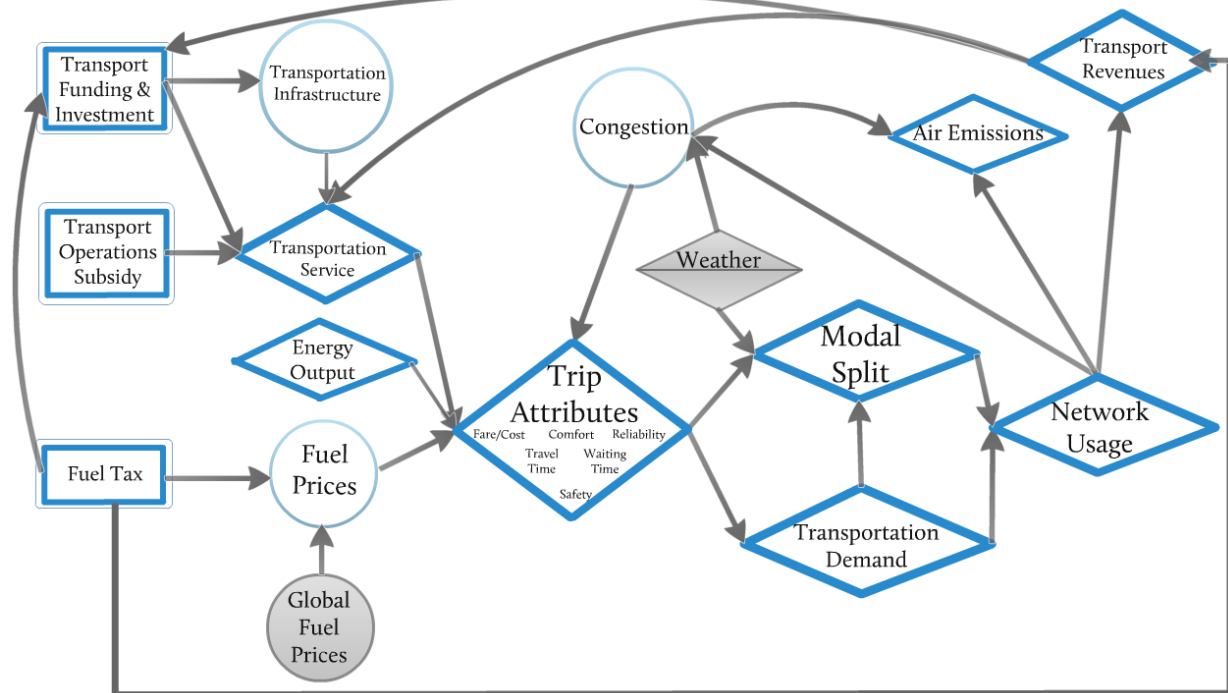


Figure 3.23. CLIOS Representation of the Transportation Subsystem (Source: Sussman et al, 2012)

¹⁵⁵ Sussman et al., *Transportation in the Northeast Corridor of the U.S.: A Multimodal and Intermodal Conceptual Framework*.

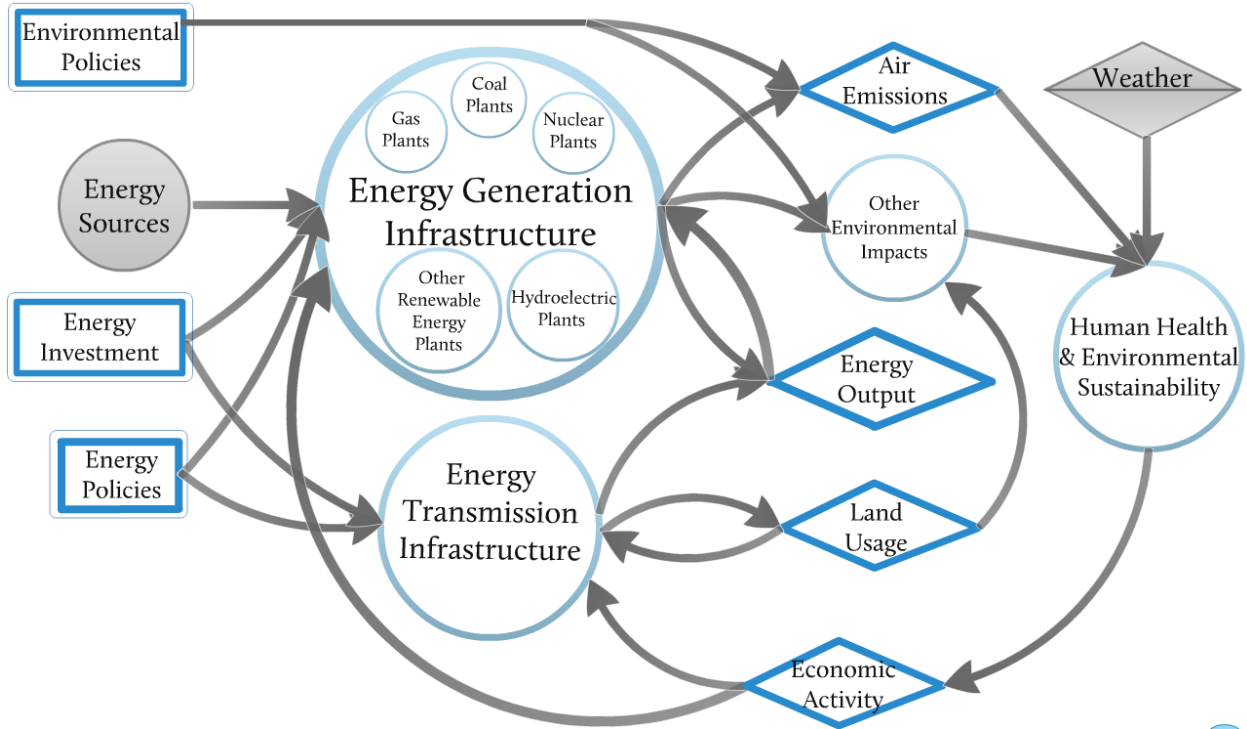


Figure 3.24. CLIOS Representation of the Energy/Environmental Subsystem (Source: Sussman et al, 2012)

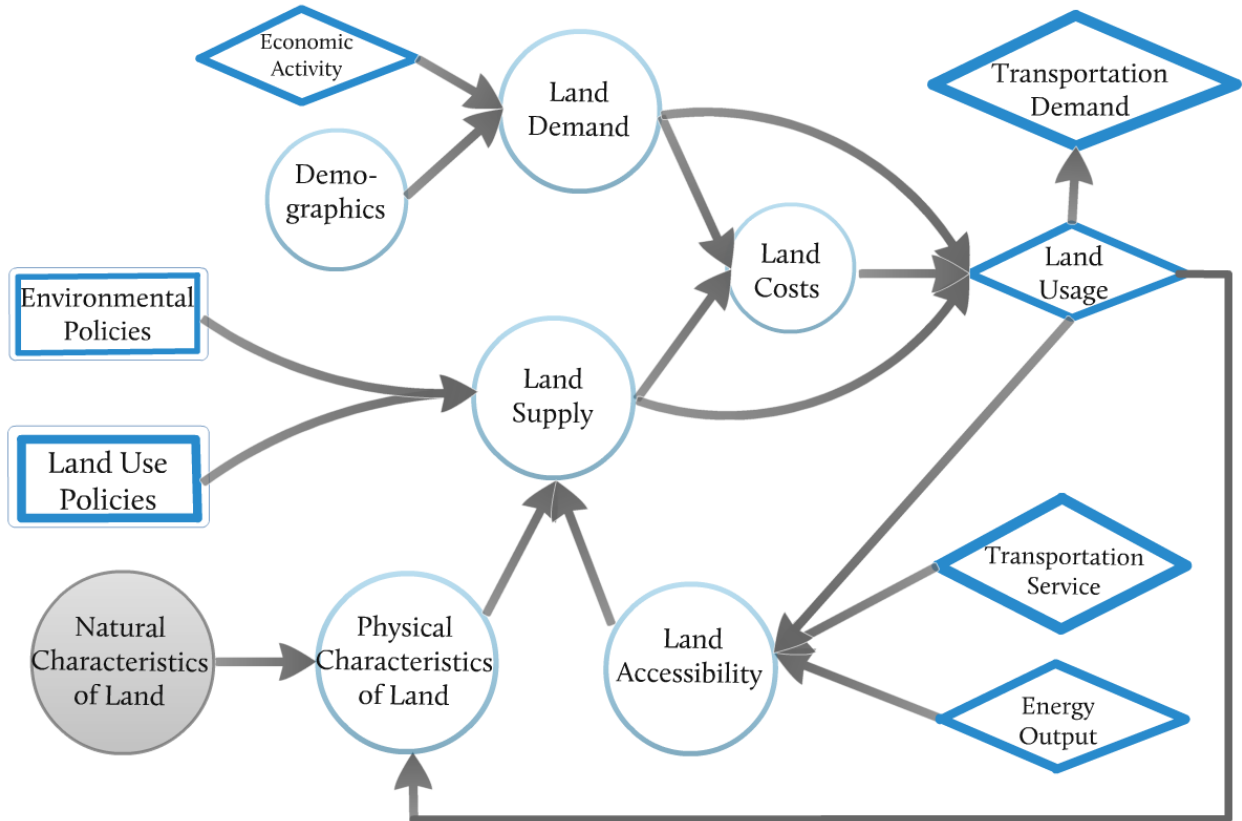


Figure 3.25. CLIOS Representation of the Land Use Subsystem (Source: Sussman et al, 2012)

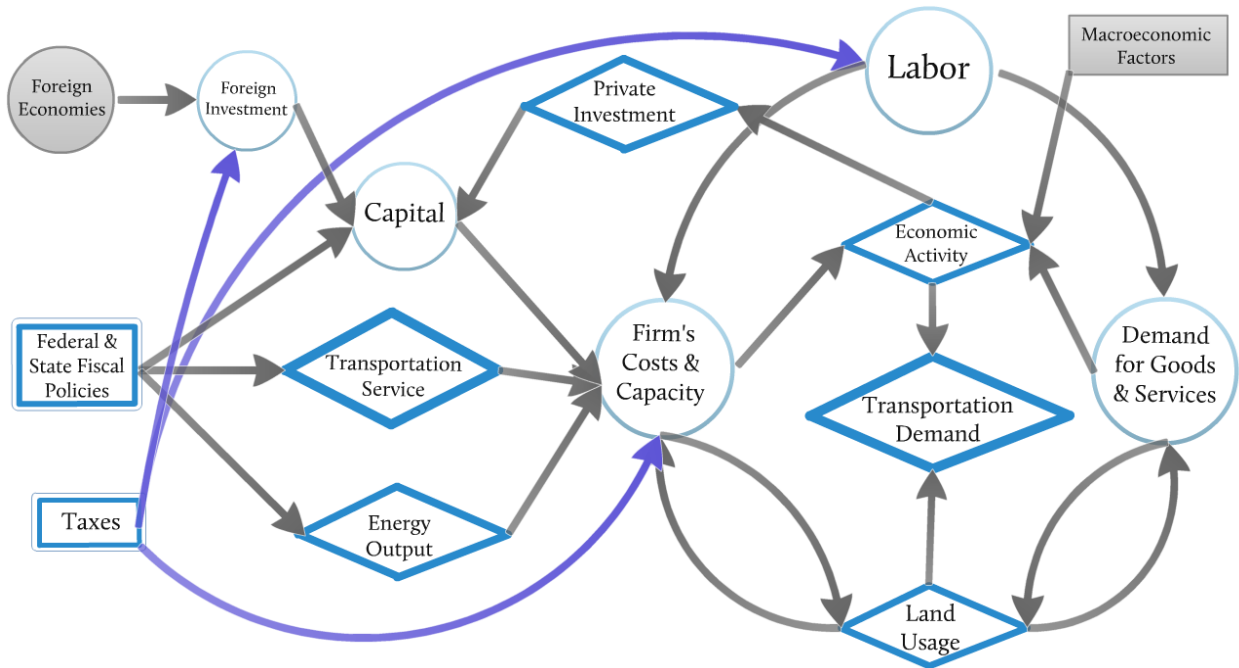


Figure 3.26. CLIOS Representation of the Economic Activity Subsystem (Source: Sussman et al, 2012)

3.6.2 Moving Forward

With the understanding we can glean from these representations, grasping how these cities functions becomes clearer. Our focus, however, will be in further describing what we glean from each city's underpinnings, especially in the realm of transportation, and then we will turn to evaluating the impact the addition of a HSR linkage may have on each city's systems. Now, in Chapter 4, we compare these cities and proposed systems. What similarities or other conclusions can we draw from the CLIOS representations we have completed, and what does that imply?

Chapter 4

4 COMPARATIVE ANALYSIS

What is the city but the people?

- William Shakespeare in *The Tragedy of Coriolanus*

4.1 COMPARING OUR SYSTEMS

With the broader background of our Portuguese and Illinois systems outlined, we can turn to a comparative analysis of these systems and our case communities therein. As highlighted, the Portuguese HSR proposal will run from Lisbon to Porto, passing through Leiria and Coimbra, which will move within the commuting region of Lisbon. The Illinois HSR proposal will run from Chicago to St. Louis (with a potential branch to Indianapolis), passing first through Kankakee and Champaign-Urbana, which will move within the commuting region of Chicago. What can we gauge in comparing these complex systems, and how will this affect the life of the people within?

4.1.1 Similarities

As we initially assess our case cities, we can see at first glance there is an uncanny similarity between the analogous Portugal and Illinois municipalities. In addition to all representing communities that will move within commuting time thresholds, the four cities are a similar distance from the metropolitan areas of Lisbon and Chicago and house comparable populations. In particular, Champaign-Urbana and Coimbra are an almost identical distance from the principal city in their region. Furthermore, there are striking parallels between the communities.

Both Coimbra and Champaign-Urbana are “university towns” that serve as an intellectual center and source of knowledge within their geography, and their populations are relatively similar as well. We see in both cases key intermediate cities with potential to be transformed by the proposed transportation upgrade.¹⁵⁶ Both feature relatively extensive local bus systems, and most of each community’s culture is heavily influenced by the major local university. In both cases, key industries include the universities, healthcare providers, and technology firms.¹⁵⁷ This combination leads to a culture of innovation and entrepreneurship. These are clear markers of the importance of the knowledge economy in both communities, and indication of the high proportion of white collar workers found in both.

Both Leiria and Kankakee are smaller communities more focused on light industry, and again with relatively similar distances from the urban centers of Lisbon and Chicago, respectively. As the HSR station stop before the larger nodes of Coimbra and Champaign-Urbana, they will face their own similar battles for relevance and profile. Both Leiria and Kankakee feature manufacturing as a main source of community support as well as also having smaller universities and healthcare centers. They are thus home to a higher proportion of blue collar workers than Coimbra and Champaign-Urbana. Both feature

¹⁵⁶ This appears to be especially true in Champaign-Urbana, which does not have existing higher-speed trains (as does Coimbra in the Alfa Pendular), and could serve as the pivot on a network between Chicago, St. Louis, and Indianapolis.

¹⁵⁷ Interestingly, these shared characteristics also sound a lot like Coimbra’s sister city, from which this research is originating, Cambridge, Massachusetts, which is a well-known center for computing and health technology.

a smaller bus system providing local mobility, but offer proportionally lesser service than their larger counterparts. Both are better connected via highway travel than on other modes to the major hubs of Lisbon and Chicago, respectively.

It turns out that both proposed HSR systems are creating very comparable linked city pairs, at similar distances from the major metropolitan hub from which the HSR extends. All these towns are ones that aspire to greater regional connectivity and networking beyond their own metropolitan area. As Stein observes about the Portuguese cities, “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.”¹⁵⁸ With these shared aspirations and the noticeable similarities amongst communities, it becomes clear that these analogous situations are a useful set of cases for comparing and contrasting effects from these two HSR proposals.

4.1.2 Differences

While there are apparent similarities between the subject communities, there are clearly a few differences as well, and these should be noted. Whereas Kankakee is basically equidistant between Chicago and Champaign, Leiria is closer to Coimbra than Lisbon and is further from Lisbon than Kankakee is from Chicago. It is also part of a somewhat more populous surrounding area, as all of Portugal’s hinterlands are denser than rural Illinois. Illinois and Portugal have similar overall populations, but a higher proportion of that population lives in Chicago than in Lisbon. Additionally, Chicago is considerably larger than Lisbon, and will thus be more influential. In corollary fashion, Coimbra and Leiria represent a larger proportion of population versus Lisbon than do Champaign-Urbana and Kankakee to Chicago. As well, the average incomes and city economic outputs are clearly higher in Illinois than in Portugal, a result of significant differences between the overall American and Portuguese economies. Tourism to Coimbra and, to a larger degree, Leiria is much more important than it is in Champaign-Urbana or Kankakee. At the same time, the University of Illinois¹⁵⁹ is significantly larger (approximately double the student population size) than the University of Coimbra.

Another difference is the differing station location planning in Portugal versus Illinois. On the Portuguese side, both proposed stations are new, one near downtown in Coimbra and one outside of town in Leiria. The stations in Illinois, on the other hand, will be at existing stations, which are both striking and functional depots. In Illinois, both are in the heart of downtown, requiring less need for adjacent new infrastructure, whereas in Portugal both station locations are reliant on new development to capitalize on proximity advantages.

The largest difference between the proposed systems may be, however, the current existence of the regional-quality HSR Alfa Pendular system in Portugal. In Illinois no such train system yet exists, and when the regional quality HSR under construction is completed in the next five years, it will travel along a separate route than through Kankakee and Champaign-Urbana.¹⁶⁰

¹⁵⁸ Stein, “Spatial Dimensions of High-Speed Rail”.

¹⁵⁹ The University of Illinois at Urbana-Champaign (UIUC) is the flagship institution and as such is colloquially called the University of Illinois. Additional branch campuses that exist include the University of Illinois at Chicago (UIC) and the University of Illinois at Springfield (UIS).

¹⁶⁰ Through Joliet and Bloomington-Normal to Springfield and St. Louis.

4.1.3 Other Considerations

Due at least in part to this difference in currently available existing modes, we see a significantly higher portion of existing intercity travel on the existing rail service between Coimbra and Lisbon than between Champaign-Urbana and Chicago. A further comparison of these existing intercity flows is worthwhile. Seeing how people move in existing conditions is an important input for comparisons.

Therefore, we have prepared an estimate of the existing volume of human movement between our subject cities. Filling out the daily behavior of the people in these communities helps complete the analysis of existing conditions. We can do this by estimating the number of people who move from community to community based on the data sources we have available. This provides us with an estimate of the existing volume of traffic by each mode, and also then allows us to consider the potential for success with a new proposed HSR system as an alternative mode of travel for these trips.

The daily trips to or from our subject cities by mode are shown in Table 4.1, within which each mode’s daily volume is included for each origin and destination.

Table 4.1. Daily Travel Volumes by Mode and Destination (Source: author, based on modal sources)

| Existing Travel Volumes (Daily) From ↓ To → | Champaign | | Kankakee | | Chicago | |
|--|-----------|-----|----------|-----|---------|-------|
| | Champaign | - | - | 293 | 6 | 7,167 |
| | - | - | 9 | 0 | 161 | 185 |
| Kankakee | 293 | 6 | - | - | 5,475 | 15 |
| | 9 | 0 | - | - | 21 | 0 |
| Chicago | 7,167 | 125 | 5,475 | 15 | - | - |
| | 161 | 185 | 22 | 0 | - | - |

| | |
|-------|-----|
| auto | bus |
| train | air |

| Existing Work Travel Volumes (Daily) From ↓ To → | Coimbra | | Leiria | | Lisbon | |
|---|---------|----|--------|-----|--------|-----|
| | Coimbra | - | - | 566 | 57 | 462 |
| | - | - | 20 | 0 | 170 | 0 |
| Leiria | 566 | 57 | - | - | 461 | 106 |
| | 20 | 0 | - | - | 25 | 0 |
| Lisbon | 462 | 56 | 461 | 106 | - | - |
| | 170 | 0 | 25 | 0 | - | - |

The total daily trips between each city pair are shown in Table 4.2.

Table 4.2. Existing Daily Travel Volumes (Source: author and 2001 Portugal Census)

| Existing Illinois | | Number of Daily |
|--------------------------|--|------------------------|
| Travel Volumes | | Trips |
| Champaign/Chicago | | 15,297 |
| Champaign/Kankakee | | 617 |
| Chicago/Kankakee | | 11,023 |

| Existing Portugal | Number of Daily | Approximate Total |
|--------------------------|--------------------------|--------------------------|
| Travel Volumes | Work/School Trips | Daily Trips |
| Coimbra/Lisbon | 1,376 | 13,760 |
| Coimbra/Leiria | 1,286 | 12,860 |
| Lisbon/Leiria | 1,184 | 11,840 |

First we will focus on Portugal. Here, the data is based on responses to the national census. This census, taken every ten years and most recently in 2011, provides information on commuting trips only, and includes destination and mode.¹⁶¹ This data gives an indication of a magnitude and modal preferences from which we can approximate total daily trips. To estimate the overall daily trips, we use the rule of thumb that approximately 10% of travel occurs during the peak hours. Thus, perhaps a very rough estimate of the total daily trips puts them about ten times higher than the commuting trips. Here we see that travel between Coimbra and Lisbon is more common than between Coimbra and Leiria, and those traveling from Coimbra are slightly more likely to go to Lisbon. However, for those traveling from Lisbon, they are slightly more likely to go to Leiria. It must again be observed that these trips are for work or school purposes only, and thus the distance between cities is an important determinant on trip frequency. Nonetheless, it seems clear that travel to/from Leiria is more common than expected by its relative size. The auto is the clear mode of choice, but both bus and train carry a moderate proportion of people. Figure 4.1 shows the modal preferences for these Portuguese travelers.

In Illinois, the modal choice is clearly heavily dominated by car. The mode of choice is shown in Figure 4.2 for these itinerants, and the significantly higher share autos carry than in Portugal is clearly seen. For Illinois, the source for data was more varied, with each mode separate. For highway travel, Average Daily Traffic (ADT) information from the Illinois Department of Transportation was used.¹⁶² For rail travel, data on station ingress and egress volumes from Amtrak were used.¹⁶³ For air, data from the United States Bureau of Transportation Statistics was used.¹⁶⁴ And for bus, the number of available daily bus routes was determined, and an estimate of their typical daily load was made. For both highway and rail volumes, the available data was distributed to the appropriate location on the network and summed to come up with a daily volume total. Thus, we see that the vast majority of trips pass to and from Chicago. There are significantly fewer trips between Champaign-Urbana and Kankakee.

¹⁶¹ "Instituto Nacional de Estatística, Censos 2011".

¹⁶² "Illinois Travel Statistics".

¹⁶³ Obtained from Amtrak and included as Appendix C.

¹⁶⁴ "Passengers All Carriers - Champaign/Urbana, IL: University of Illinois/Willard".

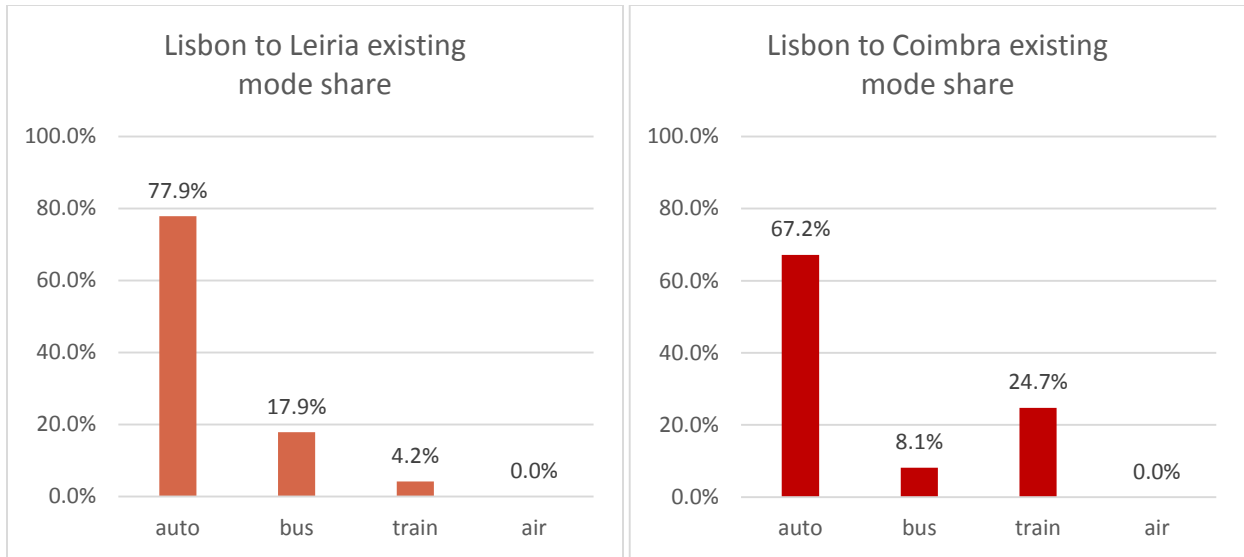


Figure 4.1. Lisbon to Leiria and Coimbra existing mode shares (Source: 2001 Portugal Census)

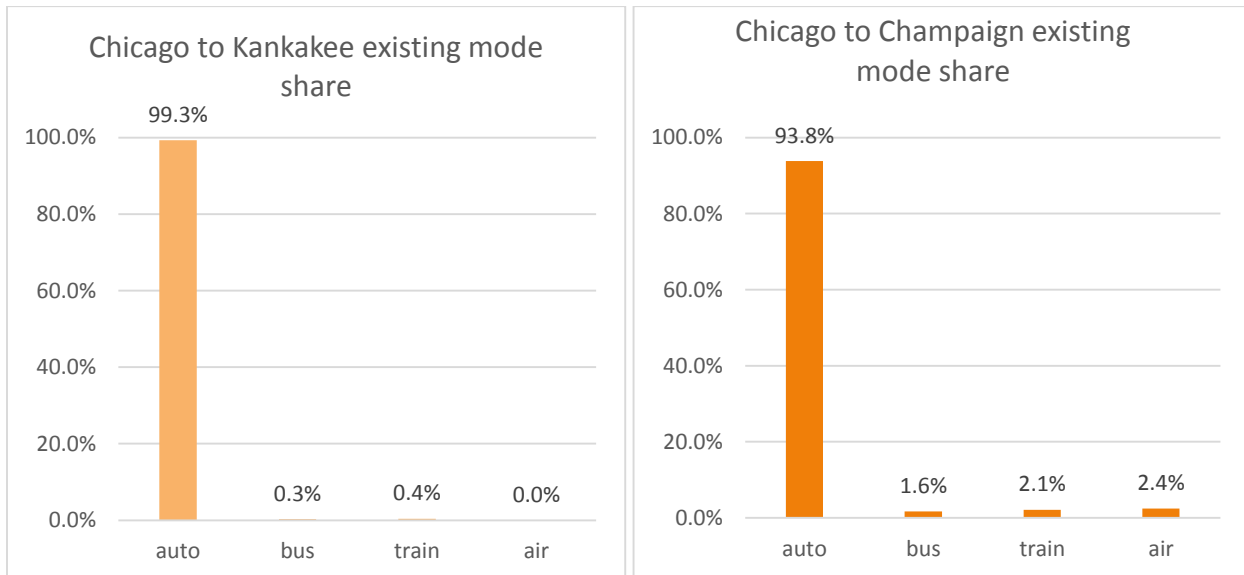


Figure 4.2. Chicago to Kankakee and Champaign existing mode shares (Source: author, based on data from modal sources)

These daily trips can then also be compared to the projected HSR ridership to determine approximately what proportion of future trips the developing agencies are anticipating. First, each city pair’s daily trips are aggregated to gain a volume of daily trips, as shown in Table 4.2 Then, based on projections from each geography^{165 166}, the anticipated annual volume of HSR passengers can be tabulated.¹⁶⁷ Table 4.3 highlights these volumes.

¹⁶⁵ Steer Davies Gleave, *Análise Custo – Benefício Da Ligação Em Alta Velocidade Ferroviária Da Ligação Lisboa – Porto*.

¹⁶⁶ University of Illinois at Urbana-Champaign and University of Illinois at Chicago, *220 MPH High Speed Rail Preliminary Feasibility Study Executive Report*.

¹⁶⁷ Projections were taken from a 2009 Steer Davies Gleave report on the Portuguese system and a 2013 University of Illinois report on the Illinois system, as cited above.

Table 4.3. Projected Annual HSR Ridership (Source: University of Illinois, 2013 and Steer Davies Gleave, 2009)

| Proposed HSR Volumes (Annual) To → From ↓ | St. Louis | Champaign | Kankakee | Chicago |
|--|-----------|-----------|----------|-----------|
| St. Louis | - | 73,000 | 46,000 | 1,171,000 |
| Champaign | 73,000 | - | 6,000 | 365,000 |
| Kankakee | 46,000 | 6,000 | - | 10,000 |
| Chicago | 1,171,000 | 365,000 | 10,000 | - |

| Proposed HSR Volumes (Annual) To → From ↓ | Porto | Coimbra | Leiria | Lisbon |
|--|-----------|---------|---------|-----------|
| Porto | - | 558,441 | 199,745 | 3,893,558 |
| Coimbra | 558,441 | - | 481,906 | 700,751 |
| Leiria | 199,745 | 481,906 | - | 998,038 |
| Lisbon | 3,893,558 | 700,751 | 998,038 | - |

Based on these projections, the anticipated daily HSR riders can be established and compared to the overall daily travel volumes. Table 4.4 provides these values.

Table 4.4. Projected Daily HSR Volumes (Source: author, based on the projected annual volumes)

| Proposed Illinois Travel Volumes Between: | Daily By HSR | % of Daily Trips |
|--|---------------------|-------------------------|
| Champaign/Chicago | 2,000 | 13.1% |
| Champaign/Kankakee | 33 | 5.3% |
| Kankakee/Chicago | 55 | 0.5% |
| Proposed Portugal Travel Volumes Between: | | |
| | Daily By HSR | % of Daily Trips |
| Coimbra/Lisbon | 3,840 | 27.9% |
| Coimbra/Leiria | 2,641 | 20.5% |
| Leiria/Lisbon | 5,469 | 46.2% |

One can quickly see that the Portuguese projections are far more substantial. The veracity of these totals may be a concern.¹⁶⁸ There are several items that seem surprising on the Portuguese side, but one that stands out is the sizable projection for the Lisbon to/from Leiria trip. Additionally, we see on the Illinois side that the route anticipated to be most preferred by forecasters is the Champaign to/from Chicago link. Whereas the Kankakee trips are relatively nonexistent.

In essence, we see that, despite very similar cities, the two proposed systems are projecting drastically different volumes of ridership. This can perhaps be explained in part by the higher willingness to ride by rail already exhibited in Portugal, but a large portion of the forecast difference may point to overly

¹⁶⁸ These volumes may not even be possible depending on the train set and frequency ultimately proposed. But consider that 16 trains a day carrying on average 400 people carries only 6,400 people.

optimistic projections in Portugal. Significant further analysis could be completed assessing the reasonableness and reliability of these forecasts, but for the purposes of this thesis, the numbers are presented, and we move to additional analysis.

4.2 CONSIDERING CAPITAL

A useful perspective to consider the effects of HSR on these communities may be in consideration of the impacts on each community's available capital. Past literature has outlined how sustainable development can be focused to improve a community's stock of capital—or resources that enhance residents' potential to perform economically useful work.¹⁶⁹ Typically, description of capital involves categorizing these resources into several categories. There have been various such categorizations, many pointing back to a seminal World Bank report¹⁷⁰ on making development sustainable, but a consistent list of capital emerges as including five types¹⁷¹: financial, natural, produced, human, and social.¹⁷² This key economic compilation allows us to assess various aspects of each affected community's local economy, as well as the overall regional effects.

The key to our assessment thus becomes whether the potential development, in our case two potential significant HSR projects, maintains or improves the stock of capital in each category. To what extent are they contributing to quality of life growth? Successful economic development, which must consider various project aspects, requires the maintenance of all types of capital to do this sustainably.¹⁷³ Examination of each kind of capital provides insights.¹⁷⁴

- **Financial Capital**
Financial capital is the monetary basis for economic production. Owners use their monetary resources to invest in inputs in order to produce outputs and thus more return. In other words, "You must spend money to make money."¹⁷⁵
- **Natural Capital**
Natural capital includes all the natural resources and environmental elements of the natural world. These resources are vital inputs in producing the amenities of our world, as well as providing sustenance for its inhabitants.
- **Produced Capital**
Produced capital is comprised of the community's physical assets, including infrastructure, which are created via human production. Often derived via the other kinds of capital, these built forms include the important networks of human life such as roads and communication links, as well as factories, homes, and machines. Overall, the built environment includes land use patterns, the transportation system, and design features.¹⁷⁶ These can then in turn be used to produce further produced capital.

¹⁶⁹ Roos et al., *Intellectual Capital*.

¹⁷⁰ Serageldin and Steer, *Making Development Sustainable: From Concepts to Action*.

¹⁷¹ Goodwin, *Five Kinds of Capital*.

¹⁷² Other categories sometimes used include intellectual, organizational, physical, and political.

¹⁷³ Adams and VanDrasek, *Transportation as Catalyst for Community Economic Development*.

¹⁷⁴ Drawing primarily from Goodwin, *Five Kinds of Capital*.

¹⁷⁵ This aphorism is originally attributed to Titus Maccius Plautus in the era of the Roman Empire around 200 BC.

¹⁷⁶ *Driving and the Built Environment*.

- **Human Capital**

Human capital refers to the personal capabilities of each person, including their intellectual prowess as well as acquired skills and abilities via education and training. These capabilities provide the labor necessary to develop productive activities, and increase productivity and entrepreneurship.¹⁷⁷

- **Social Capital**

Social capital consists of the societally-shared values and knowledge, which provide common trust and mutual understanding. Through these societal characteristics, cooperation is encouraged among people, allowing collaboration in reaching a common goal.

These types clearly fall into some of the physical domain and institutional categories outlined in Chapter 3. With understanding of these kinds of capital, we can turn to a full assessment of how the communities of Coimbra, Leiria, Champaign-Urbana, and Kankakee may be affected. Next, we move past comparisons to qualitative and quantitative evaluations of how the cities and regions may be altered by the proposed HSR systems.

4.2.1 Capital Transformation

The prior section discusses the various forms of capital a city can have. These attributes combine to make the city as attractive or unattractive as it is to prospective businesses or residents. We now examine the extent to which the proposed HSR lines can transform the capital offerings of each community in positive ways that increase their attractiveness. There are various ways that the proposed projects will produce these affects, and here we examine these and as well methods for their measurement.

Much of this effect is due to the increased opportunity for commutable work by parties in the cities linked along the HSR route. This linking of economic centers is fundamental to the exploration of HSR effects we are going to examine. And much of this results from residents, workers, and employers in the intermediate cities gaining access to the large metropolitan centers found at the HSR hubs. While past innovations have reduced the price of freight, moving people remains relatively expensive.¹⁷⁸ As we consider the benefits of agglomeration we have discussed previously, we can quickly see that access to centers of agglomeration is key for people hoping to tap into such engines of productivity. And the change in this access enabled by HSR is exactly what we would endeavor to elaborate on. Such accessibility will in turn provide produced, human, and perhaps financial and social capital transformation. As the ongoing digital revolution continues to reshape society, the importance of agglomeration is growing for the rapidly expanding “knowledge worker”¹⁷⁹ sector. The associated increases in productivity depend not only on physical capital and human effort, but also intangible capital such as individual and social knowledge, skills, and habits and behaviors designed for efficient deployment.¹⁸⁰ A rapid connection into the heart of such a knowledge-based economy would allow a previous outsider access to just these capital components.¹⁸¹ HSR can provide this opportunity whereas other modes cannot. Air, for instance, delivers its passengers to the outskirts of the city such that the

¹⁷⁷ Glaeser, Ponzetto, and Tobio, *Cities, Skills, and Regional Change*.

¹⁷⁸ Glaeser and Kohlhase, *Cities, Regions and the Decline of Transport Costs*.

¹⁷⁹ First coined by Peter Drucker, they are defined by Goodwin (2003) as: “...people whose jobs consist largely of processing and applying, and sometimes creating, knowledge and facts about the social and physical world...”

¹⁸⁰ Goodwin, *Five Kinds of Capital*.

¹⁸¹ Melo et al., *Agglomeration, Accessibility, and Productivity*.

time spent commuting to and from the airport eats up any travel time gains for trips up to approximately the 500 miles cited in Section 1.2.

These links between transport and economy have been well-documented in the literature, which shows the potential for transportation improvements leading to “market expansion, gains from trade, technological shifts, processes of spatial agglomeration and processes of innovation and commercialization of new knowledge in urban clusters.”¹⁸² These impacts are felt at various scales, necessitating a multilevel analysis.¹⁸³ Regional network effects with output and productivity changes play out at a macroeconomic (or megaregional and megapolitan) level. Agglomeration economies and labor market effects along with sub-regional network and environmental consequences act at a meso (or metropolitan) level. And local land and property market effects are felt at the micro (or city) level.¹⁸⁴ And it is just these three tiers of effects we aim to examine more closely.

4.3 METROPOLITAN AND REGIONAL EFFECTS

These metropolitan and regional effects can be outlined based on the geographic time-space transformation and its resulting impacts on the center city, newly connected outlying ones, and the region as a whole. In Section 2.3, we explored the metropolitan influences a region feels. Using this framework—within which a center city acts on outlying ones, the outlying ones act on the center city, or the outlying cities act on each other—we will explore the multilevel effects HSR has on these influences.

4.3.1 Center City to Outlying Ones

The main influence is that of the central city to now-connected outlying ones. The access gained by these outlying cities is substantial, and this access is created by a new transportation linkage. Past literature indicates that added high-speed rail access “increases market potential and thus, market integration, the most for the secondary cities close to [large cities]”.¹⁸⁵ This has resulted in shifting and broadening labor markets¹⁸⁶ and job growth¹⁸⁷, increased business productivity or expanded markets¹⁸⁸, changing population distribution¹⁸⁹ and commuting shifts¹⁹⁰, or real estate price increases¹⁹¹. The largest effects originate from the center metropolitan core and extend to the connected outlying cities, due to the magnitude of these principal places. As described in Chapter 2, these types of impacts have historically brought evolution to the metropolitan form, which is an impact worth assessing further.

4.3.1.1 Metropolitan Form

HSR is expected to bring additional outlying areas into closer contact with the central city. As we saw in Figure 1.2, this manifests itself in an expanded commuter shed. Real physical transformations can be expected to match this expanding zone, resulting from the new network brought by these HSR systems.

¹⁸² Lakshmanan, “The Broader Economic Consequences of Transport Infrastructure Investments”.

¹⁸³ Ureña, Menerault, and Garmendia, “The High-Speed Rail Challenge for Big Intermediate Cities”.

¹⁸⁴ Banister and Thurstain-Goodwin, “Quantification of the Non-Transport Benefits Resulting from Rail Investment”.

¹⁸⁵ Zheng and Kahn, “China’s Bullet Trains Facilitate Market Integration and Mitigate the Cost of Megacity Growth”.

¹⁸⁶ Haynes, “Labor Markets and Regional Transportation Improvements”.

¹⁸⁷ Loukaitou-Sideris et al., “Tracks to Change or Mixed Signals?”.

¹⁸⁸ *The Economic Impacts of High-Speed Rail on Cities and Their Metropolitan Areas*.

¹⁸⁹ Stanke, “High Speed Rail’s Effect on Population Distribution in Secondary Urban Areas”.

¹⁹⁰ Elhorst and Oosterhaven, *Effects of Transport Improvements on Commuting and Residential Choice*.

¹⁹¹ Zheng and Kahn, “China’s Bullet Trains Facilitate Market Integration and Mitigate the Cost of Megacity Growth”.

This expanded commuting region for the metropolitan area will lead to a spatial restructuring, by which the region's space will be shifted by the travel time along the HSR spokes. Past literature has observed that this time-space transformation in effect creates "a different social and economic space"¹⁹² within which the HSR travel has "significantly altered economic geography".¹⁹³ This phenomenon, shown in Figure 4.3, whereby outlying cities will become closely connected into the center metropolis while unconnected in between areas are passed over has been coined a *discontinuous region*.¹⁹⁴ Cities on the HSR line are brought closer together while bypassed areas don't see the same benefit, which may also serve to counteract sprawl as development focuses around the connected locations.

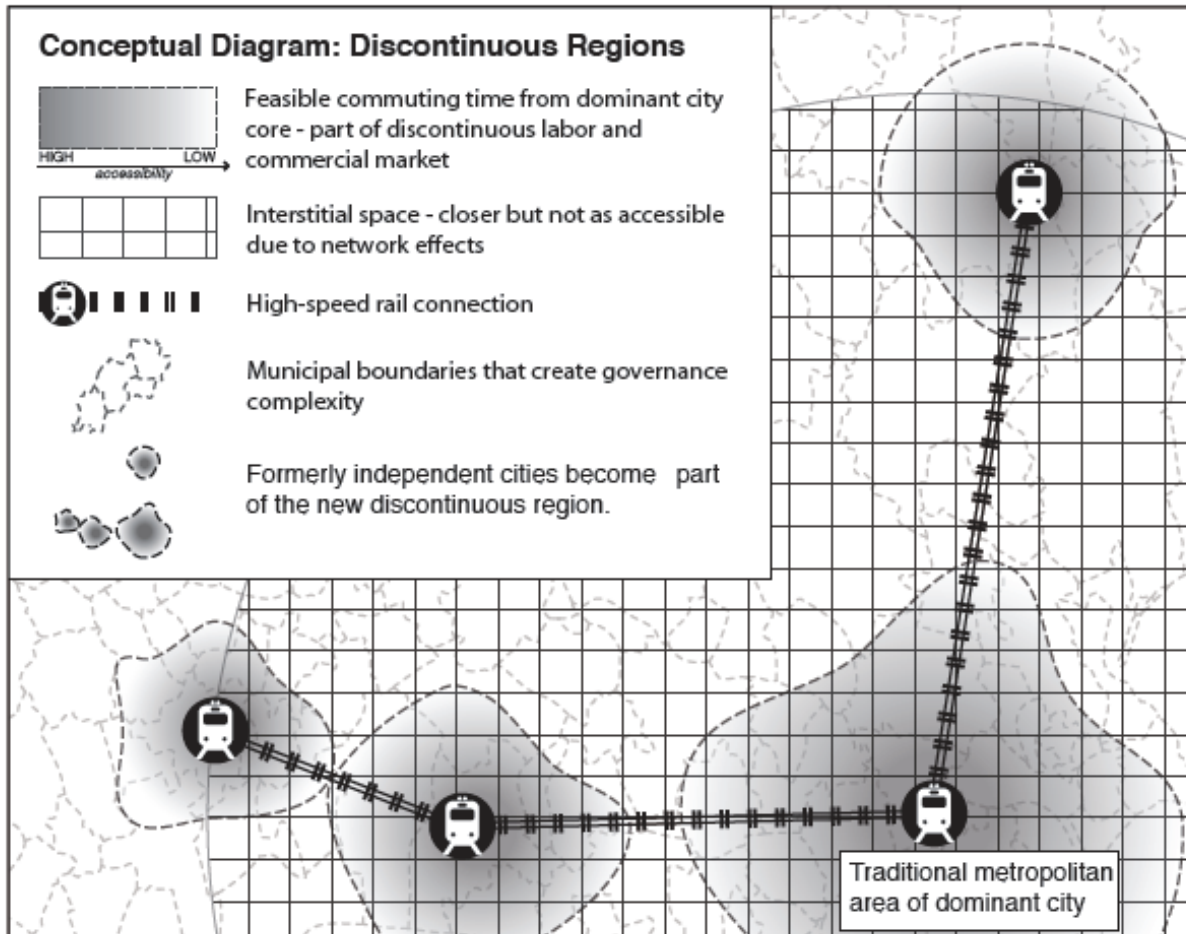


Figure 4.3. *Discontinuous Regions* (Source: Stein, 2013)

Thus, we see the resulting physical transformations as impacting the connected principal metropolitan area as well as corollary changes at the intermediate city level and in the region as a whole. The alterations to the feasible commuter shed can be clearly seen. Hence, the economic effects are especially felt in those connected areas newly within reach of the principal city, and effects are especially present with HSR due to its direct city center to city center trips.

¹⁹² Givoni, "Development and Impact of the Modern High-Speed Train: A Review".

¹⁹³ Chen and Hall, "The Impacts of High-Speed Trains on British Economic Geography".

¹⁹⁴ Stein, "Spatial Dimensions of High-Speed Rail".

Stein observes:

*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.*¹⁹⁵

The metropolitan center thus grows not contiguously, but in leaps along transportation networks. And it appears the positive externalities from the urban center are dispersed along these transport lines.¹⁹⁶ These effects may lead to corporate and residential clustering at these nodes, all reliant on a now shortened access time to the center of the metropolis. Together, these nodes are propelled further towards functioning as polycentric nexuses comprising the region as a whole, which more than ever relies on the transport link that now connects its major centers of economy. These trends in growth repeat patterns we have observed throughout history, as described in Chapter 1.¹⁹⁷ But it seems clear HSR is again shifting the metropolitan form. The extent those resulting from HSR can be differentiated, perhaps due to their longer geographic length, becomes an important query.

4.3.1.1.1 21st Century Garden Cities?

In some respects, this discontinuous regional form hearkens back to a much earlier urban concept. Near the end of the 19th century, Ebenezer Howard outlined his version of optimal urban development form. Calling his concept a *garden city*, he envisioned central cities surrounded by a greenbelt, connected by rail with outlying cities.¹⁹⁸ This network of connected cities would function as a garden city-based metropolitan area. Despite its potential promise, "...the garden suburb had a short-lived history in the U.S., where it was nudged aside by the automobile in favor of today's cul-de-sac plus strip-mall-plus-highway-interchange model of conventional suburban sprawl that covers most of our landscape."¹⁹⁹

HSR, however, could naturally lead to new opportunities for creation of emerging centers in the notion of the garden cities movement, as shown in Figure 4.4. One envisions neighborhood clusters of density around local HSR stations, with the overall city form bowing to the center of density around the historic downtown area and the new HSR stations. Even further, consideration for greenbelts around these clusters could help control sprawling growth not conducive to the city lifestyle sought. This sounds like the sort of growth several of the case communities have discussed in seeking to capitalize on HSR development. Coimbra,

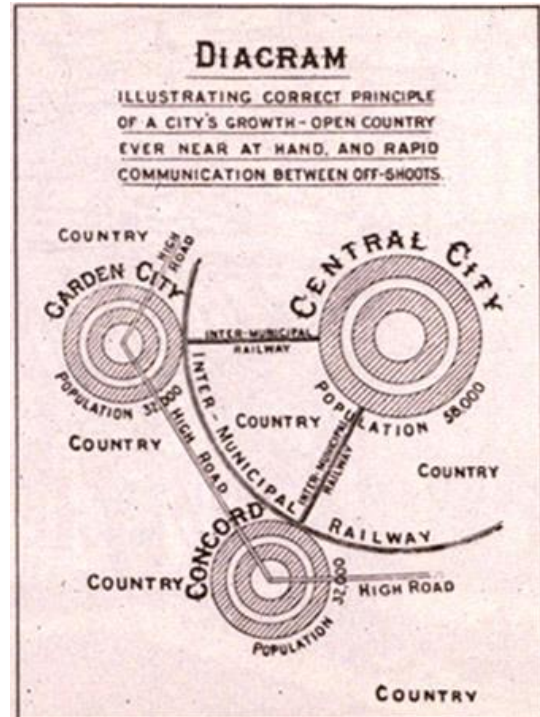


Figure 4.4. Garden Cities (Source: Howard, 1902)

¹⁹⁵ Ibid.

¹⁹⁶ Graham and Melo, "Assessment of Wider Economic Impacts of High-Speed Rail for Great Britain".

¹⁹⁷ Muller, "Chapter 3: Transportation and Urban Form".

¹⁹⁸ Howard, *Garden Cities of To-Morrow*.

¹⁹⁹ Gallagher, "Paradise Lost? How Garden Suburbs Can Save Detroit".

for instance, has developed a concurrent plan for urbanization around the proposed new HSR station. But this also emphasizes the importance of station location. A city center station will be much more strongly suited to perpetuate this developmental approach.

This garden city movement from over a century ago noticeably exhibits unique characteristics similar to current thinking on urban development best practices of the 21st century. Key to such development, of course, are other related urban design concepts.

4.3.1.1.2 Transit-Oriented Development

Attempts to capitalize on the high access provided at transit stations have been commonplace across urban areas. Mixed-use higher density development in proximity to transit stations or intermodal transfer facilities has been dubbed *transit-oriented development* (TOD). As we consider the linkages a HSR system will have, this style of development fits, especially for those HSR stations located within the commuting region of a central city. The greater the density of development adjacent to such stations, the more people who have direct access to the mobility the HSR network provides. In the cases of our case cities, the potential for such development is clear. When the HSR station proposed is located within or adjacent to an existing downtown (e.g. Coimbra, Champaign, and Kankakee), some of this density is already naturally present. In all cases, additional development can be added. But in cases where the station is located at the edge of town (e.g. Leiria), dual centers of density may develop. And additionally, fewer existing local residents may be able to take advantage of the development in that scenario.

TOD provides additional benefits beyond greater mobility for nearby residents. Such communities also reduce the amount of driving some residents undertake, since they use transit in lieu of driving more frequently.²⁰⁰ Freight deliveries can be streamlined, and mixed uses joined well. This leads to positive environmental externalities, and often to reduced costs for transport. The desirability of such places shows in the declining rent gradient as one moves away from transit stations.²⁰¹

Historically, prior to automobiles, most cities naturally developed in this fashion. Clusters of development formed around transit stations, with growth occurring along the transportation networks. Throughout history, the pattern of metropolitan development has been heavily influenced by mass migrations of people to cities and ongoing changes in technology—especially for transportation. To some extent, as was discussed in Chapter 2, the automobile was just another such technological advance, for which the effect on metropolitan form was large. However, many practitioners have begun to recognize more the vitality that prior transit cluster development provided. As has been shown, the higher densities and urban form in these types of places provide additional benefit to dwellers and their cities. Thus, a movement to regain these past design best practices has developed.

4.3.1.1.3 New Urbanism

The desire to bring back the urban form of yesteryear has led to the rise of an urban planning movement described as *new urbanism*. The goal of this movement is to return new development to the historic urban form prior to the advent of auto-oriented development, and has been brought to public attention by the formation of the Congress for the New Urbanism founded in 1993. Adherents seek to encourage walkable mixed-use neighborhoods with a range of housing and business types. It embraces principles of TOD and sometimes is more broadly connoted by the term *smart growth*. The Smart Growth movement

²⁰⁰ Renne and Ewing, *Transit-Oriented Development: An Examination of America's Transit Precincts in 2000 & 2010*.

²⁰¹ Bartholomew and Ewing, "Hedonic Price Effects of Pedestrian- and Transit-Oriented Development".

grew to prominence in the late 1990s, and advocates improved urban planning. At the core of these urban design considerations is an aim to prevent development form seen as inefficient and mistaken, with a return to design principles shown to be successful over centuries of urban development.

It seems possible for our subject cities to begin learning from mistakes others have made. By leapfrogging²⁰² developmental eras that are harmful, they can potentially move directly into the future of transportation and land use best practice, avoiding environmentally, economically, or socially harmful stages of development by not following the development trajectory others, including much of the United States, have. Thinking back to the eras of development²⁰³ perspective, there is relevance for our cities today. As outlined in Chapter 2, most metropolitan areas have experienced spreading growth in the automobile era. Furthermore, the evolution in neighborhood form through that time as well, from traditional to grid to suburban, matches a move through those eras. But the future can be different. Now, why couldn't cities with a new HSR linkage, taking hints from these planning movements, move quickly past the freeway and cul-de-sac era, to the 21st century era of urban revitalization?

4.3.2 Outlying Cities to Center One

Just as the central city will have effects on outlying ones, perhaps in the form of metropolitan expansion, the outlying ones will have related impacts on the central city. One can expect that these will be smaller in magnitude due to the typically differing sizes, but nonetheless, they are present. And part of this effect is related to the annexation into the central city metropolitan area via a new discontinuous linkage such as HSR offers. We can posit that these outlying cities could become new urban clusters at the fringe of the central metropolitan area, continuing to drive the overall region towards a more polycentric composition, as discussed previously in Section 2.2 and shown in Figure 4.5.

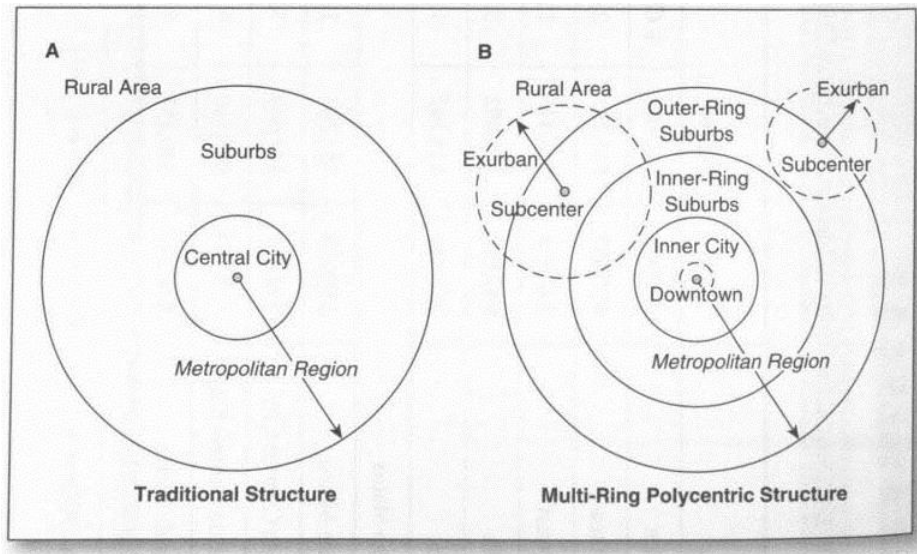


Figure 4.5. Metropolitan Area Structures (Source: Blakely and Leigh, 2009)

With this connection and growth, these outlying clusters will prove to be springboards from which new growth can be created for Chicago and Lisbon. At a minimum they expand the labor and commercial

²⁰² The concept, now used in the context of sustainable development, based on Joseph Schumpeter's notion of 'creative destruction'. from Schumpeter, *Capitalism, Socialism and Democracy*.

²⁰³ As discussed in Section 2.2.1 via Muller, "Chapter 3: Transportation and Urban Form".

markets of the central city. The growth at these nodes will thus be distinctly oriented towards the new connection to the main urban hub.

4.3.2.1 *Micro-urban Area Creation*

As such, we posit the creation of new micro-urban intermediate points at the nodes on a HSR system within commuting distance of a metropolitan center. These nodes or economic centers in this evolving discontinuous region will propel the overall regional growth by strengthening the existing center cities and adding to the overall economic potential of the megapolitan region. Micro-urban areas are introduced as a category of metropolitan areas fulfilling a specific archetype.

In this context, we consider a micro-urban city a community of less than 250,000 residents, which, although lacking the population of a larger metropolitan area, exhibits specific attributes more typically found in a larger urban center. Characteristics generally associated with micro-urban locations are diversity, vibrant arts, culture, and nightlife, technology, public discourse, global awareness, sustainability, and public transportation.²⁰⁴

Often more energetic and innovative than similarly sized communities, micro-urban communities are frequently more dense than typical for their size, exhibit outsized agglomerative benefits, are hotbeds of research, and contribute intellectually at a high rate. Many times they are home to large universities, the presence of which contributes to their ability to augment these metropolitan urban attributes. Together, these research-based industry—often technology focused—and academic presences contribute to the knowledge economy considered prototypical for 21st century needs. These trends speak well of the potential for these communities in the coming decades.

While micro-urban areas carry many of the characteristics that contribute to quality of life typically found in major urban centers, these smaller communities often may also have positive characteristics a larger area may not, such as a lower cost of living (typically via lower real estate prices) or less congestion. These smart, innovative, globally connected, and culturally rich communities serve as desirable urban dwelling destinations. Within these 21st century “urban villages”²⁰⁵, it is easy to anticipate transit-oriented, garden city styled, new urbanist developments surrounding a HSR station, contributing to and enhancing the micro-urban nature of linked cities.

4.3.2.1.1 History and Convention

Originally “used by urban planners to describe small urban areas with patterns of high-energy usage”, the term micro-urban was coined for usage in describing these particular smaller metropolitan communities by Mike Ross, the director of the Krannert Center for the Performing Arts on the campus of the University of Illinois.²⁰⁶ The original exemplar conceived was the Champaign-Urbana metropolitan area, but similar communities obviously exist throughout the United States and globally.

Broader usage for this term is anticipated due to its neat filling of the interval across existing standard United States Census Bureau definitions and its intuitive translatable description of these amenity-filled but diminutive urban areas. Micro-urban areas fall between “micropolitan”, which was introduced by the United States Census Bureau in 2003 to refer to areas with populations of 10,000-49,999, and

²⁰⁴ “CHAMPAIGN-URBANA: Smart. Innovative. Micro-Urban.”

²⁰⁵ Hansen, “Looking to the Village for Tomorrow’s City Design”.

²⁰⁶ Merli, “Toolkit Touts Successes of Micro-Urban C-U”.

"metropolitan" areas that are typically thought of as larger. These levels of geographic hierarchy were introduced in Table 2.1.

Definitions of urban areas vary across the world. Some countries define any place with a population of 2,500 or more as urban; others set a minimum of 20,000. There are no universal global standards, and generally each country develops its own set of criteria for distinguishing urban areas. Urban areas in the United States are defined by the U.S. Census Bureau via a population density measurement as contiguous census block groups with a population density of at least 1,000 /sq mi (390 /km²) and with any census block groups around this core having a density of at least 500 /sq mi (190 /km²). Urban areas are delineated without regard to political boundaries and the U.S. Census Bureau considers any settlement with greater than 2,500 residents urban if it meets the density requirements.²⁰⁷

The U.S. Census Bureau has two distinct categories of urban areas: Urbanized Areas have populations of greater than 50,000, while Urban Clusters have populations of less than 50,000. An urbanized area serves as the center of a metropolitan statistical area, while an urban cluster serves as the core of a micropolitan statistical area.²⁰⁸ The micro-urban categorization thus becomes a way to further classify metropolitan urbanized areas. Therefore, we would consider as micro-urban, by our definition, a city between 50,000 and 250,000 exhibiting certain economic characteristics, namely the presence of knowledge workers such as one would find at universities and/or in technology commerce.

It seems these types of communities may be especially important to a region's overall health. Table 4.5 lists several such micro-urban prototypes from around the globe. Typically these communities range in population between 75,000 and 250,000 and are homes to universities or technology parks or both.

Table 4.5. Micro-Urban Community Prototypes (Source: author)

Domestic

Albany, NY
 Amherst, MA
 Ann Arbor, MI
 Asbury Park, NJ
 Asheville, NC
 Bloomington, IN
 Champaign-Urbana, IL
 Charlottesville, VA
 Eugene, OR
 Fargo-Moorhead, ND/MN
 Gainesville, FL
 Greater Binghamton, NY
 Helena, MT
 Iowa City, IA
 Lawrence, KS
 Madison, WI
 New Haven, CT
 Norman, OK

International

Cambridge, England
 Chemnitz, Germany
 Coimbra, Portugal
 Cottbus, Germany
 Galway, Connaght, Ireland
 Guelph, ON, Canada
 Kimberley, Northern Cape, RSA
 Kitchener/Waterloo/Cambridge, ON, Canada
 Koblenz, Germany
 Lancaster, England
 Minami-Uonuma, Japan
 Orléans, France
 Osnabrück, Germany
 Oxford, England
 Regensburg, Germany
 Rostock, Germany
 Rouen, France
 Saku, Japan

²⁰⁷ U.S. Census Bureau.

²⁰⁸ U.S. Census Bureau.

Domestic

Olympia, WA
 Roanoke, VA
 Rochester, NY
 Santa Barbara, CA
 Syracuse, NY

International

Sudbury, ON, Canada
 Ulm, Germany

The potential as urban outposts for these smaller cities may read as a surprise to some. One observer notes, “We don’t tend to think or mention small towns in the same breath with innovation, technology or millennials. Small towns are quaint at best, definitely not hip. Maybe it is time to take another look and we may be surprised what we see. Could small towns across the United States already have benefited from the apparent comeback of cities? Can they, too, attract hipsters and millennials? Does small town urbanity really exist and can it provide [a] happy balance...? Can there be economic development in small towns...?”²⁰⁹

4.3.2.2 Megaregion Agglomeration

This points to an important aspect of the benefit from outlying cities to the central ones. These outlying cities often exhibit unique and valuable characteristics that can improve the quality and quantity of knowledge ‘in the air’ throughout the metropolitan and megapolitan regions and megaregion as a whole.

Part of the advantage for megaregions as they compete in a global economy is their collectiveness. At a larger scale than metropolitan areas do, they exhibit parallel characteristics of agglomeration. There are instances of shared resources or labor pools or knowledge wherein these shared components move through the megaregional network. And it is the mobility offered by the underlying transportation network that allows this to occur. Increased accessibility via a new HSR system would clearly improve the movement of these elements throughout the megaregion.

But a megaregion is really a collection of connected nodes. It is inherently a polycentric geography. It is these various points throughout the region that individually sum to the whole. And it is in these cities that the benefits of urban agglomeration rise. But only cities of a certain size and density pack an agglomerative punch that contributes to the economy and productivity of the area as a whole in a meaningful way. Again, the key is the number of people with access to a downtown conurbation of business density. A transport mechanism such as HSR is thus doubly effective. With downtown station locations, it expands the reach of each connected individual urban center in a megaregion, adding to the number of people with daily accessibility to that center, while also connecting more effectively each of these urban centers in the megapolitan region and megaregion.

The outlying intermediate cities, which may have previously been somewhat disconnected, are thus connected not only into a metropolitan area if they move within daily commuting distance, but the megaregion as a whole. This allows their benefitting attributes to be shared across these geographic scales.

²⁰⁹ Philipsen, “Is Small Town America the Home of Happiness?”.

4.3.3 Outlying Cities to Each Other

Lastly, the outlying cities are now linked more closely together. We can perhaps consider these linked intermediate cities as a string of connected nodes²¹⁰ that could begin to function more effectively as a unit or, at a minimum, increase their interaction with each other. Past literature “presents evidence that high speed rail systems, by bringing economic agents closer together, sustainably promote economic activity within regions that enjoy an increase in accessibility.”²¹¹

While all these cities experience large effects due to the principal metropolitan cities typically found at each end of these systems, they also experience various interactions with each other. Some intermediate communities may be to some extent economic rivals, while others seek ways to cooperate. The high-speed travel facilitated by new access will affect these relationships. Especially for communities whose industries complement each other, such linkage may prove additive. Perhaps they can begin to act as a duo, with a more substantial combined economic presence helping economic benefits be realized. Based on this potential, we posit the existence of a microregion, which links two intermediate, especially micro-urban, cities. As Figure 1.2 shows, the microregion consists of the connected intermediate cities along the HSR line forming a tandem conglomeration.

A concern, however, is that such linkages could also serve only to redistribute resources between connected communities. Whereas prior to the HSR system each community needed various local economic components, with closer access to neighboring cities, these functions could shift to that neighboring community. Thus, there is the real potential for redistributive effects, especially at this local intermediate level.²¹² Of course, the potential for redistribution of people and industry also exists from these outlying cities to the central ones. This has been the ongoing pattern of population shifts throughout the world as rural residents have migrated to urban areas. Thus, perhaps it is only via cooperation that these intermediate cities can sustain the economic presence necessary to maintain their future vitality in the vicinity of growing adjacent megacities.

An important part of this understanding will depend on the relative impacts these cities have on each other. Therefore, we now go in Chapter 5 to specific assessment of the expected effects the proposed HSR lines may have on our case communities.

²¹⁰ Introduced in Chapter 2 as a “string of pearls”.

²¹¹ Ahlfeldt and Feddersen, *From Periphery to Core: Economic Adjustments to High-Speed Rail*.

²¹² Murakami and Cervero, *High-Speed Rail and Economic Development*.

Chapter 5

5 PREDICTING IMPACTS

Transportation technology that allows individuals to access the megacity without living within its boundaries offers potentially large social benefits.²¹³

-Siqi Zheng and Matthew E. Kahn

5.1 SOCIAL EFFECTS

In Chapter 1, we provided background on wider economic benefits, and in Chapter 2 context on cities and regions. Chapters 3 and 4 provided added background on our case cities and HSR systems. With this backdrop set, and the concept of agglomeration conveyed, we can turn our attention to what impacts analysis will show. Our analytical focus is on measuring the potential benefit brought by added accessibility to agglomeration.

But it is also clear that particular non-economic effects will result from added transportation links such as these Portugal and Illinois high-speed rail systems. In other words, we know effects are not only physical, but social as well. Therefore, as we now go to analysis of these networks, we first deal with these social effects and then turn to the economic ones. A key component of this will be the impact on quality of life for people living in Coimbra, Leiria, Champaign-Urbana, and Kankakee. To what extent will the living conditions change? We find that accessibility is important both socially and economically so measurement focusing on accessibility speaks to both these interests. In essence, consideration of social effects frames the importance of understanding the overlapping economic effects.



Figure 5.1. Depiction of a "livable community" (Source: Chicago Metropolitan Agency for Planning [CMAP])

²¹³ Zheng and Kahn, "China's Bullet Trains Facilitate Market Integration and Mitigate the Cost of Megacity Growth".

When society attempts to describe desirable living conditions—a good quality of life, if you will—they often now turn to a recently popularized term, livability.²¹⁴ An increase in livability is understood to mean an increase in quality of life. A stated goal of the United States Department of Transportation (DOT) is to encourage livability.²¹⁵ But what does “livability” mean? Livability is a concept, depicted in Figure 5.1, that has taken on an entire spectrum of meaning, and which everyone seems to be in favor of. To avoid being bereft of meaning—and knowing if something means anything, it ultimately means nothing—we now aim for a more useful and specific set of criteria upon which to base our understanding of livability.

Using the concepts of accessibility and mobility, we can more carefully parse our goals for livability, and ultimately better understand the systems we are examining. Transportation livability, as defined by the U.S. DOT, is the creation and maintenance of a transportation network that is “safe, reliable, integrated and accessible” and “enhances choices for transportation users, provides easy access to employment opportunities and other destinations, and promotes positive effects on the surrounding community”²¹⁶. Note the use of accessible as a criterion. What do we mean by accessibility within a metropolitan area?

Understanding accessibility is important as it is “often a misunderstood, poorly defined and poorly measured construct.”²¹⁷ Others have specifically identified “accessibility to essential services, such as employment, education, health care, and recreation, [as] a key component of livability”²¹⁸. Accessibility in the context²¹⁹ of transportation and land use is something we will begin by simply categorizing as the ability to gain entry to the system. Components of accessibility include the distribution of opportunity, transportation availability, the attributes of opportunity, the attributes of users, and available information communication technologies. The second portion of the U.S. DOT phrase quoted above deals implicitly with mobility. Mobility is a further clarifying concept helpful for the qualification of livability. By mobility, we mean “the ability to get people from one place to another and to get goods and services to people wherever they are located.”²²⁰

It is further useful to draw from the findings of economist Amartya Sen, who classifies the term *capability* as a type of freedom that enables one to choose a lifestyle one wants to live.²²¹ This is helpful, and we suggest that accessibility is truly the capability to use the urban system; for which transportation becomes the enabler, which in turn enables one to pursue the quality of life they desire. In Section 5.3 we will further quantify the extent to which accessibility in the newly linked communities on the HSR lines will be impacted.

Thus, between these two measures—accessibility and mobility—we have the potential to create a more full and specific definition of livability. As transportation professionals, we have become quality of life providers. Former U.S. DOT Secretary Ray LaHood sums it up by saying, “Livability means a community where you can take kids to school, go to work, see a doctor, go to the grocery store, have dinner and a

²¹⁴ “Livability - CMAP”.

²¹⁵ “U.S. DOT Livability Initiative”.

²¹⁶ *Livability in Transportation Guidebook: Planning Approaches That Promote Livability*.

²¹⁷ Geurs and van Wee, “Accessibility Evaluation of Land-Use and Transport Strategies”.

²¹⁸ Ducas, “Incorporating Livability Benefits into the Federal Transit Administration New Starts Project Evaluation Process through Accessibility-Based Modeling”.

²¹⁹ Note that the concept of accessibility is used in other contexts as well (e.g. handicapped accessibility).

²²⁰ Wachs, “Transportation Policy, Poverty, and Sustainability”.

²²¹ Sen, *Development as Freedom*.

movie, and play with your kids in a park, all without having to get into a car.”²²² And HSR could play a distinct role in meeting this goal.

5.1.1 Quality of Life

An important consideration when evaluating a transportation investment becomes its impact on the livability adjacent to the system. There are several impacts worth noting when considering a HSR project’s effects.

Quality of life is undoubtedly something perceived in the eye of the beholder. As a society, we all desire to live with a certain quality of life. This is not standard of living, which is relatively income dependent, but considers alongside relative wealth the ability to pursue education and satisfactory employment, health, welfare, recreation, and community.²²³ A city that can provide the capability to pursue all of these could obviously range a gamut of urban types. However, literature shows that there seems to have arisen some consensus as to the general types of community perceived as most livable. These communities “are typically moderately dense, diverse, walkable, safe, affordable, accessible and well-served by public transit systems.”²²⁴ Central to this consensus seems to be the pursuit of sustainability. Cities see sustainability as a fundamental way to provide quality of life in the 21st century. We touched on this concept in Chapter 4; however a broader background is helpful.

5.1.1.1 Sustainability

The concept of sustainability as applied to transportation planning connotes a definition that runs across economic, social equity, and environmental dimensions. While discussion of sustainable development first began to broadly appear in the early 1990s, the deeper definition we now operate evolved over the decade following this period, and thus is relatively recent.

The origins of sustainability as a driving factor in developmental considerations are traced to a special independent United Nations (UN) commission, the World Commission on Environment and Development (also known as the Brundtland Commission, after its chair the Norwegian Prime Minister Gro Harlem Brundtland) organized in 1983. This Commission released a report in 1987, following worldwide public meetings, entitled “Our Common Future” which outlined a path towards global sustainable development. Within, it describes sustainable development as that which “meets the needs of the present without compromising the ability of future generations to meet their own needs.”²²⁵ Subsequent discussions led to the Earth Summit held in Rio de Janeiro in June 1992. At this second international meeting to discuss the environment and development (following the 1972 United Nations Conference on the Human Environment, or the Stockholm Conference),

Sustainability Timeline

1983-1987: UN Brundtland Commission
 1992: UN Rio Earth Summit and Agenda 21
 1993: President Clinton establishment of President’s Council on Sustainable Development
 1994: World Bank report on Sustainable Development
 1994: John Elkington coins “The Triple Bottom Line”
 1996: Scott Campbell coins “The Planner’s Triangle”
 2002: UN World Summit for Sustainable Development in Johannesburg, South Africa

²²² “U.S. DOT Livability Initiative”.

²²³ Nussbaum and Sen, *The Quality of Life*.

²²⁴ Miller, Witlox, and Tribby, “Developing Context-Sensitive Livability Indicators for Transportation Planning”.

²²⁵ “History of Sustainability”.

an Agenda for the 21st Century (or Agenda 21) was developed that spoke to the goals of attaining sustainability and creating “a more just, secure and prosperous habitat for all humanity.”²²⁶ This led to various national efforts to move towards these international goals. In the United States, President Clinton established a President’s Council on Sustainable Development in 1993.

With more widespread awareness of the concept, additional research and thinking developed around this idea. While initially sustainability was heavily focused on the environment, its conception began to broaden. In 1994, the World Bank prepared a seminal report on Sustainable Development, which tied sustainability to capital and economic development.²²⁷ Also in 1994, John Elkington, a British business consultant, coined the term “triple bottom line” to refer to “Three P’s”: profit, people, and planet, playing off the importance of private sector businesses meeting their “bottom line” or profitability.²²⁸

Then, in 1996, Scott Campbell, a professor of urban planning at the University of Michigan, proposed the “planner’s triangle” as a theory of sustainable development.²²⁹ He created this triangle, shown in Figure 5.2, to illustrate the tension between the various requirements and ideals associated with pursuit of sustainable development.

Planners address three fundamental priorities:
And three resulting conflicts..

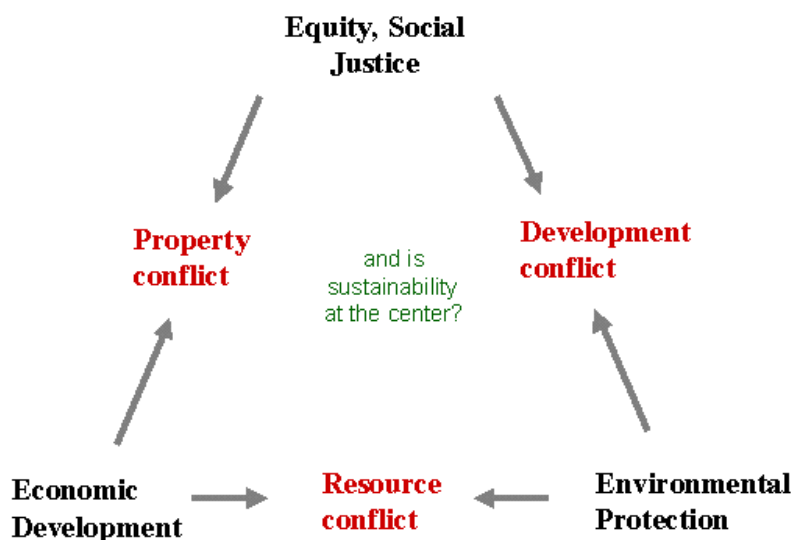


Figure 5.2. The Planner’s Triangle: Three Priorities, Three Conflicts (Source: Campbell, 1996)

These “Three E’s”, Economy, Equity, and Environment, which correlate to the triple bottom line categories, have become fundamental to sustainability considerations in the world of planning and development. Growth that achieves a balance between these trifold components is considered sustainable.

Corollary to growing interest in sustainability, offshoots of such thought have driven the push for ‘smart’ development. For instance, a smart city is one “with which you can interact. [It is] a city that acts more

²²⁶ Ibid.

²²⁷ Serageldin and Steer, *Making Development Sustainable: From Concepts to Action*.

²²⁸ “Idea: Triple Bottom Line”.

²²⁹ Campbell, “Green Cities, Growing Cities, Just Cities?”.

like a living organism, a city that can respond to your needs.”²³⁰ It appears that the phrase “smart city” was coined in the early 1990s²³¹ to illustrate how urban development was now turning towards technology, innovation and globalization. Others have suggested that the phrase’s popularity rose out of the “Smart Growth” movement²³² of the late 1990s, which advocated improved urban planning. This movement in turn appears to also be rooted in part in the concept of sustainability.

Following this period of growing knowledge, the UN held another conference on sustainable development ten years after their prior one. The World Summit on Sustainable Development was held in Johannesburg in 2002, and five priority areas of water, energy, health, agriculture and biodiversity were set. While there is currently not another conference scheduled, resolutions were adopted to meet goals in these five areas by 2015.²³³

Public awareness has continued to grow as corporate and business, as well as governmental, sustainability is in the spotlight. Proposed projects are evaluated in this fashion as are daily practices. Social and environmental impacts are weighed against economic gain, and more than ever, sustainable pursuits are deemed most worthy by the public, and institutions are changing their behavior accordingly.²³⁴ More than before, governments are being driven by a pursuit of sustainability. The attributes of communities deemed most livable conjoin well with the pursuit of sustainability, and this is by design.

5.1.1.2 *Quality of Life and HSR*

This awareness has led to the “mainstreaming of livability and sustainability concepts into the [sic] transportation planning.”²³⁵ And this focus allows one to assess the potential for HSR to promote livable and sustainable lifestyles, which would improve the quality of living for users and nearby stakeholders.

Cities, as congested centers of human activity, can face challenges due to their inefficiency, crowding, pollution, and a resulting unsatisfactory quality of life. A city’s success is in constant tension with the consequences of such success. In fact, the agglomeration that underlies as the benefit to city life also has intrinsic costs. The ability for agglomerative benefit to grow, and outweigh costs, is largely a result of the metropolitan area transportation network’s ability to provide mobility and accessibility. The built environment in a city thus both generates the need and provides opportunity for travel.²³⁶ Therefore, transportation projects are increasingly being weighed on their ability to facilitate accessibility to the agglomerative center, and thus on their capacity to deliver sustainable livability. HSR provides a continued step towards increasing a city’s functional potential.

HSR technology helps reduce commuting times into major cities, thus easing congestion in those metropolitan areas while also bringing greater access to the principal city for the connected smaller cities. This helps stimulate real estate growth, and makes additional markets attractive to people in the region. Some have suggested that this creates a “safety valve” of expansion potential without the

²³⁰ Wakefield, “Tomorrow’s Cities: Do You Want to Live in a Smart City?”.

²³¹ Gibson, Kozmetsky, and Smilor, *The Technopolis Phenomenon*.

²³² Burchell, Listokin, and Galley, “Smart Growth”.

²³³ “History of Sustainability”.

²³⁴ Portney, *Taking Sustainable Cities Seriously*.

²³⁵ Miller, Witlox, and Tribby, “Developing Context-Sensitive Livability Indicators for Transportation Planning”.

²³⁶ *Driving and the Built Environment*.

traditional limitations of congestion for metropolitan areas.²³⁷ Additionally, access is a quality of life improvement. The access brought by HSR could bring added productivity in smaller connected cities, more balanced real estate prices, and a more sustainable economic profile. Table 5.1 shows the effect improved transportation has on travel²³⁸, the critical component in these productive connections, which has resulted in the metropolitan form changes outlined in Chapters 2 and 4.

Table 5.1. Effects of Technological Innovations on Travel Speeds and Times (Source: author and Pickrell, 1999)

| <i>Technology</i> | <i>Approximate date introduced</i> | <i>Typical door-to-door speed (mph)</i> | <i>Travel time per mile (minutes)</i> |
|-----------------------|------------------------------------|---|---------------------------------------|
| Walking | Early | 3 | 20 |
| Horse-drawn omnibus | 1827 | 4 | 15 |
| Horse-drawn streetcar | 1835 | 5 | 12 |
| Cable car | 1875 | 8 | 7.5 |
| Electric streetcar | 1890 | 10 | 6 |
| Rail rapid transit | 1910 | 15 | 4 |
| Motor bus | 1915 | 20 | 3 |
| Automobile | 1920 | 30 | 2 |
| High-speed rail | 1964 | 120 | 0.5 |

Furthermore, HSR as a transportation network fits well the design form of communities aspiring to be livable communities. The types of compact development sought have come to be characterized by “five D’s”: density, diversity, design, destination accessibility, and distance to transit.²³⁹ The ability to create clusters of development at station locations inherently allows the fulfillment of these requisite features. Design around a HSR station has the potential to bring the density, diversity, and walkability that inhabitants find livable and allows accessibility. Meanwhile vehicle miles traveled (VMT) and their associated negative externalities can be reduced.²⁴⁰ The notion of garden cities of the 21st century formed via micro-urban clusters along a string of HSR stations feels like a sustainable transportation and land use match.

5.1.2 Equity

An additional important consideration is the impact of HSR on spatial and social equity. As outlined in the discussion of sustainability, the impact of a transportation proposal on quality of life is closely tied to its ability to balance benefits amongst the economy, environment, and equity. The focus of this thesis largely leaves aside the potential environmental benefits HSR can have, although both via direct (increased efficiency on a per passenger basis versus air²⁴¹) and indirect (potential for more efficient cluster development, as we have discussed) measures there appear to be potential benefits. And we will

²³⁷ Zheng and Kahn, “China’s Bullet Trains Facilitate Market Integration and Mitigate the Cost of Megacity Growth”.

²³⁸ Pickrell, “Chapter 12: Transportation and Land Use”.

²³⁹ *Driving and the Built Environment*.

²⁴⁰ *Ibid.*

²⁴¹ Clewlow, “The Climate Impacts of High-Speed Rail and Air Transportation”.

return to further discussion of economic impacts in Section 5.2. However, a closer look at the impacts on equity is useful, as they round out the picture in the social realm.

A helpful framework is via the use of *passive use benefits*. These positive externalities of a transportation network consist of three elements: existence benefits, indirect benefits, and option value.²⁴² Existence benefits are the advantages related to the fact the system exists. The potential future use by people or their neighbors, which could provide communitywide positives, brings value. Indirect benefits are those to non-users of the system who nevertheless see benefits. For instance, congestion on another mode of travel could be reduced via implementation of a new system. Option values represent the benefit of having the option to use another mode, especially if your primary mode of transport becomes temporarily unavailable. These passive benefits arise for people in spatial proximity to a project, and decay with distance. But it is exactly these that are so important to disadvantaged communities, and for whom equity is a great concern. The ability to access economic opportunity and the too prevalent spatial mismatches between certain residential areas and job locations or amongst community neighborhoods are an important factor for investment in transportation.²⁴³

Traditionally, consideration of equity in transportation is along four dimensions: equity across geographic areas, amongst various socioeconomic groups, across transport modes, and to all ages.²⁴⁴ For all these spectrums of consideration, the spread of passive use benefits is important. We can consider the impact of HSR on all these equity areas. First, the geographic areas served are clearly dependent on station locations. For our projects, three of the four case communities will have a station within or near their downtown area. This will serve each community equitably with relatively equidistant trips from throughout the metropolitan areas, and allow quick access to the business centers in town. Leiria's exurban station location is of higher concern here. Matching access to this station with the Mobilis transit bus system will be vital. In all locations, intermodal connection to the existing transit networks will be important. Champaign-Urbana has an advantage in this area with the existing intermodal station facility; however Coimbra would have the opportunity to build in such access with their urban redevelopment around the new station area.

Consideration for the population surrounding the station locations segues to consideration of the socioeconomic groups affected. If HSR were setup to cater only to particular, especially well-off, segments of society, whether due to cost or geography, this could be problematic. This is especially a concern in the United States, where consideration of impacts across racial lines are an important matter. Interestingly, in both Champaign-Urbana and Kankakee, areas of minority, especially African-American, populations are located in close proximity to the station areas. Figures 5.3 and 5.4 show the racial distribution in these communities, with the station location marked.²⁴⁵ This speaks well as to the potential for HSR to serve these racially diverse communities if priced well. In Portugal, racial differences are less a concern and less information on the distribution of income across the communities is available.

²⁴² Miller, Witlox, and Tribby, "Developing Context-Sensitive Livability Indicators for Transportation Planning".

²⁴³ O'Regan and Quigley, "Chapter 13: Accessibility and Economic Opportunity".

²⁴⁴ Shi and Zhou, "How Cities Influenced by High Speed Rail Development".

²⁴⁵ "The Racial Dot Map: One Dot Per Person".

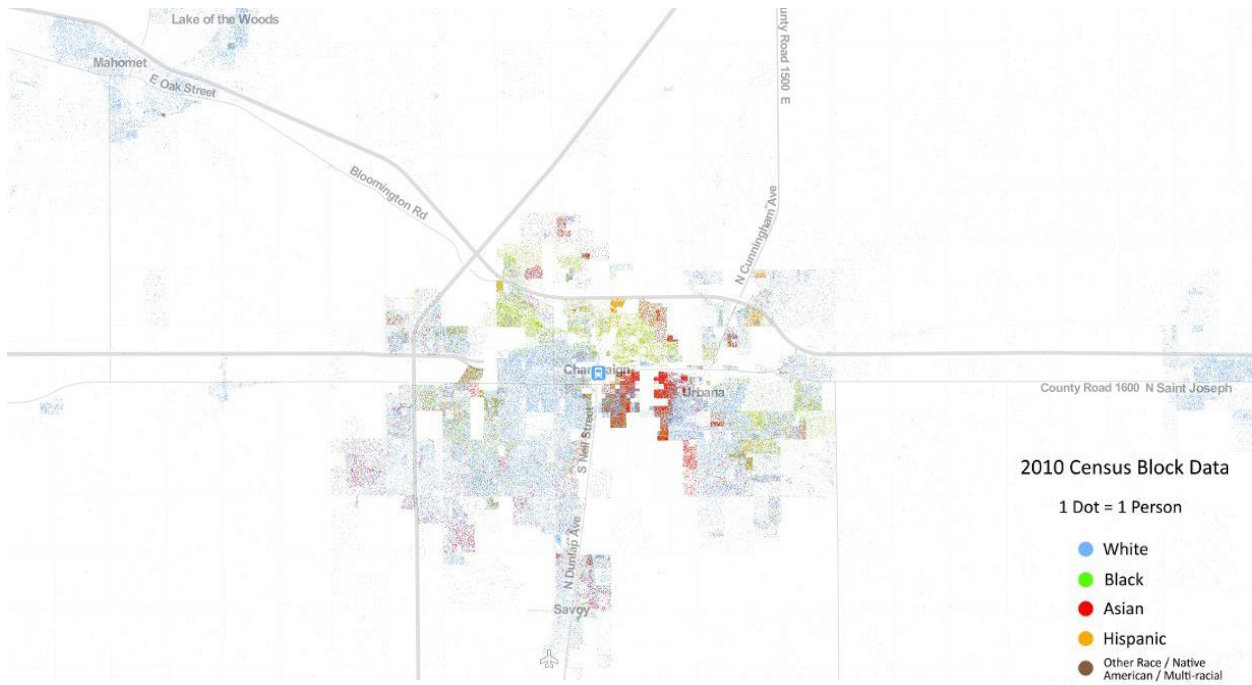


Figure 5.3. Champaign-Urbana 2010 Census Racial Dot Map
 (Source: Dustin A. Cable | University of Virginia | Weldon Cooper Center for Public Service | Reference Data by Stamen Design)

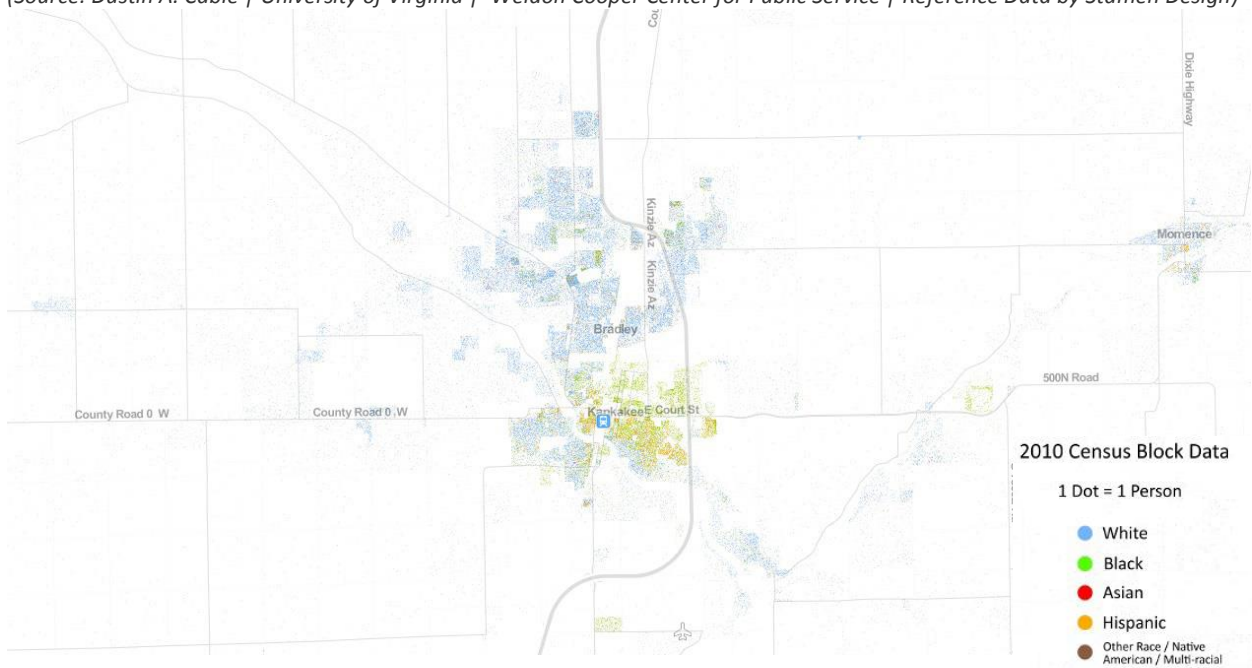


Figure 5.4. Kankakee 2010 Census Racial Dot Map
 (Source: Dustin A. Cable | University of Virginia | Weldon Cooper Center for Public Service | Reference Data by Stamen Design)

However, more broadly the notion of HSR’s ability to distribute knowledge currently centered in the larger urban cores across these regions seems to lend itself well to equitable connection. Others have observed, “The high-speed railway systems regulate the knowledge exchangeability among cities in the short-run and play crucial role [sic] in determining the economic geography of knowledge distribution in

the long run.”²⁴⁶ As we observed in Section 1.2.2, wider economic effects can contribute to community equity variation both regionally or locally. The equal distribution of accessibility across the linked communities is an important consideration.²⁴⁷ As such, we can consider accessibility as a proxy for the ability of community members to pursue their goals.

Therefore, measuring the accessibility offered by a transportation project is an important part of considering its impact on equity. We posit that an indicator of accessibility will provide vital data on the ability for transportation investment to bring positive equity changes. Hence, the consideration we make in the following sections to measure access to agglomeration captures as well some of the potential for equity value. A full analysis that used GIS and parcel level data, with full consideration of the transportation networks and land use planning in each of our case communities, may be necessary to understand the local ramifications, but our work will begin to inform the effects at the regional level. The use of accessibility in evaluation of projects will thus inherently speak to their equity impacts.

5.2 ECONOMIC EFFECTS

5.2.1 Underlying Economic Theory

The main methodological component of this thesis lies in exploring the economic effects felt by communities linked via HSR into a new metropolitan area. Central to this consideration is the question of to what extent local and regional economic growth is produced by transportation infrastructure investments. This includes direct economic effects as well as wider economic impacts. Further understanding these expected benefits helps advance understanding of necessary components in a full benefit-cost analysis.²⁴⁸ Specifically in the case of HSR in Portugal and Illinois, we will attempt to quantify the extent to which agglomeration is dispersed across these HSR networks. In other words, how accessible to each city are the agglomerative benefits found at the metropolitan center?

In order to explore the accessibility to other communities’ economic presence, we must understand the underlying economic background used in this realm of study. In the style of Wanli Fang²⁴⁹, our approach to the interaction between transport investment and economic development will rest on three schools of theory: New Economic Geography, urban economics theory, and endogenous growth theory. Figure 5.5 shows the relationship between these theories; our work on economic accessibility falls at their intersection.

²⁴⁶ Kobayashi and Okumura, “The Growth of City Systems with High-Speed Railway Systems”.

²⁴⁷ Monzón, Ortega, and López, “Social Impacts of High Speed Rail Projects”.

²⁴⁸ de Rus, *The Economic Effects of High Speed Rail Investment*.

²⁴⁹ Fang, “Dispersion of Agglomeration through Transport Infrastructure”.

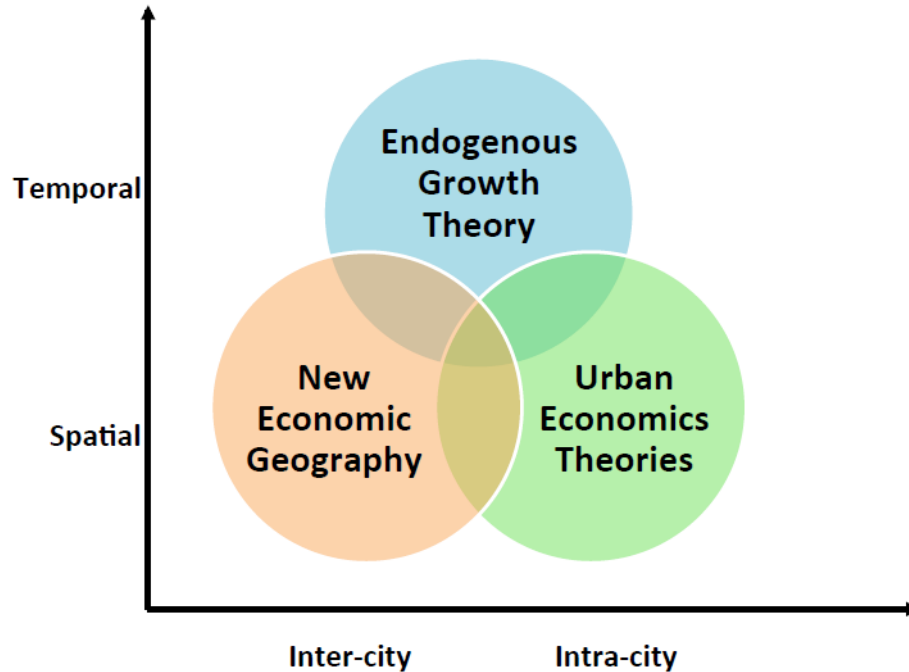


Figure 5.5. Theoretical Foundations (Source: Fang, 2013)

New Economic Geography (NEG) is a relatively recent evolution of economic geography, which is comprised of “the size, land use patterns, and production capacities of respective cities...”²⁵⁰ With the rise of the new knowledge economy and globalization, the spatial distribution of economic activities has shifted and NEG seeks to explain the clusters that arise in this new spatial economy. NEG principles recognize this growing role of globalization, increased technology, and the knowledge economy, while considering the linkage between transport and local economies based on these. These fundamentals thus point to the “spatial demand linkages that contribute to agglomeration”.²⁵¹ Spurred by the work of Paul Krugman in the early 1990s, this line of research has produced growing understanding of the links between transport costs and economic growth.²⁵² Past NEG efforts have concluded, “More precisely, as transport costs fall, the same centrifugal and centripetal forces driving the agglomeration of economic activities in early stages of integration will also cause the spread of industry to less developed regions as integration proceeds.”²⁵³ Figure 5.6 shows how this ties infrastructure and agglomeration together. NEG thus suggests that ongoing transportation and technology improvements feed back to economic development via geographic specialization.²⁵⁴ Cities now grow based not only on natural resources but based on comparative transport and technology advantages. And they continue to concentrate in a self-reinforcing fashion, whether this is driven by industry clustering, transportation, technology, or remaining resource advantages.

²⁵⁰ Kobayashi and Okumura, “The Growth of City Systems with High-Speed Railway Systems”.

²⁵¹ Hanson, “Market Potential, Increasing Returns and Geographic Concentration”.

²⁵² Fujita, Krugman, and Venables, *The Spatial Economy*.

²⁵³ Teixeira, “Transport Policies in Light of the New Economic Geography”.

²⁵⁴ Storper, *Keys to the City*.

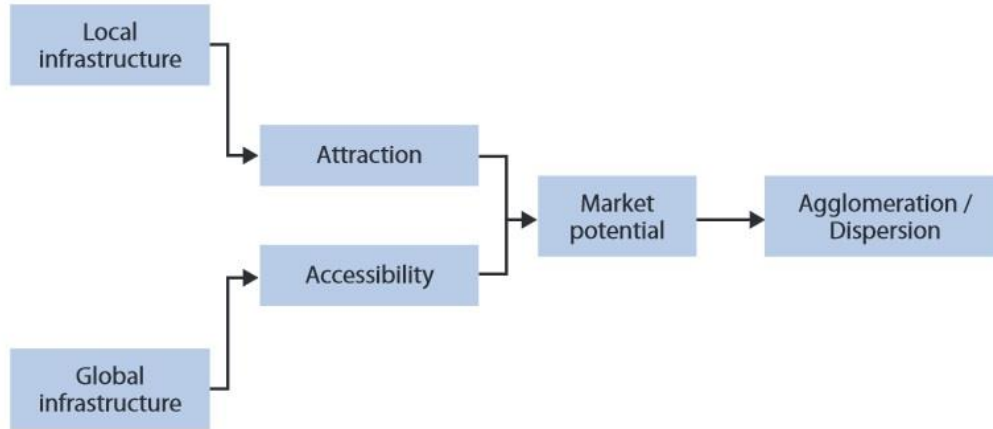


Figure 5.6. Infrastructure and Economic Geography (Source: Ottaviano, 2008)

Urban economics theory focuses spatially much more narrowly, with the economic motivations fundamental to the formation and growth of cities. Central to this has been the development of the declining rent gradient as one moves away from the city center. As land values decrease, the cost of transport back to that central business district increases. However, if a transport mode allows new access, this rent curve can be influenced. Figure 5.7 shows this potential effect. Fang observes:

“This is particularly true for medium and small cities within commuting distance of a megacity. The HSR stations may turn a periphery location into a gateway of the home city. Such a gateway location, once combined with favorable policy and matching investment, will foster the formation of sub-centers and reshape the configuration of the city.”²⁵⁵

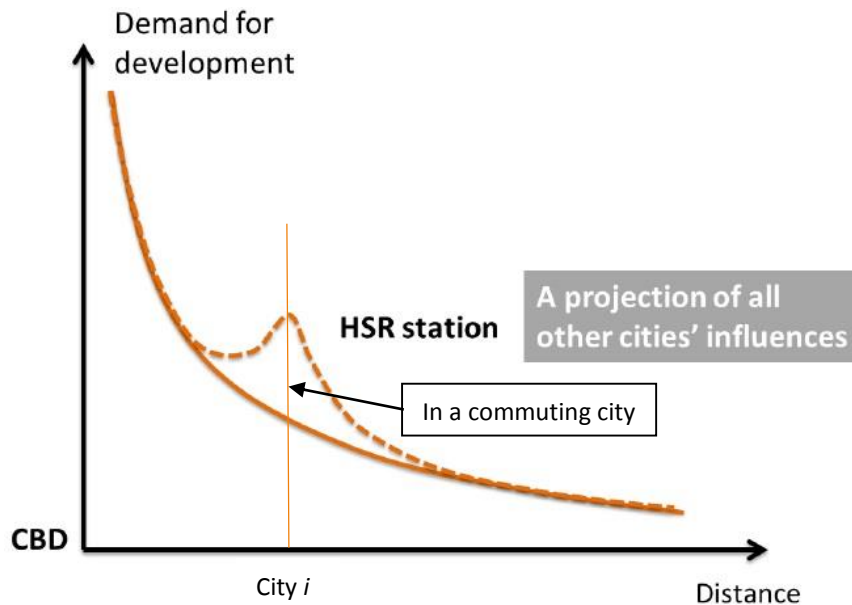


Figure 5.7. HSR Station Impact on Rent Gradient (Source: author and Fang, 2013)

²⁵⁵ Fang, “Dispersion of Agglomeration through Transport Infrastructure”.

Endogenous growth theory considers the major contributors to economic growth. Classically, these have been capital and labor. This theory suggests that with technology determined by human and produced capital, the expansion of knowledge is considered a driving force in economic growth. This leads to growing productivity.²⁵⁶ If this theory is extended to include accessibility as an input, the opportunity to access knowledge directly relates to the dispersion of agglomeration since knowledge spillovers are one of the three pillars of agglomeration.

With these three theoretical economic perspectives, a combined approach evolves that treats accessibility across geographic areas as central to the spread of agglomerative benefits. Communities investing in transport infrastructure seek a “long-term increase in economic activity which can be attributed to the specific investment, and which can be shown to be an addition to the direct transport benefits...”²⁵⁷ Ideally this is done without growth being redistributive only.²⁵⁸ In a seminal paper, Banister and Berechman observe that for this additive growth to occur, certain conditions must be in place: positive underlying economic externalities, investment factors, and supportive political factors. Figure 5.8 illustrates these principles.

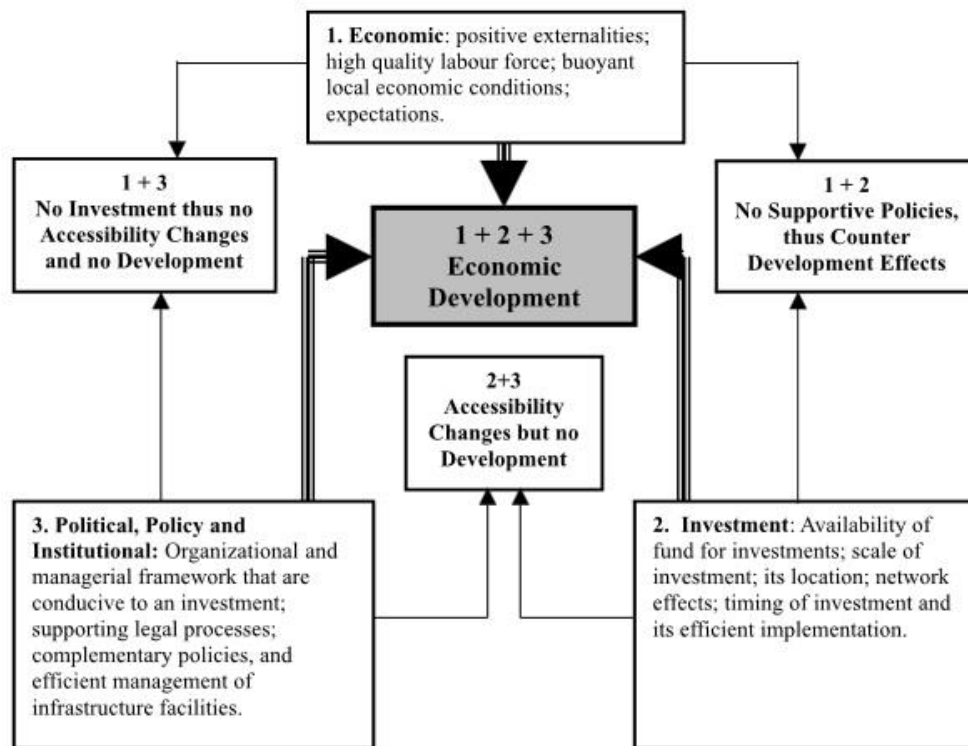


Figure 5.8. Necessary Conditions for Economic Development (Source: Banister and Berechman, 2001)

They conclude that, “Policy-making is the crucial factor in realizing economic growth benefits from a transport infrastructure investment.”²⁵⁹ This point is critical as the various jurisdictions and stakeholding entities involved in a project seek such investment. In order to see an investment as worthwhile that

²⁵⁶ Ibid.

²⁵⁷ Banister and Berechman, “Transport Investment and the Promotion of Economic Growth”.

²⁵⁸ Murakami and Certero, *High-Speed Rail and Economic Development*.

²⁵⁹ Banister and Berechman, “Transport Investment and the Promotion of Economic Growth”.

economic return is often seen as necessary. Understanding how this is realized is essential to transportation economics.

A helpful lens for understanding these economic effects involves recognizing the varying scales they play out at. As we noted in Section 4.3.1, these can be felt regionally, or locally, across metropolitan areas. Additionally, the influences amongst cities shared in Section 4.4 work across these scales. In total, a complex cycle of inputs and outputs influence the effects transportation has on the economy.

Thus, the underlying mechanisms shaping the interaction between transportation investment and economic performance can be illustrated via Figure 5.9, which shows the positive cycle added accessibility can ignite. This figure was modified to incorporate the trifold theoretical approach that predicts agglomeration effects.

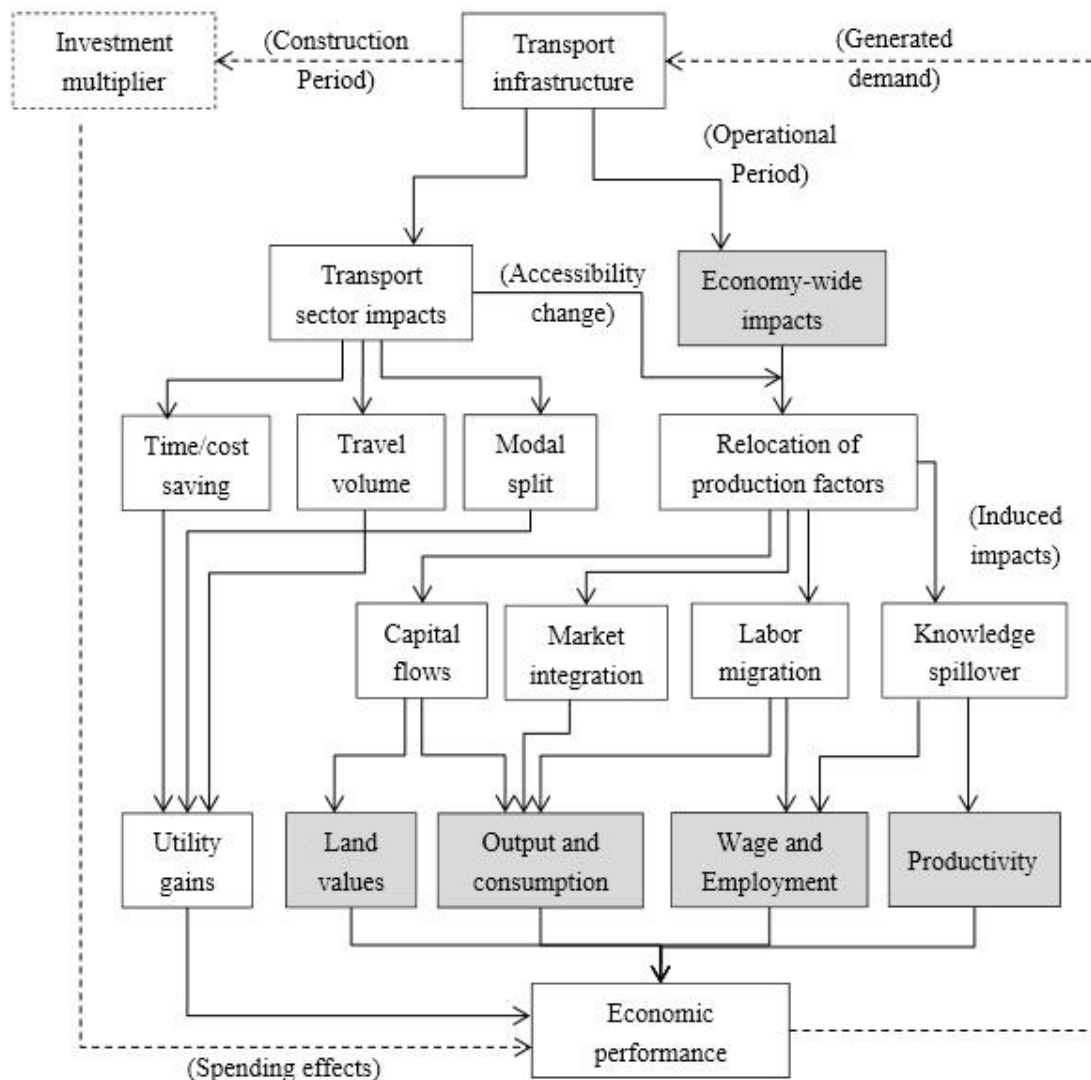


Figure 5.9. Transportation and the Economy (Source: Banister and Berechman, 2001 and modified by Fang, 2013)

With this background, we turn to the particular aspect of economic effects we are concerned with.

5.3 WIDER ECONOMIC EFFECTS

Measuring the specific effects the proposed HSR systems will have on each of our communities is a challenge. As we discussed, HSR will reduce travel time between the connected cities, and thus, increase opportunities for trading, labor market access, and knowledge spillovers between the connected cities that become functionally close (although not physically closer).²⁶⁰ Todd Litman observes, “The ultimate goal of most transportation is ‘access,’ people’s ability to reach desired goods, services and activities. Transportation decisions often involve tradeoffs between different forms of access. How transport is measured can have a key impact on these tradeoffs.”²⁶¹ With this pursuit of agglomeration key, we will create a measurement that captures the accessibility to and effect of agglomeration in connected cities.

To quantify the effects the addition of these links will have on the affected cities, we set out to create an indicator of the potential for growth in agglomerative accessibility based on the addition of each respective city’s market to the system. This measure will provide an assessment of the extent to which new HSR access can improve a city’s access to agglomerative benefits in an adjacent metropolitan area.

5.3.1 Formulating an Accessibility Indicator

As we highlighted earlier, agglomeration depends on specific sharing, which leads to productivity gains. Accessibility to a metropolitan area that houses such agglomerative benefits thus becomes important for nearby communities, and more specifically for the people in them. Peoples’ ability to quickly access a central business core, for instance, contributes to their potential livelihood. As a transporter of people, HSR will prove especially useful in providing knowledge and labor transfers. Graham and Melo observe:

*Transport improvements can increase the strength of agglomeration economies to the extent that they increase connectivity within the spatial economy. ...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.*²⁶²

Therefore, we aim to illustrate the extent to which new accessibility to useful agglomeration benefits could be added by the proposed HSR systems in Illinois and Portugal. And further, a quantification of these new benefits will illustrate the economic advances the linkages can bring and as well provide a basis for comparative analysis and advancing project evaluation.

5.3.1.1 Background on Accessibility Indicators

Accessibility measures the ease, via the transportation available, with which a user can access an urban system. Therefore, an indicator of this accessibility will provide quantification of the magnitude of available system accessible. Past literature outlines the progression of these types of analytical techniques.^{263 264 265} Various approximations have used varying compilations of pertinent variables.

²⁶⁰ Zheng and Kahn, “China’s Bullet Trains Facilitate Market Integration and Mitigate the Cost of Megacity Growth”.

²⁶¹ Litman, *Measuring Transportation*.

²⁶² Graham and Melo, “Assessment of Wider Economic Impacts of High-Speed Rail for Great Britain”.

²⁶³ Gutiérrez, “Location, Economic Potential and Daily Accessibility”.

²⁶⁴ Martín and Reggiani, “Recent Methodological Developments to Measure Spatial Interaction”.

²⁶⁵ Martínez and Viegas, “A New Approach to Modelling Distance-Decay Functions”.

Differing types of indicators for a particular location could be built on a location index based on weighted trip times, economic potential²⁶⁶, or daily accessibility reach, among other formulations.²⁶⁷

To focus on the benefits of agglomeration, we are concerned with the growth in economic potential of communities linked on a new transportation system. Most prior examples in this realm trace their heritage to the work of Chauncy D. Harris, an innovator in modern urban geography, published in 1954. He outlined a foundational market potential function, which postulates that the potential demand for goods from a location is based on the sum of the transport-weighted purchasing power at all other locations within reach.²⁶⁸ Recently, this strand of learning has been advanced via the NEG body of research.²⁶⁹ Before proposing our own accessibility indicator, we highlight several considerations that influence the choice of variables in our accessibility indicator.

While we are positing that agglomerative benefits will flow out from the urban centers, it is clear these benefits decay with distance. The closer parties are in proximity, the stronger agglomeration effects tend to be.²⁷⁰ The extent to which this decay occurs is part of the necessary assessment. Typically, this distance decay has been a function of the physical geographic distance away from the central point one travels. The costs, both financial and in time, of traveling between places serve as friction travel needs to overcome. However, travel time is now often considered instead of travel distance. There do not appear to be any obvious reasons agglomeration would be limited over greater distances traveled in the same time.²⁷¹ Thus, comparisons between modes with differing travel times or frequencies point to differences in agglomerative reach even though the distances may be similar. Our measurement of accessibility to agglomeration will include a distance decay factor based on the travel time differences.

Additionally, one must ask what the propensity for this agglomerative benefit to flow over travel networks is. Economic activity in geographic space results in positive spillovers, which are possible due to mutual access to the space. This sharing would seem to be available to anyone who can access the pooled space. As such, one's ability to travel to and from this agglomerative gateway controls their access to the agglomerative benefits. Additionally, as we learned in Chapter 2, despite technological communication innovations, face-to-face interaction still matters.

It quickly becomes apparent that there are several ramifications to this. First, the type of transport affects the type of agglomerative benefit available. Trucking and freight access will allow shared resource use and realize economies of supply and distribution for firms. But this will be less effective in diffusing knowledge. As aforementioned, people-moving transport like HSR, however, would seem to serve firms' needs for labor and shared knowledge. Each mode may provide differing types of agglomeration benefits due to their variable speed or types of loads (i.e. freight versus passengers). Second, the type of industry or business you have may be more or less prone to seeing agglomerative benefits spread far over travel networks. Most past research has focused on agglomerative benefits in manufacturing. Some have shown varying impacts across industry sectors.²⁷² But clearly, the types of 21st century jobs relying on technological know-how and innovation are prime candidates for

²⁶⁶ Alternatively described as market potential, economic mass, or effective density.

²⁶⁷ Fang, "Dispersion of Agglomeration through Transport Infrastructure".

²⁶⁸ Hanson, "Market Potential, Increasing Returns and Geographic Concentration".

²⁶⁹ Fujita, Krugman, and Venables, *The Spatial Economy*.

²⁷⁰ Graham and Melo, "Assessment of Wider Economic Impacts of High-Speed Rail for Great Britain".

²⁷¹ Ibid.

²⁷² Graham, Gibbons, and Martin, *The Spatial Decay of Agglomeration Economies*.

agglomerative spillovers, especially with the need for face-to-face interaction understood. Our measurement will consider the specific benefits wrought through agglomeration by industry type and available to transportation focused on people.

Further, the approximation for agglomeration must be found in some measure of mass or weight of an urban center. The greater the density of businesses and productivity in a downtown center, the more attractive and as well agglomerative it is likely to be. Various approximations for this density of economic function have been made, and we will need to provide our own as a factor in our estimation of the reach of agglomeration.

Finally, the daily frequency of the transportation service matters. Past accessibility literature has largely not considered this component, but one can readily recognize that even if a potential trip were an hour shorter, if you could only take that trip once a day at a set time, it may still be more valuable for you to use a slower form of travel and leave when you want to. Some literature has considered relative frequency in discussion of mode shifts, and shown that frequency, along with travel time and fares, does matter in the choices people make for travel.²⁷³ We will delve into our own estimate of the relative importance within our proposed accessibility indicator.

An accessibility indicator measuring economic potential will therefore focus on connections between locales, with the assumptions being that these interactions will be weighted based on the economic mass at each location but will decline with distance.²⁷⁴ Various studies have chosen differing appropriate accessibility measurement models, and no method seems distinctly superior for all situations. Thus, a potential measure should reflect prior best practices and be appropriate for the available data and needed outcomes for the target study.

5.3.2 An Accessibility Indicator Proposal

Based on these past measurement efforts, a new indicator can be created that provides the appropriate measurement. We therefore propose an overall measure that gives information on both the locational and economic potential for each place. Our proposal is aimed as a proof of concept outlining a new approach to considering agglomeration as a benefitting externality, and that demonstrates a technique that could make sense for inclusion of this benefit in project evaluation.

A city's agglomeration growth potential relates to its residents' ability to access adjacent agglomeration-based economies. This potential can be represented as the sum of the total linked cities' economic potential weighted by factors that consider the friction induced by travel times and available trip frequency. The accessibility indicator we use is thus called the Agglomeration Growth Potential (AGP):

$$\text{Agglomeration Growth Potential (AGP): } A_i = \sum_{j \neq i} \left(\frac{GDP_j \times E_{A_j}}{POP_j} \times \gamma \ln(F_{ij}) \times e^{-\alpha T_{ij}} \right)$$

GDP_j , POP_j , and E_{A_j} represent the Gross Domestic Product, Population, and Agglomerative Employment of a linked city, respectively. Here, F_{ij} is the daily trip frequency and T_{ij} is the travel time in minutes between city i and j . This index will measure the extent access to adjacent metropolitan areas provides agglomerative benefit to the linked city. This is accomplished by a focused look at agglomeration

²⁷³ Behrens and Pels, "Intermodal Competition in the London–Paris Passenger Market".

²⁷⁴ Karou and Hull, "Accessibility Modelling".

potential by industry and a formulation is prepared that considers an economic mass approximation of agglomeration, travel time, and trip frequency.

Thus, the proposed accessibility indicator is comprised of three components: a measure of economic or market mass, a measure of frequency, and a measure of travel time. Each component is formulized in the following sections.

5.3.2.1 A Measure of Economic Mass

Each linked city j will provide a market to which people in city i can access, and this measure provides an estimate of the magnitude of this market. To compile this portion of the formula, two values are used; the Gross Domestic Product per capita ($\frac{GDP_j}{POP_j}$) is multiplied by the Agglomerative Employment (E_{A_j}).

Therefore, the estimate of market mass or economic weight used in this equation is composed of a city's GDP multiplied by its agglomerative employment and divided by its population. This product represents the size of the agglomeration economy in linked city j . These variables are now discussed.

The first variables used include the total Gross Domestic Product (GDP) for each city as well as its population. This component is equivalent to the product between each city's GDP/capita. GDP and population were found in Table 1.5. We should note that some cities used to compile the results are not shown in this table as they are not subject cities in and of themselves. However, data was also included in Portugal for Aveiro and Porto, and in Illinois for Decatur, Springfield, and St. Louis.²⁷⁵ All these stations occur along the same HSR network as our subject cities, and are obviously economically linked as well. The full tables with data and information for all cities are included in Appendix B.

Next, we must make an estimate of the agglomeration-based employment (E_{A_j}) in each city, which is essentially the number of employees for whom agglomeration matters. This will serve as the basis for our approximation of each city's agglomeration economy mass. To do this for each city, we categorize their employment by industry and then create a multiplier based on the agglomerative potential via HSR of each specific industry. The effort to divide this effect by industry category is due to the variance in relevance to agglomeration in these groupings. Past literature has shown this²⁷⁶, but techniques are not clear.²⁷⁷ To facilitate the end measurement, and in order to provide the industry specificity we desire, we implemented a multistep process to arrive at this variable. Thus, there are four steps needed to produce this variable, which is an author-defined component of this formulation.

Step 1: To begin, a set of industry categories must be chosen. Data varies across countries, and a representative set of categories, which would also reflect the varying roles agglomeration can play across industry categories, were chosen. Industries were selected based on the employment categories largely common between our data sets. Illinois employment data was based on the U.S. Bureau of Labor and Statistics²⁷⁸ data while Portuguese data came from the "Where To Invest in Portugal" website (WTIP)²⁷⁹. These industry categories are shown in Table 5.2.

²⁷⁵ As well as Bloomington-Normal for the lower-speed HSR project currently under construction in Illinois.

²⁷⁶ Ellison, Glaeser, and Kerr, *What Causes Industry Agglomeration?*.

²⁷⁷ Past work by Graham (several citations) has attempted to estimate the elasticities of agglomeration by industry, but this work remains nascent.

²⁷⁸ "U.S. Bureau of Labor Statistics".

²⁷⁹ "Where-to-Invest-in-Portugal".

Step 2: Next, upon selection of the industry categories, an agglomeration weighting index was created by the author. Each industry category was assigned a weight, from zero to one, with zero indicating an industry where no workers benefit from agglomeration and one indicating they all do. Industries for which a particular type of agglomeration matters highly are assigned a higher weight in that category, whereas those with lower value receive a lower weight. These weights were then averaged, producing a mean benefit weight by industry category. In essence, these weights can be considered to represent the proportion of employees in each category for which the three aspects of agglomeration benefits matter. The types of agglomeration benefit are based on the three pillars of agglomeration highlighted in Section 1.2.3. By averaging, we are weighing each of these components equally.

This compilation of agglomeration accessibility benefits is shown in Table 5.2. We can see that this methodology shows that workers in professional and technical services or universities and education highly value knowledge spillovers. Industries such as construction and manufacturing, on the other hand, highly value labor market pooling. And several categories place relatively high value on shared inputs. Overall, based on the weights chosen, knowledge-based industries such as health care, professional or technical services, and universities or education rank most highly by this estimate. The relevance of agglomeration, and varying types of agglomerative benefits, across industries is a useful consideration, and one that could provide future value in ongoing work on agglomeration economies.

Table 5.2. Agglomerative Accessibility Benefits (Source: author)

| Industry Categories | Agglomerative Accessibility Benefits | | | Average Benefit Weight |
|---|--------------------------------------|----------------------|---------------|------------------------|
| | Knowledge spillovers | Labor market pooling | Shared inputs | |
| <i>Accommodations/ Food Services</i> | 0.20 | 0.50 | 0.70 | 0.47 |
| <i>Agriculture</i> | 0.10 | 0.20 | 0.40 | 0.23 |
| <i>Construction</i> | 0.20 | 0.80 | 0.30 | 0.43 |
| <i>Finance/Insurance /Real Estate</i> | 0.40 | 0.20 | 0.70 | 0.43 |
| <i>Government</i> | 0.40 | 0.10 | 0.10 | 0.20 |
| <i>Health Care</i> | 0.70 | 0.50 | 0.60 | 0.60 |
| <i>Manufacturing</i> | 0.40 | 0.80 | 0.30 | 0.50 |
| <i>Professional/ Technical Services</i> | 0.80 | 0.70 | 0.80 | 0.77 |
| <i>Retail and Trade</i> | 0.20 | 0.50 | 0.70 | 0.47 |
| <i>Transportation and Utilities</i> | 0.60 | 0.50 | 0.40 | 0.50 |
| <i>Universities/ Education</i> | 0.90 | 0.70 | 0.70 | 0.77 |

These agglomerative benefit weights will then be applied to employees of each case city to produce an estimate of employees for whom agglomeration matters.

Step 3: Then, the number of employees in each city and industry category must be estimated. To estimate the size of each place’s workforce consistently, a simple approximation that matches well with official estimates was used. Each metropolitan area’s population was divided by two to approximate the potential workforce size²⁸⁰ and then all unemployed workers were subtracted from that remainder. Table 5.3 shows the resulting size of each city’s employment base.

Table 5.3. Workforce Size Estimate (Source: U.S. Census Bureau and Bureau of Labor Statistics and WTIP)

| <i>Metropolitan area</i> | <i>Metro Population</i> | <i>Unemployment</i> | <i>Estimated Workforce</i> |
|--------------------------|-------------------------|---------------------|----------------------------|
| Chicago | 9,461,105 | 8.9% | 4,309,533 |
| Kankakee | 113,449 | 10.8% | 50,598 |
| Champaign-Urbana | 231,891 | 7.5% | 107,250 |
| Springfield | 210,170 | 7.6% | 97,099 |
| St. Louis | 2,787,701 | 7.2% | 1,293,493 |
| Lisbon | 3,035,000 | 11.7% | 1,339,953 |
| Leiria | 126,879 | 10.7% | 56,651 |
| Coimbra | 435,900 | 12.4% | 190,924 |
| Porto | 1,817,172 | 16.5% | 758,669 |

This overall number of employees is then multiplied by the percentage of people employed in each industry category for each city. Again, this data was obtained from the U.S. Bureau of Labor Statistics and WTIP. This product is reported in the Total Employment column in Table 5.5. It must be noted that due to some mismatches between national labor data, assignment to our industry categories sometimes involved mapping jobs in one category to another. The categories were mapped as shown in Table 5.4, where our industry categories are shown on the left and the source categories are on the right. Some categories are split according to apparent job types, with these relative splits estimated to match some more specific data available.

²⁸⁰ The potential workforce does not include children or those retired, amongst other groups.

Table 5.4. Employment Industry Category Mapping (Source: author)

| | | |
|---------------------------------|---|--|
| Portugal category mapping: | | from WTIP data |
| Accommodations/Food Services | = | .33(commerce, hotel and restaurant industry) |
| Agriculture | = | agriculture, forestry, hunting and fishing PLUS mining and quarrying |
| Construction | = | construction and public works |
| Finance/Insurance/Real Estate | = | .5(financial activities, real estate and services provided to companies) |
| Government | = | .33(public administration, health and others) |
| Health Care | = | .5(public administration, health and others) |
| Manufacturing | = | manufacturing |
| Professional/Technical Services | = | .5(financial activities, real estate and services provided to companies) |
| Retail and Trade | = | .67(commerce, hotel and restaurant industry) transport, storage and communication PLUS production and distribution of electricity, gas and water |
| Transportation and Utilities | = | and water |
| Universities/Education | = | .167(public administration, health and others) |
| U.S. category mapping: | | from BLS data |
| Accommodations/Food Services | = | Leisure and hospitality |
| Agriculture | = | Farm PLUS Mining and logging |
| Construction | = | Construction |
| Finance/Insurance/Real Estate | = | Financial activities |
| Government | = | Government MINUS government university employees |
| Health Care | = | .67(Education and health services); .75 Kankakee; .5 Champaign |
| Manufacturing | = | Manufacturing |
| Professional/Technical Services | = | Professional and business services PLUS Information |
| Retail and Trade | = | Other services PLUS .75*(Trade, transportation, and utilities) |
| Transportation and Utilities | = | .25(Trade, transportation, and utilities) |
| Universities/Education | = | .33(Education and health services) PLUS government university employees |

Step 4: Next, the agglomeration benefit weights derived in the second step in Table 5.2 are then multiplied by the total number of employees in each industry category in each studied city calculated in the third step. This product gives an estimate of the number of employees in each category who benefit from agglomeration. Simply summing each city's agglomeration-weighted industry employment thus results in an estimate of the total number of agglomeration benefitting employees in each city. Table 5.5 shows the results for our subject cities, with the total for the Agglomerative Employment column representing E_A for each city, respectively.²⁸¹

²⁸¹ The additional reference cities required to compute the AGP for each case city are included in Appendix B.

Table 5.5. Agglomerative Employment by Case City

| Industry | Agg. Ben. Wt. | Lisbon | | | Leiria | | | Coimbra | | |
|---------------------------------|---------------|--------|-----------|----------------|--------|-----------|----------------|---------|-----------|----------------|
| | | % | Tot. Emp. | E _A | % | Tot. Emp. | E _A | % | Tot. Emp. | E _A |
| Accommodations/Food Services | 0.47 | 8.1% | 108,777 | 50,763 | 8.8% | 5,010 | 2,338 | 11.6% | 22,241 | 10,379 |
| Agriculture | 0.23 | 0.2% | 2,010 | 469 | 2.1% | 1,190 | 278 | 0.6% | 1,146 | 267 |
| Construction | 0.43 | 4.9% | 65,658 | 28,452 | 15.5% | 8,781 | 3,805 | 7.6% | 14,510 | 6,288 |
| Finance/Insurance/Real Estate | 0.43 | 19.6% | 262,631 | 113,807 | 6.9% | 3,881 | 1,682 | 9.0% | 17,088 | 7,405 |
| Government | 0.20 | 4.4% | 58,811 | 11,762 | 3.4% | 1,926 | 385 | 6.2% | 11,908 | 2,382 |
| Health Care | 0.60 | 6.7% | 89,107 | 53,464 | 5.2% | 2,918 | 1,751 | 9.5% | 18,042 | 10,825 |
| Manufacturing | 0.50 | 3.2% | 42,878 | 21,439 | 25.8% | 14,616 | 7,308 | 11.0% | 21,002 | 10,501 |
| Professional/Technical Services | 0.77 | 19.6% | 262,631 | 201,350 | 6.9% | 3,881 | 2,975 | 9.0% | 17,088 | 13,101 |
| Retail and Trade | 0.47 | 16.5% | 220,851 | 103,064 | 18.0% | 10,172 | 4,747 | 23.7% | 45,155 | 21,073 |
| Transportation and Utilities | 0.50 | 14.6% | 195,633 | 97,817 | 5.8% | 3,286 | 1,643 | 8.6% | 16,419 | 8,210 |
| Universities/Education | 0.77 | 2.2% | 29,762 | 22,817 | 1.7% | 974 | 747 | 3.2% | 6,026 | 4,620 |
| | | 100% | 1,339,953 | 705,203 | 100% | 56,651 | 27,658 | 100% | 190,924 | 95,050 |
| E _A % of Total | | | | 52.6% | | | 48.8% | | | 49.8% |

| Total Employment | Agg. Ben. Wt. | Chicago | | | Kankakee | | | Champaign-Urbana | | |
|---------------------------------|---------------|---------|-----------|----------------|----------|-----------|----------------|------------------|-----------|----------------|
| | | % | Tot. Emp. | E _A | % | Tot. Emp. | E _A | % | Tot. Emp. | E _A |
| Accommodations/Food Services | 0.47 | 9.7% | 419,927 | 195,966 | 9.1% | 4,587 | 2,141 | 9.8% | 10,485 | 4,893 |
| Agriculture | 0.23 | 0.1% | 3,555 | 829 | 2.0% | 1,034 | 241 | 1.2% | 1,330 | 310 |
| Construction | 0.43 | 3.3% | 143,988 | 62,395 | 2.7% | 1,343 | 582 | 3.3% | 3,495 | 1,515 |
| Finance/Insurance/Real Estate | 0.43 | 7.0% | 299,559 | 129,809 | 4.6% | 2,350 | 1,018 | 4.0% | 4,272 | 1,851 |
| Government | 0.20 | 11.3% | 485,665 | 97,133 | 15.3% | 7,720 | 1,544 | 23.9% | 25,680 | 5,136 |
| Health Care | 0.60 | 10.5% | 453,988 | 272,393 | 15.1% | 7,636 | 4,582 | 10.8% | 11,625 | 6,975 |
| Manufacturing | 0.50 | 8.5% | 367,238 | 183,619 | 12.2% | 6,154 | 3,077 | 7.2% | 7,767 | 3,883 |
| Professional/Technical Services | 0.77 | 20.2% | 871,195 | 667,917 | 8.6% | 4,363 | 3,345 | 10.0% | 10,679 | 8,187 |
| Retail and Trade | 0.47 | 17.7% | 762,818 | 355,982 | 18.3% | 9,248 | 4,316 | 13.6% | 14,620 | 6,823 |
| Transportation and Utilities | 0.50 | 6.5% | 280,300 | 140,150 | 7.2% | 3,618 | 1,809 | 5.3% | 5,671 | 2,835 |
| Universities/Education | 0.77 | 5.2% | 223,606 | 171,431 | 5.0% | 2,545 | 1,951 | 10.8% | 11,625 | 8,913 |
| | | 100% | 4,309,533 | 2,277,623 | 100% | 50,598 | 24,606 | 100% | 107,250 | 51,322 |
| E _A % of Total | | | | 52.9% | | | 48.6% | | | 47.9% |

Based on the economic and employment information outlined, the results of this data for use in the AGP index are found in Table 5.6.²⁸²

Table 5.6. Agglomeration Growth Potential (AGP) economic mass variable values

| Metropolitan Area | GDP | Metropolitan Population | GDP/capita (1000s of \$) | E_A (millions of people) |
|-------------------|---------|-------------------------|--------------------------|----------------------------|
| Chicago | \$571.0 | 9,461,105 | \$60.35 | 2.277623 |
| Kankakee | \$3.5 | 113,449 | \$30.67 | 0.024606 |
| Champaign-Urbana | \$9.5 | 231,891 | \$40.97 | 0.051322 |
| St. Louis | \$136.7 | 2,787,701 | \$49.03 | 0.679246 |
| Lisbon | \$95.2 | 3,035,000 | \$31.37 | 0.705203 |
| Leiria | \$2.3 | 126,879 | \$18.11 | 0.027658 |
| Coimbra | \$7.8 | 435,900 | \$17.93 | 0.095050 |
| Porto | \$41.6 | 1,817,172 | \$22.89 | 0.391536 |

This concludes the explanation of the first term in the AGP formulation. The remaining components in our accessibility indicator relate to the ability to access the economic conurbation comprised as noted. There are two additional factors we consider.

5.3.2.2 A Measure of Frequency

In this next portion of the formula, we are considering daily trip frequency (where F_{ij} is daily trip frequency for a particular mode). Although not typically present in accessibility indicator formulations, we believe this is a key consideration for potential consumers seeking to access an agglomerative center. Inclusion of the daily frequency with which one can access a market allows cross-mode comparisons and more closely follows a real world decision process. Thus, we have formulated a reasonable impedance function based on the available trip frequency. Its form is: $\gamma \ln(F_{ij})$

This term uses the logarithm of the daily trip frequency, matching some past work in this functional form.²⁸³ An example of this type of function applied in the Northeast Corridor in the United States is shown on Figure 5.10.²⁸⁴ The choice of functional form is important as other functional forms would be possible, and return differing results. A key consideration is at what point of increasing frequency marginal returns increase most quickly. With the logarithmic form, moving from very low frequency (say one or two trips per day) to more returns the most value. An alternative form such as an exponential one would return higher margins as you reduced headways from low to even lower (say going from ten minute headways to five). We feel that the former approach is appropriate, and the results provided with this approach seem reasonable. It is possible a piecewise function could be found that would further adjust the results most appropriately; however the simple logarithmic form is practicable for our work.

Additionally, an independent variable associated with frequency (γ) is used to allow modification of the importance of this term. Based on experimentation returning reasonable results for the range between

²⁸² The additional reference cities required to compute the AGP for each case city are included in Appendix B.

²⁸³ Behrens and Pels, "Intermodal Competition in the London–Paris Passenger Market".

²⁸⁴ Zupan, Barone, and Lee, "Chapter 8: The Intercity Rail Alternative to Air Travel".

the upper values versus lower values, we let $\gamma=1$ as the null value. Further sensitivity analysis could point towards more precise specification for this term.

Rail Share as Function of Frequency Ratios

Source: Regional Plan Association

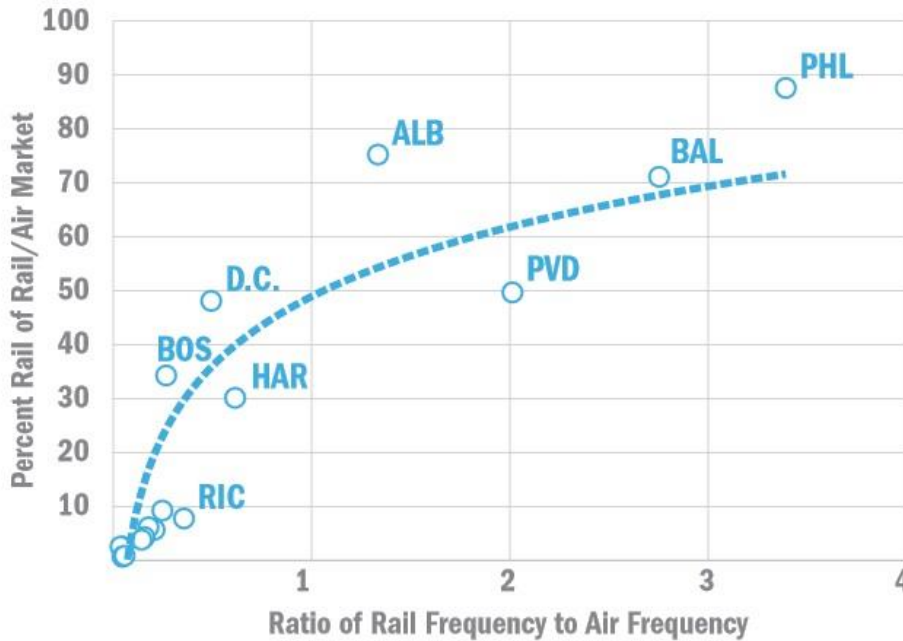


Figure 5.10. Rail Share as Function of Frequency Ratios (Source: Zupan et al, 2011)

For trip frequency, it is assumed that the new HSR trains will operate at a certain daily frequency, which will serve to compete with other modes accordingly. Competing modes considered include personal vehicles, which we approximate can leave at any point in the day and we estimate for comparison purposes this can happen in any 5-minute period.²⁸⁵ That assumption could also range in value. Conventional rail and air are considered as well. In Illinois, the operating plan sees HSR service beginning at 6 am, with final departures at 8 pm, and service typically every half-hour.²⁸⁶ In Portugal, it is assumed the proposed HSR will operate similarly to the existing Alfa Pendular service. It is also assumed that each mode will offer an equivalent number of trips in each direction daily. Table 5.7 indicates the daily trip frequency by mode and location for Portugal (from Lisbon) and Illinois (from Chicago), respectively.

Table 5.7. Trip Frequencies by Mode (Source: as noted)

| Portugal | Mode | Leiria Frequency | Coimbra Frequency | Aveiro Frequency | Porto Frequency |
|----------|----------|------------------|-------------------|------------------|-----------------|
| Existing | Car | 192 | 192 | 192 | 192 |
| | IC Train | 5 | 12 | 9 | 9 |
| | AP Train | 0 | 11 | 11 | 11 |
| | Air | 0 | 0 | 0 | 42 |
| Proposed | HSR | 11 | 11 | 11 | 11 |

²⁸⁵ Thus: 16 hours x 12 cars/hour = 192 daily trip possibilities

²⁸⁶ University of Illinois at Urbana-Champaign and University of Illinois at Chicago, *220 MPH High Speed Rail Preliminary Feasibility Study Executive Report*.

Table 5.7. (cont.)

| Illinois | Mode | Kankakee Frequency | C-U Frequency | Decatur Frequency | Springfield Frequency | St. Louis Frequency |
|----------|--------------------|-----------------------|------------------|----------------------|--------------------------|------------------------|
| Existing | Car | 192 | 192 | 192 | 192 | 192 |
| | Train | 3 | 3 | 0 | 5 | 5 |
| | Air | 0 | 6 | 3 | 3 | 28 |
| Proposed | Lower speed HSR | - | - | - | 3 | 3 |
| | HSR | 21 | 21 | 21 | 21 | 21 |

Note: Frequencies for Portugal are from Lisbon and for Illinois from Chicago; other city pair linkage frequencies are as follows:

| | |
|---|---|
| Air- St. Louis:Decatur= | 3 |
| Train- Coimbra, Aveiro, and Porto:Leiria= | 3 |
| Lower speed HSR- Bloomington-Normal | 3 |

This concludes the explanation of the second term in the AGP formulation, and we thus turn to consideration of the final factor in this formulation. These two terms, frequency and travel time, together measure the ease with which any potential user in a city can access the agglomerative mass available in other cities connected via HSR and other modes.

5.3.2.3 A Measure of Travel Time

Finally, travel time must be considered. As has been outlined, the cost—in money, distance, and time—it takes for someone to access an area affects the feasibility of daily access and how much it impacts them. While many past formulations consider only the geographic distance, we use travel time (where T_{ij} is travel time) as a measure of the distance between cities for a more useful true measure of space, as has more literature in recent years.²⁸⁷ This variable is usually used in accessibility indicators, and can also take various forms.²⁸⁸ We use a distance decay function taking a negative exponential form, which appears frequently in past literature.²⁸⁹ Its form is: $e^{-\alpha T_{ij}}$

The AGP formula is therefore a gravity-type indicator with inclusion of this decay equation, and this term provides an estimate of the rate at which agglomeration flows decrease with distance. As well, in the style of Harris²⁹⁰ market potential equations, an $\alpha=0.02$ is used to measure the spatial decay rate as the neighboring city j 's influence on city i wanes. Based on a sensitivity analysis and past literature, we believe this value is reasonable. We are further presuming that benefits will flow along HSR lines similarly to how they do other urban transport systems, and that the decay gradient will be similar across modes. Note that each mode has its own travel time, however. The travel times for each locale were shown in Tables 1.2 and 1.3.²⁹¹

²⁸⁷ Graham and Melo, "Assessment of Wider Economic Impacts of High-Speed Rail for Great Britain".

²⁸⁸ Zheng and Kahn, "China's Bullet Trains Facilitate Market Integration and Mitigate the Cost of Megacity Growth".

²⁸⁹ Karou and Hull, "Accessibility Modelling".

²⁹⁰ Harris, "The Market as a Factor in the Localization of Industry in the United States".

²⁹¹ The additional travel times for reference cities are included in Appendix B.

Perhaps also helpful is comparison between the impact of travel time and frequency. Figure 5.11 shows the functional results over a range of travel times and frequencies and the results based on the γ and α chosen for this work.

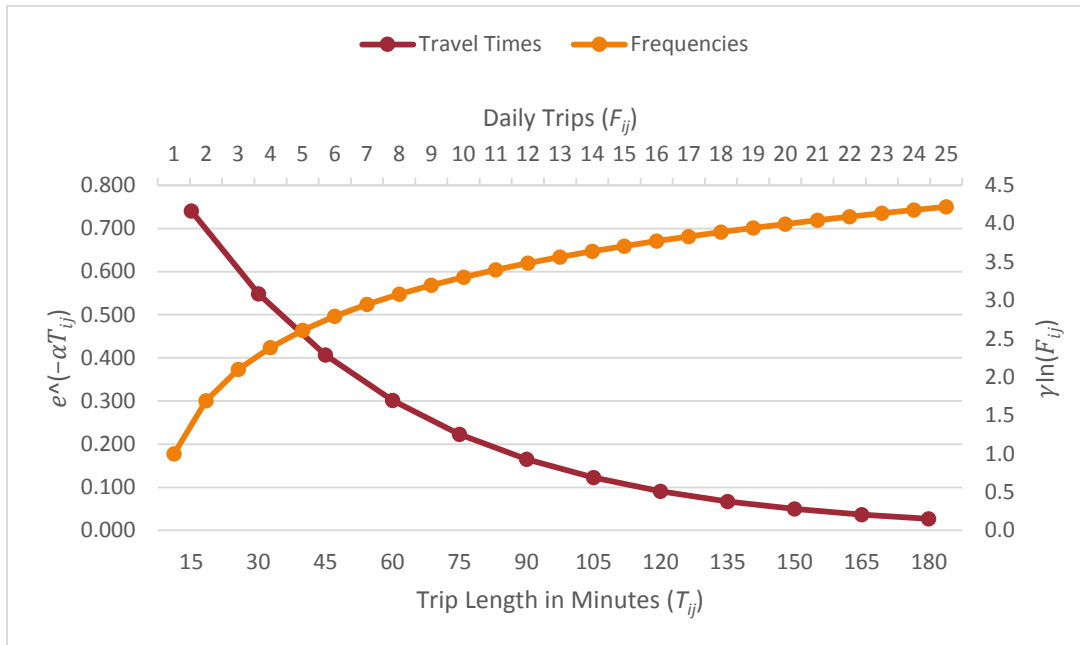


Figure 5.11. Travel Time (min.) and Frequencies (daily trips) (Source: author)

This concludes the explanation of the third, and final, term in the AGP formulation. These components will serve together to provide a summary of each city's ease of access to the agglomerative centers to which they are linked.

5.3.2.4 Other Considerations

It is worth noting several other variables that are not included in our formulation. The two main areas that come to mind are environmental effects and price. These and others are not included as we are not estimating mode share, but simply the potential value of externality benefits dispersed along the transport line. One could postulate, for instance, that a significant difference in environmental consequences between modes would affect the use of some modes and as well the propensity to move between cities. However, it is unclear that consumers will react to this concern and how. Additionally, some concern for these negative externalities may already be priced into each service.

One might also seek to consider inclusion of cost to the traveler as a factor. However, a measure of accessibility should not include cost as it is rather meant to measure the value of the available trip itself. This is clear as we further consider pricing in transportation. First, the costs between modes are perceived differently. While driving may not be as much cheaper than other modes as many users anticipate, its corollary perception may differ between countries and skew the results. Second, while variable, if the costs are relatively similar, their effect is likely less than the time and frequency in determining mode share, meaning it is worthwhile to keep the focus on these latter considerations. Third, future costs are difficult to estimate. Without solid data, this analysis could become more speculative than we are comfortable with. For consideration purposes, however, estimated costs for a typical trip in Portugal and Illinois respectively are shown in Table 5.8.

Table 5.8. Typical Trip Costs by Mode (Source: author, as noted)

| Mode | Coimbra to/from Lisbon | C-L Existing Mode Shares | Champaign to/from Chicago | C-C Existing Mode Shares | Leiria to/from Lisbon | L-L Existing Mode Shares | Kankakee to/from Chicago | K-C Existing Mode Shares |
|---------------------------------|------------------------|--------------------------|---------------------------|--------------------------|-----------------------|--------------------------|--------------------------|--------------------------|
| Auto Cost | \$53.58 | 67.2% | \$36.61 | 93.8% | \$37.96 | 77.9% | \$15.52 | 99.3% |
| Bus Fare | \$20.10 | 8.1% | \$24.00 | 1.6% | \$20.10 | 17.9% | \$22.00 | 0.3% |
| Train Fare | \$57.35 | 24.7% | \$15.00 | 2.1% | \$19.95 | 4.2% | \$7.00 | 0.4% |
| Air Fare | - | 0.0% | \$275.00 | 2.4% | - | 0.0% | - | 0.0% |
| Weighted Average Existing Cost* | \$51.80 | | \$41.64 | | \$34.01 | | \$15.51 | |
| Potential HSR Fare | \$50.00 | | \$40.00 | | \$35.00 | | \$15.00 | |

Table Notes:

- > Auto prices are from Michelin
- > Alfa Pendular (Coimbra) and Regional (Leiria) in Portugal, Amtrak in Illinois
- > U.S. ticket prices are from American Airlines

* Weighted average is calculated using the existing mode shares (as calculated in Ch. 4) and their respective costs

This table quickly makes clear the potential for added HSR mode share. Additionally, these potential HSR fares were checked against existing HSR fares in France (average \$34.50) and Spain (average \$51.67), and they are very much in line with existing trips of a similar length. Therefore, based on a simple estimate of potential fares, we can begin to speculate about the demand and mode share implications of these systems with further information on the potential value of these trips.

The price of any one of the trips we are considering may actually be considered in part a result of our AGP results, as opposed to an input. Presumably, a consumer's willingness to pay is related to the value they garner from the trip. Additional agglomerative opportunity would increase that value. However, managing agencies and operators could misprice trips, which would skew use. We would posit, though, that a measure of value like AGP for a city-to-city linkage combined with price should serve to be predictive of mode share or demand. This is an area of potential further research.

As well, it must be emphasized that there are various functional forms any of the functional components could take. Economic mass could be estimated based only on population or on another product of variables. We have made the choices we presented above based on the rationale shared, and are hopeful they serve as a reasonable estimate for the effects we seek to capture. Overall, however, the overarching purpose of preparing this methodology is again to serve as a proof of concept. Any one of these components could undoubtedly be studied further, but the value of our contribution is in bringing them together to show the potential for measuring agglomerative potential.

With all variables described and data accounted for, the analyses can be completed and we can assess the AGP of our subject cities. Due to the formulation some interesting results will be possible. First off, comparisons in existing conditions only will allow assessment of which modes are currently most beneficial to the spread of agglomeration to these intermediate cities. But second, we will be able to compare the potential for HSR in influencing these agglomerative benefits to the current situation. And

third, the results will point to those cities most impacted as a result of these proposed systems even prior to construction. These analyses will thus speak to the value of the proposed systems as well as potential winners and losers amongst the linked communities.

5.3.3 Analysis Results

With the analytical technique laid forth, we can turn to the results of the methodology. For each mode, a measure of the agglomeration growth potential (AGP) is made, with each city receiving benefit from the other connected cities. Its overall AGP for each mode is the sum of those intercity benefits. This number may be considered a unitless index, and although results are not entirely linear, the magnitudes are comparable. Tables 5.9 and 5.10 share the results for Portugal and Illinois, respectively.

Within these tables the results for each city can be read left to right for each mode. So, for instance, Table 5.9a shows Lisbon receives a total magnitude of 3.43 in agglomeration growth potential via auto from its linked cities. Each column provides the total received from the respective cities. The magnitude shown for each mode is comparable across the various modes, and, if the AGP rises, we can consider this the potential gained by any cohort of passengers who could travel by the associated mode.

This technique should be applicable to any added transportation investment in any mode that adds intercity linkages. So if an airport adds new routes or a railway or highway hub a new spoke, this framework will allow estimate of the added agglomeration growth potential for the linked cities.

Table 5.9. Portugal AGP Results

5.9a. Portugal Existing AGP by City - Auto

| <i>Community</i> | Lisbon | Leiria | Coimbra | Aveiro | Porto | <i>Total</i> |
|------------------|--------|--------|---------|--------|--------|--------------|
| Lisbon | - | 0.453 | 0.935 | 0.438 | 1.604 | 3.43 |
| Leiria | 20.008 | - | 3.362 | 2.168 | 6.128 | 31.67 |
| Coimbra | 12.136 | 0.989 | - | 2.986 | 11.165 | 27.28 |
| Aveiro | 5.907 | 0.663 | 3.104 | - | 18.408 | 28.08 |
| Porto | 3.960 | 0.342 | 2.122 | 3.367 | - | 9.79 |

5.9b. Portugal Existing AGP by City -IC Train

| <i>Community</i> | Lisbon | Leiria | Coimbra | Aveiro | Porto | <i>Total</i> |
|------------------|--------|--------|---------|--------|-------|--------------|
| Lisbon | - | 0.024 | 0.460 | 0.210 | 0.538 | 1.23 |
| Leiria | 1.075 | - | 0.253 | 0.304 | 0.569 | 2.20 |
| Coimbra | 5.970 | 0.074 | - | 2.192 | 5.603 | 13.84 |
| Aveiro | 2.840 | 0.063 | 2.014 | - | 9.210 | 14.13 |
| Porto | 1.328 | 0.031 | 0.942 | 1.685 | - | 3.99 |

5.9c. Portugal Existing AGP by City - AP Train

| <i>Community</i> | Lisbon | Leiria | Coimbra | Aveiro | Porto | <i>Total</i> |
|------------------|--------|--------|---------|--------|--------|--------------|
| Lisbon | - | - | 0.599 | 0.336 | 0.968 | 1.90 |
| Leiria | - | - | - | - | - | 0.00 |
| Coimbra | 7.776 | - | - | 2.291 | 6.604 | 16.67 |
| Aveiro | 4.532 | - | 2.381 | - | 11.333 | 18.25 |
| Porto | 2.390 | - | 1.255 | 2.073 | - | 5.72 |

5.9d. Portugal Existing AGP by City - Air

| <i>Community</i> | Lisbon | Leiria | Coimbra | Aveiro | Porto | <i>Total</i> |
|------------------|--------|--------|---------|--------|-------|--------------|
| Lisbon | - | - | - | - | 1.843 | 1.84 |
| Leiria | - | - | - | - | - | 0.00 |
| Coimbra | - | - | - | - | - | 0.00 |
| Aveiro | - | - | - | - | - | 0.00 |
| Porto | 4.549 | - | - | - | - | 4.55 |

5.9e. Portugal Proposed AGP by City - HSR

| <i>Community</i> | Lisbon | Leiria | Coimbra | Aveiro | Porto | <i>Total</i> |
|------------------|--------|--------|---------|--------|--------|--------------|
| Lisbon | - | 0.585 | 1.333 | 1.071 | 4.796 | 7.78 |
| Leiria | 25.818 | - | 2.739 | 2.201 | 9.853 | 40.61 |
| Coimbra | 17.307 | 0.805 | - | 3.284 | 14.122 | 35.52 |
| Aveiro | 14.456 | 0.673 | 3.413 | - | 17.597 | 36.14 |
| Porto | 11.835 | 0.551 | 2.684 | 3.219 | - | 18.29 |

Table 5.10. Illinois AGP Results

5.10a. IL Existing AGP by City - Auto

| <i>Community</i> | Chicago | Kankakee | C-U | Decatur | Springfield | St. Louis | <i>Total</i> |
|------------------|---------|----------|-------|---------|-------------|-----------|--------------|
| Chicago | - | 1.172 | 0.838 | 0.211 | 0.247 | 0.328 | 2.79 |
| Kankakee | 213.361 | - | 2.837 | 0.658 | 0.595 | 1.869 | 219.32 |
| Champaign-Urbana | 54.761 | 1.018 | - | 2.320 | 2.016 | 6.330 | 66.45 |
| Decatur | 23.173 | 0.398 | 3.907 | - | 4.669 | 15.260 | 47.41 |
| Springfield | 15.847 | 0.210 | 1.979 | 2.723 | - | 28.940 | 49.70 |
| St. Louis | 1.354 | 0.042 | 0.400 | 0.572 | 1.861 | - | 4.23 |

5.10b. IL Existing AGP by City - Train

| <i>Community</i> | Chicago | Kankakee | C-U | Decatur | Springfield | St. Louis | <i>Total</i> |
|------------------|---------|----------|-------|---------|-------------|-----------|--------------|
| Chicago | - | 0.193 | 0.172 | - | 0.070 | 0.089 | 0.52 |
| Kankakee | 35.071 | - | 0.739 | - | - | - | 35.81 |
| Champaign-Urbana | 11.216 | 0.265 | - | - | - | - | 11.48 |
| Decatur | - | - | - | - | - | - | 0.00 |
| Springfield | 3.666 | - | - | - | - | 5.373 | 9.04 |
| St. Louis | 0.368 | - | - | - | 0.422 | - | 0.79 |

5.10c. IL Existing AGP by City - Air

| <i>Community</i> | Chicago | Kankakee | C-U | Decatur | Springfield | St. Louis | <i>Total</i> |
|------------------|---------|----------|-------|---------|-------------|-----------|--------------|
| Chicago | - | - | 0.253 | 0.046 | 0.129 | 4.999 | 5.43 |
| Kankakee | - | - | - | - | - | - | 0.00 |
| Champaign-Urbana | 16.552 | - | - | - | - | - | 16.55 |
| Decatur | 5.040 | - | - | - | - | 2.013 | 7.05 |
| Springfield | 8.309 | - | - | - | - | - | 8.31 |
| St. Louis | 20.635 | - | - | 0.075 | - | - | 20.71 |

5.10d. IL Proposed AGP by City - HSR

| <i>Community</i> | Chicago | Kankakee | C-U | Decatur | Springfield | St. Louis | <i>Total</i> |
|------------------|---------|----------|-------|---------|-------------|-----------|--------------|
| Chicago | - | 1.261 | 2.131 | 0.865 | 1.266 | 7.381 | 12.90 |
| Kankakee | 229.678 | - | 3.883 | 1.577 | 2.306 | 13.449 | 250.89 |
| Champaign-Urbana | 139.307 | 1.394 | - | 2.600 | 3.802 | 22.174 | 169.28 |
| Decatur | 95.266 | 0.953 | 4.378 | - | 5.560 | 32.425 | 138.58 |
| Springfield | 66.465 | 0.665 | 3.054 | 2.652 | - | 46.475 | 119.31 |
| St. Louis | 30.468 | 0.305 | 1.400 | 1.216 | 3.653 | - | 37.04 |

5.10e. IL Proposed AGP by City - Lower speed HSR

| <i>Community</i> | Chicago | Bloomington-Normal | Springfield | St. Louis | <i>Total</i> |
|--------------------|---------|--------------------|-------------|-----------|--------------|
| Chicago | - | 0.338 | 0.119 | 0.368 | 0.83 |
| Bloomington-Normal | 17.768 | - | 1.016 | 3.126 | 21.91 |
| Springfield | 7.670 | 1.241 | - | 7.240 | 16.15 |
| St. Louis | 1.518 | 0.246 | 0.466 | - | 2.23 |

5.3.3.1 *Takeaways*

As we assess the results for these case proposals, immediately obvious are several resultant takeaways. Overall, the AGP in the principal cities is far lower than the other cities. This makes sense as these principal cities add very little agglomeration from outside their community. However, the smaller outlying communities can add tremendous opportunity via the larger principal city. The value of potential agglomeration flowing out of the largest and richest cities is clearly more than that from small cities. Reading down in the first column shows how this potential fades as distance from the larger economy grows. For instance, in 5.10a we see Kankakee receives an AGP over 200 via auto from Chicago, which falls to around 50 in Champaign-Urbana, and to just over one in St. Louis. Thus, overall AGP tends to reduce as we move away from the principal cities.

This also indicates that the economy matters, as larger centers of economic activity disperse greater agglomeration growth potential. Illinois, with HSR values ranging up to 250, has greater agglomerative potential than Portugal, with values ranging only up to 40, despite Illinois' cities being spread further apart. This is due to Illinois' relative economic vitality. With higher productivity and population, the Illinois cities offer more potential agglomerative benefit. To further illustrate this, the cities are listed by their economic mass in Appendix B.

Further, frequency matters, as lower frequencies cannot be made up for by quick travel times. In Illinois, sensitivity analysis shows that if the frequency of the proposed HSR system dips its advantage over auto begins to shrink. And in the case of Kankakee, where auto travel into the Chicago metropolitan area is relatively easy, if the frequency dips below 15 HSR trips per day, auto maintains its lead over HSR. If HSR frequency is only 14/day the AGP from HSR for Kankakee is only 217.48, lower than the auto's 219.32. We can also see that the AGP via existing non-auto modes in Illinois is severely hampered by their extremely low frequencies. It is little wonder mode share for autos in Illinois is over 90% when, in the instance of Champaign-Urbana, AGP is ten times more for auto than the existing train services. Therefore, whether the proposed Illinois HSR truly will achieve the high frequency shown in the feasibility study²⁹² is an important consideration as the project progresses.

Additionally, speed really matters, with travel time differences clearly illustrated. Note the difference in performance between the regional-quality train services (with speeds between 80 and 150 mph) and the proposed international-quality service (with speeds greater than 150, and proposed over 200, mph). Despite being billed as high-speed rail, these slower services do not offer users benefits beyond what they could attain via a personal vehicle. We see this as AGP values in 5.9c and 5.10e are lower than 5.9a and 5.10a. It appears that both Portugal and Illinois would experience significant additional benefits from the potential flow of agglomerative benefits along these proposed express HSR systems. Thus, the incremental improvement offered by international-quality high-speed rail proves to move high-speed rail as an alternative mode past auto, a significant tipping point. This speaks strongly to the worthwhile pursuit of the highest speed train projects.

Additional figures more completely illustrate the results. Figures 5.12 through 5.15 convey the results compared to each other across modes and cities in both Portugal and Illinois. We see more clearly here, for instance, that in Portugal, the existing non-auto modes are more favorable than in Illinois due to their relatively greater travel time efficiency and frequency.

²⁹² University of Illinois at Urbana-Champaign and University of Illinois at Chicago, *220 MPH High Speed Rail Preliminary Feasibility Study Executive Report*.

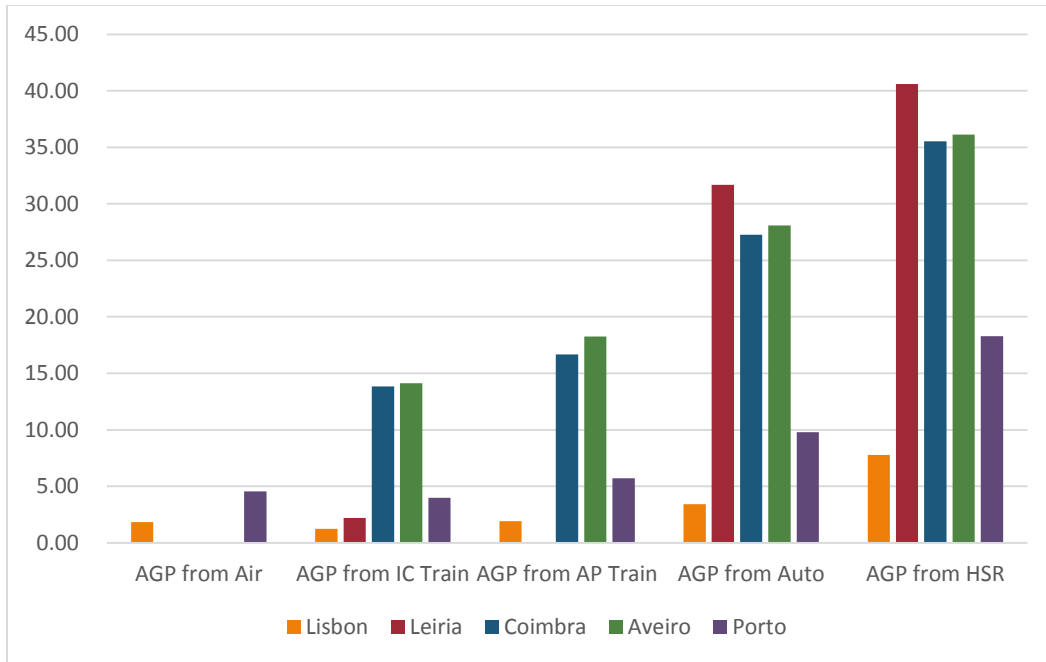


Figure 5.12. Portugal Mode AGP by City (Source: author)

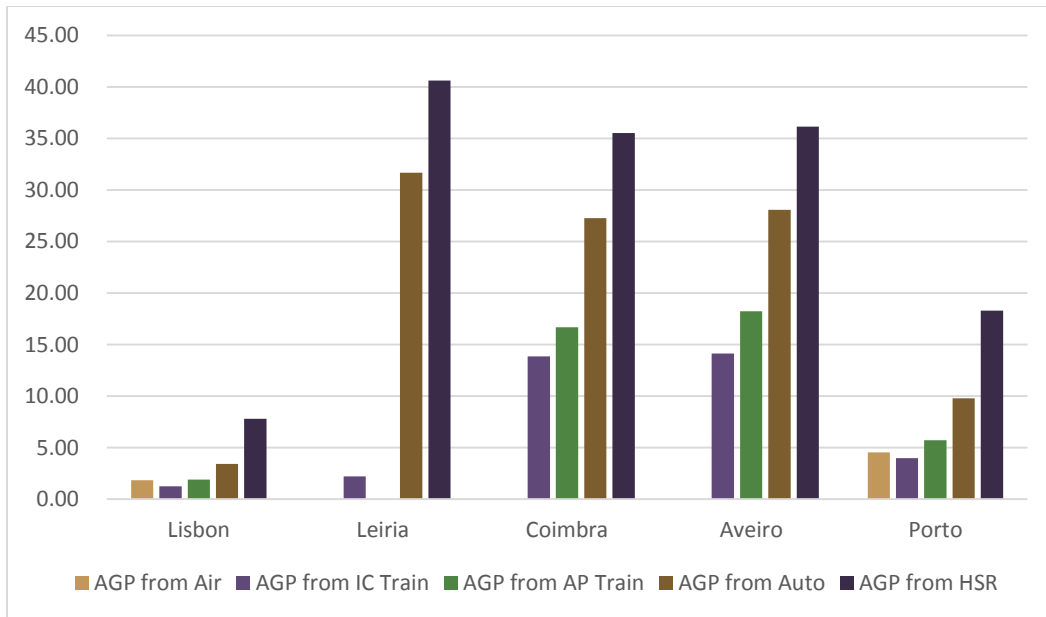


Figure 5.13. Portugal City AGP by Mode (Source: author)

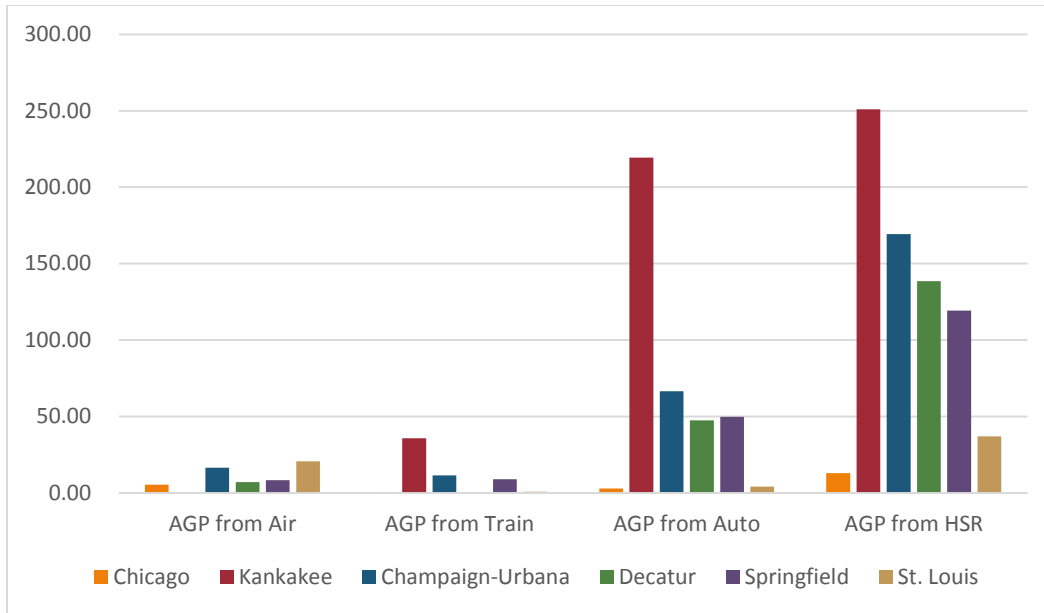


Figure 5.14. Illinois Mode AGP by City (Source: author)

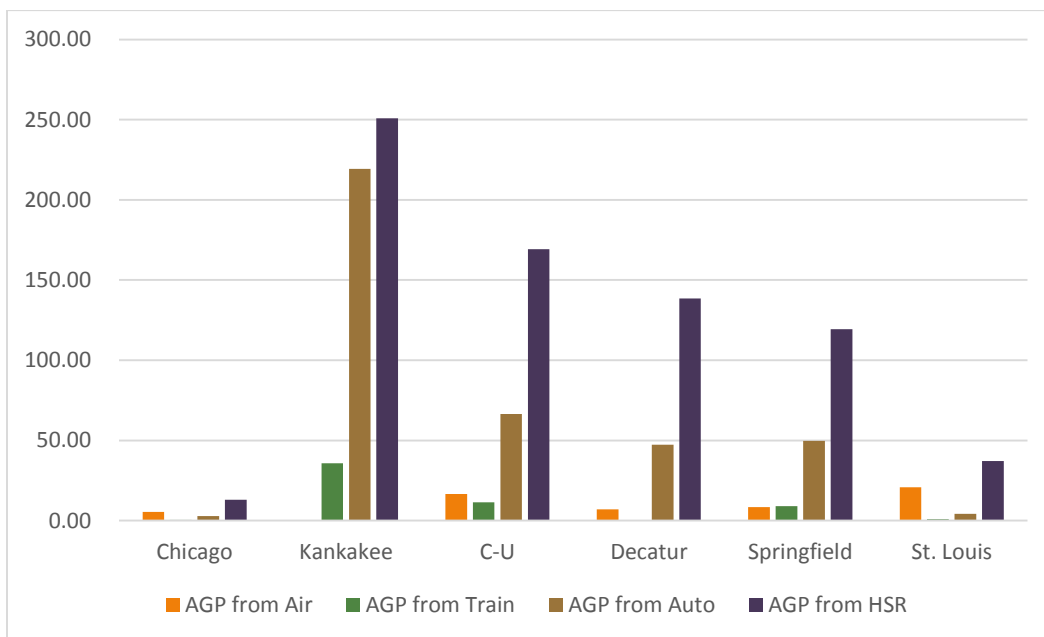


Figure 5.15. Illinois City AGP by Mode (Source: author)

The existing mode with the highest agglomeration growth potential for all locations except two is auto, as seen here and in Tables 5.9a and 5.10a. Clearly, the value of nearly ubiquitous potential service frequency along with the other conveniences of personal vehicles indicate this result makes sense. The two locations where the mode of choice is not auto are St. Louis and Chicago, which feature large international airports, and, in the case of Chicago the most connected airport nationally, and, in the case of St. Louis the most connected medium-sized airport.²⁹³

²⁹³ Wittman and Swelbar, *Modeling Changes in Connectivity at U.S. Airports*.

But despite the relatively high performance of auto, the proposed HSR systems improve upon that mark. As can be seen in Tables 5.11 and 5.12, the potential for agglomeration growth is increased in all cases based on the current HSR proposals. With the addition of HSR, AGP improves by approximately 25% to 125% in Portugal and 15% to 150% in Illinois amongst the case communities. This is a noteworthy and positive result as we consider the potential for agglomeration dispersion along HSR lines.

Table 5.11. Portuguese AGP Improvement

| City | Best Existing Mode | % improvement w/ HSR |
|---------|--------------------|----------------------|
| Lisbon | Auto | 126.95% |
| Leiria | Auto | 28.25% |
| Coimbra | Auto | 30.22% |
| Porto | Auto | 86.79% |

Table 5.12. Illinois AGP Improvement

| City | Best Existing Mode | % improvement w/ HSR |
|------------------|--------------------|----------------------|
| Chicago | Air | 137.76% |
| Kankakee | Auto | 14.40% |
| Champaign-Urbana | Auto | 154.76% |
| St. Louis | Air | 78.86% |

Interestingly, the greater magnitude of improvement is at the project termini in Portugal (Lisbon and Porto) but found along the center of the system in Illinois (Champaign-Urbana). This is likely due in part to the overall length of the Illinois system, but also speaks to a potential differentiation in effects between these two projects.

Finally, these results again call into question some of the prior projections prepared for these HSR systems. As reported in Table 4.4, these ridership volumes form the basis for projections as to a future system's feasibility. Based on the differences in results, questions about a couple of these projections are confirmed. First, the volume between Kankakee and Chicago seems too low. At the price we have projected in Table 5.8, HSR should be anticipated as extremely competitive. In Portugal, we would anticipate volumes between Coimbra and Lisbon to more closely match those anticipated between Leiria and Lisbon. Additionally, we would expect that projected ridership volumes will match the difference in AGP, with cost taken into consideration. And we further believe that these results could be used to more carefully project the proposed mode shares and volumes as these projects are planned.

5.3.3.2 A Robust Proof of Concept

Based on the results shown, it can be first be observed that the methodology framework prepared appears to return robust results. This indicates strong potential for this concept, and serves as a valuable proof of concept for this process. The results, at first glance, appear to be legitimate and informative. Based on these results, the framework should be further explored, with additional data sets input. Further potential next steps are outlined in Chapter 6.

With this concept outlined and the results reported, we can turn to a complete look at the findings and conclusions based on this work in Chapter 6. As well, recommendations for the case communities in addition to next steps for this research are summarized.

Chapter 6

6 FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

*HSR has the greatest potential to add needed transportation capacity in the most cost-effective manner possible... It is our nation's single greatest hope for expanding and improving our national, regional and local transportation network.*²⁹⁴

- Christopher J. Taylor

*Instead of focusing on enormously expensive high-speed rail as our transportation future, the government would do well to stop hindering [innovation] by its obsolete thinking about our nation's roads.*²⁹⁵

- Clifford Winston

6.1 FINDINGS

We began this research wondering in Chapter 1 whether the HSR systems of today can transform our urban and regional connections. And specifically, to what extent they are capable of doing so? We expanded our context in Chapter 2 by providing background on the geography of our focus, that being cities and their metropolitan areas, megapolitan regions, and megaregions. Through our research efforts, outlined in Chapters 3 through 5, we have shown tangible results that point to specific returns on such potential investments in settings such as these. Specifically we saw that Agglomeration Growth Potential (AGP) provided by HSR improves over the best existing mode by approximately 25% to 125% in Portugal and 15% to 150% in Illinois amongst the case communities.

We have thus explored the mechanisms by which hoped-for economic growth would take place in conjunction with significant transportation investment. In particular, via the proof of concept for a methodology developed in this research, we have focused on measurement of the spread of agglomeration along these HSR lines. In other words, accessibility to agglomeration, as a driving economic force for the connected communities, matters. Using our case communities of Coimbra and Leiria in Portugal and Champaign-Urbana and Kankakee in Illinois, we have illustrated the extent of this dispersion. Based on this analysis, and the corollary background research, several findings can be elucidated.

6.1.1 Major Findings From the Literature

First, we direct readers to the major findings captured in the literature predating our own work. This list can by no means be exhaustive, but several examples of past work that proved integral in this research are highlighted. All these are worth further review by the interested reader.

This work was organized around a few concepts, each of which has influential past research. In the area of the unique role of cities, the work of economists such as Glaeser (several citations as listed in the bibliography) or physicists such as Bettencourt (2013) rises to the top. The extensive work from Florida (several citations) and Katz (several citations) is also very helpful. In discussion of the HSR systems,

²⁹⁴ Taylor, "Selling the Value of High-Speed Rail".

²⁹⁵ Winston, "Paving the Way for Driverless Cars".

Givoni (2006) provides helpful background on HSR trains. Several papers dealing with the overall economic impacts of HSR or transportation more broadly are helpful, especially Banister and Berechman (2001), Chen and Hall (2011), de Rus (2012), Loukaitou-Sideris et al (2013), and Ottaviano (2008). In the specific arena of wider economic impacts, Banister and Thurstain-Goodwin (2011), Lakshmanan (2011), and Vickerman and Uljed (2009) are useful. In understanding the relationship between transportation and agglomeration, the work of Graham is fundamental, and especially useful is Graham and Melo (2011). For understanding accessibility measurements, we point to Gutiérrez (2001) and Zheng and Khan (2013) as essential. In providing crucial background on the underlying economic theory, we suggest the work of Ahlfeldt and Feddersen (2010), Fang (2013), the seminal Fujita et al (1999), and Hanson (2005). There are undoubtedly more, and glaring omissions are solely the responsibility of the author.

Lastly, this work builds on past work conducted within the research group at MIT from which it originates. Past theses by Stein (2013) and Melibaeva (2010) proved especially useful. These theses addressed regional planning implications while focusing on the Portuguese HSR project also subject in this work. Stein’s work was particularly helpful as she narrowed focus to intermediate cities such as Coimbra and Leiria while also contributing to the regional planning perspective we carry forward here.

6.1.2 Perspective and Quantitative Framework

The major contribution of this thesis is the conceptualization of these HSR-linked regional systems as a string of interconnected cities with dynamic effects for the intermediate cities moving within the principal cities’ commuting areas. Figure 6.1 illustrates the regional hierarchy introduced. This perspective was then the basis for a quantitative proof of concept prepared to measure the accessibility to agglomeration in our case communities. The surrounding background and discussion of corollary effects for the case cities and their regions provide a unique vantage point on such proposed infrastructure investments. We have thus formulated a methodological concept that provides robust findings on the extent of agglomeration growth potential for communities linked by a new transportation system. This methodology is based on past accessibility indicator work and measures agglomerative spread. The approach laid forth should prove helpful in quantifying the wider economic benefit provided by agglomeration and will offer insights to future planning endeavors.

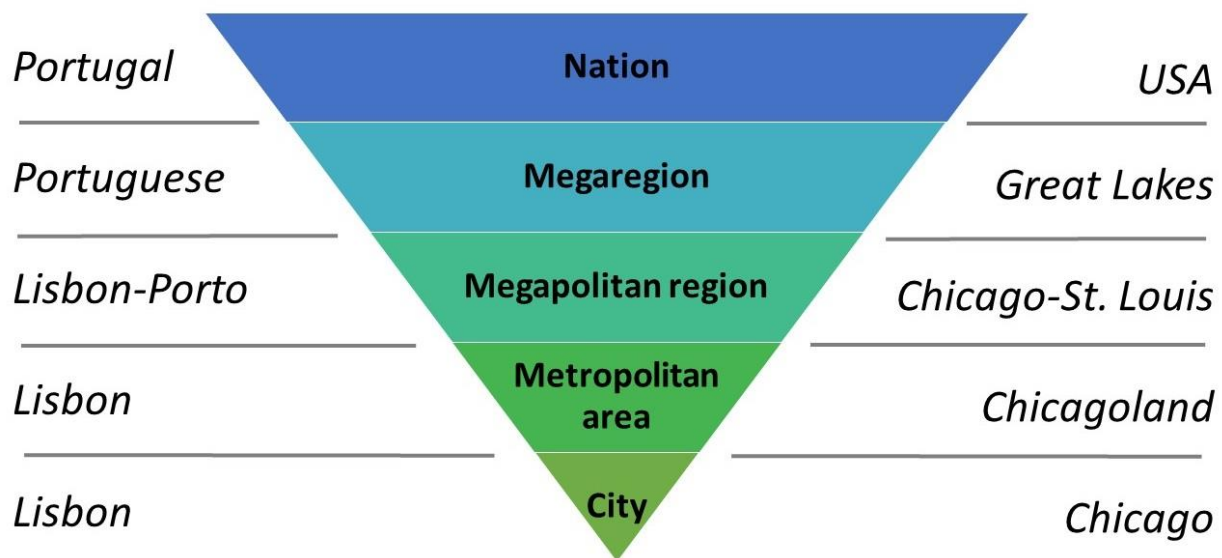


Figure 6.1. Case Geography Regional Hierarchies (Source: author)

Our methodology, resulting in an indicator of agglomeration growth potential, features three components, as conveyed in Chapter 5. These include a measure of agglomeration economy mass, a measure of frequency provided by transport modes, and a measure of travel time. The economic mass component uses Gross Domestic Product per capita and an author-generated estimate of agglomerative employment in various sectors. The frequency component uses a logarithmic function of the available modal frequency. And the travel time component uses an exponential function to generate the decay brought by distance.

The result of this formulation can be used to assess relative impacts brought by large-scale transportation investments such as the HSR systems proposed in the case geographies. In our case, this speaks to the potential for HSR as well as the potential impacts in our case communities. Again, we show that HSR can improve AGP amongst the case communities by approximately 25% to 125% in Portugal and 15% to 150% in Illinois over the best existing modes.

6.1.3 Case City Impacts

The communities part of the proposed Portuguese and Illinois HSR systems, Coimbra and Leiria in Portugal and Champaign-Urbana and Kankakee in Illinois, will see economic development as part of these proposals. One question is to what extent this economic development is growth as opposed to redistribution²⁹⁶; our research is not intended to answer this question. What we do show is that there is potential growth through access to agglomeration amongst all our case communities based on the HSR systems proposed. That this may occur at the expense of other unconnected cities part of the same metropolitan area cannot be determined here. Further, we are able to show several specific findings about the impacts felt in our case cities.

6.1.3.1 *HSR can move cities into the commuter shed of nearby principal cities*

We have shown that the time-space effects of HSR travel will bring previously outlying intermediate cities in a region into the commuting area of a principal city. Past literature has shown commutes typically extend to approximately one hour²⁹⁷, so the reduction of travel time to below that threshold induces this effect. Specifically in our case communities, Coimbra and Leiria in Portugal and Champaign-Urbana and Kankakee in Illinois will all move into the commuter shed of Lisbon and Chicago, respectively. This move from a non-commuting area to a commuting one occurs around the important one-hour travel time threshold. This illustrates why we considered travel time rather than simple geographic distance. This move also allows daily accessibility, which offers significant economic differences beyond occasional (say, once a week) travel. Further, this move has been facilitated by the significant relative travel time savings HSR allows beyond other modes, especially for city-center to city-center travel. This can have strong effects on the metropolitan form, and serve to reshape a megapolitan region's interior. This transformation will not affect these cities equally, however.

6.1.3.2 *Past literature showing interregional findings may not accurately capture the intraregional dynamics*

The spatial-economic effects of a HSR proposal are still an unsettled debate. A common assertion in the field of transportation economics is that a significant transportation investment such as a HSR system that creates transformative time-space effects may only serve to make the most well off cities more

²⁹⁶ For further discussion of the extent to which HSR brings economic development, refer to Levinson, *Economic Development Impacts of High Speed Rail*.

²⁹⁷ As was introduced more thoroughly within Section 1.2.1.

dominant.²⁹⁸ Others maintain that intermediate cities can be strengthened by their newfound access.²⁹⁹ Potential effects that could induce the former have been outlined. These include the *straw effect*, by which economic activities move to more desirable central locations along transport infrastructure (the primary city is “sucking up” the secondary’s resources), and the *shadow effect*, by which economic activities move to the gateway location (the primary city’s gateway capacity casts a shadow over the secondary city’s capabilities).³⁰⁰ In both cases, it is thought that economic clustering will be more likely in the principal city. Thus, many deduce that a large-scale transportation improvement such as HSR will actually strengthen the economic activity of the gateway metropolitan hub.

However, some of these purported effects are based on past work conducted at varying scales, many at the interregional level between separate megapolitan regions or megaregions.³⁰¹ The evidence of this thesis, as conveyed in Table 5.11 and 5.12, where we see the potential for significant gains in the intermediate cities in Illinois suggests the intraregional scale, or economic shifts within one megapolitan region, may return differing results than prior interregional research indicates. But the results are mixed, as in Portugal it appears the terminus cities may gain most. A key differentiator appears to be the distances traveled when comparing against existing modes, or the size of the region. Further empirical exploration is needed here.

Past literature does suggest the potential for this intermediate growth potential scenario. It is observed that geographic disparities could potentially be mitigated by transportation in three cases: 1) If the prices (of goods, real estate, etc.) are much lower in the secondary location, 2) If this better infrastructure allows for long-distance commuting, or 3) If improving communication technology coupled with the transportation improvement allow a far-off place to feel closer, fostering local culture and knowledge diffusion within the outlying cities.³⁰² All these conditions appear to be met within intermediate cities moving into commuting reach of a large city. Our exploration could perhaps add another category; if the intermediate city is home to its own bed of knowledge in the form of a distinguished research university or key segments of the knowledge economy like technology or healthcare it may also gain further impetus for growth with a new transportation linkage. Furthermore, as previously outlying cities are moved into the commuter shed of a single metropolitan area, these outlying cities will exhibit specific strengths within the newly shaped overall metropolitan area that could bring them new competitive advantages.

Therefore, our research appears to show economic growth potential within intermediate cities, and suggests that HSR may not only improve the stature of its principal cities.

6.1.3.3 HSR could serve to reinforce the type of development central to micro-urban areas

We have posited the creation of micro-urban intermediate regional points at HSR station nodes within daily reach of principal cities. The daily patterns of usage suggested by such a system reinforce the types of development fundamental to such micro-urban settings. This also serves to support the types of development that are seen as most livable and bringing sustainable quality of life. Residents in sprawling areas have been shown to be comparatively economically disadvantaged and of poorer health than

²⁹⁸ Puga, “Agglomeration and Cross-Border Infrastructure”.

²⁹⁹ Chen and Hall, “The Impacts of High-Speed Trains on British Economic Geography”.

³⁰⁰ Ottaviano, “Infrastructure and Economic Geography”.

³⁰¹ Puga, *European Regional Policies in Light of Recent Location Theories*.

³⁰² Ottaviano, “Infrastructure and Economic Geography”.

those in more compact livable development.³⁰³ Therefore, the micro-urban concept, built on past urban planning precepts³⁰⁴, holds great promise as a pattern of development for small regional cities linked to principal metropolitan areas. Additionally, the types of jobs well supported by HSR travel are likely to be those this research shows as most agglomeratively benefited. Thus, we could expect to see jobs transformation in these linked communities towards knowledge-based industries such as education, technology, and healthcare. These job types will also reinforce the micro-urban nature of these communities. This thesis thus shows that new transportation capability together with existing local strengths could propel knowledge-based communities such as Coimbra and Champaign-Urbana forward as micro-urban prototypes.

6.1.4 Regional Impacts

Just as the affected cities realize HSR effects, the region(s) within its spread do as well.

6.1.4.1 *Microregional effects are not substantial*

Potential exists for microregions to form between linked outlying cities along a HSR line.³⁰⁵ While this may indeed be the case, and increased economic cooperation could emerge, our findings conveyed in Chapter 5 show the economic effects felt between these cities is not substantial in the presence of the much larger metropolitan areas just beyond. Tables 5.9 and 5.10 show that in Portugal more than 80% of the economic potential in intermediate cities is from the termini cities and in Illinois it is more than 90% for all such cities. In short, the agglomeration available from Lisbon and Chicago matters far more to a community than the economic influence of the closest station cities. While every bit of economic growth matters, and certainly Leiria and Kankakee will benefit from added connection to Coimbra and Champaign-Urbana, respectively, the shift to being part of the principal city's functional metropolitan area, or commuting region, is more important than the microregion connections formed.

6.1.4.2 *HSR effects are megapolitan and megaregional*

At what scale is the phenomenon that is economic benefit from HSR focused? We suggest it affects all levels of the regional hierarchy. HSR reinforces the regional connection from megapolitan region end to megapolitan region end (with an optimal travel spread of 200-500 miles). And as a prototypical form of transport for megaregions, HSR thus also serves to revitalize the megaregion as a whole. It does this by strengthening connections between metropolitan areas, transforming them to megapolitan regions, and linking these as well. With a network of these linkages, clusters of megapolitan regions are joined facilitating greater accessibility megaregion-wide.

6.1.4.3 *HSR effects are metropolitan*

HSR also helps grow the metropolitan areas from which it extends, spreading their commuting regions and improving their local economic potential. By improving the individual metropolitan success, as well as megapolitan linkages, the megaregion success noted above is attained. To the extent a HSR line moves one smaller metropolitan area into the commuter shed (and thus the functional economy) of a larger one (Coimbra to Lisbon or Champaign-Urbana to Chicago, for instance) it is helping create megapolitan connections, which in turn are linked to form megaregions.

³⁰³ *Measuring Sprawl 2014*.

³⁰⁴ From the Garden City movement to New Urbanism and Transit-Oriented Development.

³⁰⁵ As discussed in Section 4.3.3, and shown on Figure 1.2.

Really, the notion discussed in Chapter 2 that a nation's growth is driven by its economic engine cities only partially captures the layers of influence. A nation is as productive as its megaregions, which are as productive as their megapolitan regions, which are as productive as their metropolitan areas, which are as productive as their central core business districts. A nation's economy is based on the building blocks of all its geographic components. And HSR serves to link these layers in a unique and agglomerative way.

6.1.5 HSR Implications

In our last set of findings, we note the implications from this research for the future of HSR investment.

6.1.5.1 *Past literature provides a broad overview of HSR benefits*

As the quotes at the beginning of this final chapter make clear, there are strong and opposing opinions on the value of HSR. As we have outlined, it requires a large investment, and dialogue on benefits remains ongoing.³⁰⁶ Many have expressed caution at investment in such "megaprojects", observing that the economic growth often promised does not necessarily materialize.³⁰⁷ HSR undoubtedly requires high costs. To deal with apprehensions over potential HSR investment, both concerns with its high price as well as questions as to whether it brings the benefits it purports to must be answered. This research does not speak to these high outlays, but rather focuses on specific aspects amongst the benefits. The past literature review has provided a broad overview of consensus for HSR benefits.³⁰⁸

HSR investment brings many direct and indirect benefits to users, communities, and the regions and nations they are in. These benefits include direct ones such as **added capacity**, which supports new riders as well as relieving congestion on existing railway links and/or alternative modes, and **reduced travel times** for users versus prior modes, which together build new intercity relationships.³⁰⁹ Or, additionally, several more indirect benefits are realized, including **environmental** benefits resulting from a reduction in pollution and energy use per user, affirmative **city form** growth and development incentive and ease of use with typically **city-center to city-center travel**, and **time-space effects** that improve the economic geography by bringing places functionally closer.

6.1.5.2 *The wider economic benefits from HSR matter*

In addition to the direct benefits found from HSR, this thesis has shown wider spatial implications of HSR, and that there is also the potential for economic benefit from agglomerative value found in HSR systems. Not only do we share the current state of understanding in the literature that agglomeration happens and is important³¹⁰, but our Chapter 5 results show HSR can add agglomerative benefit. This is another part of the overall benefits a HSR proposal brings, which should be quantified and included in any benefit-cost analysis.³¹¹ A dollar value for the wider economic value of added agglomeration shown here could be estimated, which would improve the evaluation of these case projects, as well as other proposals globally. Building on past such nascent work, further exploration of the monetized value of these wider economic benefits would thus be useful. This proof of concept quantification methodology showing the agglomeration growth potential for each of the cities on the Portuguese and Illinois systems provides a valuable first step in a new look at these values. Do the positive outcomes make worthwhile

³⁰⁶ Levinson, *Economic Development Impacts of High Speed Rail*.

³⁰⁷ Flyvbjerg, Bruzelius, and Rothengatter, "Chapter 6: Regional and Economic Growth Effects".

³⁰⁸ Givoni, "Development and Impact of the Modern High-Speed Train: A Review".

³⁰⁹ Garmendia, Ribalaygua, and Ureña, "High Speed Rail: Implication for Cities".

³¹⁰ As outlined in Section 1.2.3.

³¹¹ Venables, "Evaluating Urban Transport Improvements".

the large up-front investments required? Further work will hopefully continue to show the answer to this important question. But it is clear that there are wider economic and ancillary benefits brought by HSR that must be fully considered to provide that complete answer.

6.1.5.3 HSR speed and frequency matter

For these benefits to accrue, however, the HSR systems must exhibit certain key characteristics. The most important one is that the line must actually bring a travel time savings over existing modes. And we have further shown that there is a potentially significant difference between international-quality and regional HSR in this regard. While transportation planners have rightly deemphasized sheer speed in favor of actual travel time,³¹² the difference in speed between these HSR types results in a difference in travel time. We have shown that auto use is still more worthwhile versus regional HSR. However, the time-space effects of international-quality HSR lines result in an advantage for this fast service over auto. Thus, while travel time is what really matters, the speed we need to get the travel times we need to make the HSR investment competitive is a critical consideration in HSR system design. And this points to the need to seriously consider international-quality proposals rather than regional HSR. Furthermore, an appropriate frequency should be set such that HSR can offer a competitive service versus other high frequency modes such as auto or air. The combination of high-speed and appropriate frequency will result in a service that is most advantageous, and thus competitive, for a trip of the right distance.

6.1.5.4 Local access to HSR matters

Because of this importance of travel time, local access to HSR also is essential.³¹³ Even if the HSR travel time is very short, if significant time must be invested in getting to the HSR station this advantage is lost. Therefore, dedicated transportation feeding to the HSR station from key points throughout the station communities is important. But again important is the development of additional business and residential locales nearby the station. Adding as much density as is comfortable in the community's character within walking distance of the station is vital. Then making the connection between the station and the surrounding transport systems and neighborhood as seamless as possible will maximize the interface between people and the city.

Furthermore, this is important for communities to capitalize on the economic growth possible via HSR. Businesses and the local economy will rely on access to this new mode. Therefore, these station locations must become the central transportation hub within their community, with transportation and land use planning to support this role. As others have observed, "On the local level, the focus [must be] on the way the station serves the city, both for the resulting level of service of the HSR and for the future of the cities in terms of development (new urbanized areas, airports, local transportation systems and so forth)."³¹⁴

6.2 CONCLUSIONS

6.2.1 Case City Conclusions

We now return to the geographic focus in this thesis. The resulting importance for both these outlying communities (Coimbra and Leiria in Portugal and Champaign-Urbana and Kankakee in Illinois) and the

³¹² Chen and Hall, "The Impacts of High-Speed Trains on British Economic Geography".

³¹³ Stein, "Spatial Dimensions of High-Speed Rail".

³¹⁴ Garmendia, Ribalagya, and Ureña, "High Speed Rail: Implication for Cities".

principal metropolitan cities (Lisbon and Porto and Chicago and St. Louis) of this transportation investment is clear. Several conclusions are key. As intimated, each case community will see effects that could be variable. It is worth a final closer look at the anticipated impacts on each of the communities as a result of the added HSR network.

First, in Coimbra, we see a knowledge economy that will see improvement in access to the principal cities of Lisbon as well as Porto via HSR. The best existing mode is auto, which HSR betters by over 30%. Corollary to the HSR addition, a new station and surrounding urbanized area are planned. The combination of this new developable area, quick commutable access to the principal Portuguese cities, and an existing solid knowledge economy to build on mean this proposal is valuable for Coimbra. This presents an opportunity to strengthen their position as the national university and healthcare center, while potentially adding agglomerative benefit from the principal cities. We would expect real estate prices as well as wages to rise as Coimbra begins to function as a central area commutable to both Lisbon and Porto.

In Leiria, a mix of manufacturing and tourism signal an area seeking an identity. Access to the principal cities will be improved via HSR over auto at almost the same proportion as in Coimbra. But due perhaps to their existing lack of reliable rail service it is a more highway-centric area and mode shifts may be slower. Further, the proposed station is located out of the urban center. While this location could possibly help the District as a whole, it raises caution from Leiria's perspective. The location on this proposed line, versus being bypassed by the Alfa Pendular service, is important, but corollary planning may not bring the return hoped for. The local economy is less well-based in the knowledge economy, and from this perspective as well the HSR may not be as strong a match to the city's makeup. While we would expect some real estate speculation around the station location, we are less certain of the overall community lift foreseen elsewhere. It is possible some of the Leiria area's assets could be siphoned off not only to Lisbon but to Coimbra. We might expect much of this area to begin functioning as a bedroom community as opposed to an economic center on its own.

Champaign-Urbana, like Coimbra, is strongly focused on the knowledge economy and it sees the largest improvement via HSR over auto of any of our case communities. The best existing mode is auto, which HSR betters by greater than 150%. Simply put, the new rapid access to the center of Chicago brings tremendous potential for both Chicago and Champaign-Urbana. With a new existing station in the burgeoning downtown Champaign area, the opportunity for new growth at the center of town is clear. This new commutable access and the strong existing knowledge economy on which to build mean this HSR proposal brings potential for high wider value to the Champaign-Urbana area. This access would be expected to strengthen the status of the university, with gains also possible for other knowledge-based local industries. We expect real estate prices as well as wages to rise as Champaign-Urbana begins to become more integrated into Chicago's economy.

In Kankakee, the local economic growth focus is on manufacturing and light industry. While the HSR as proposed shows improvement over the best existing mode of auto, this improvement just over 10% is less than any other community measured. The auto already provides essentially the same service to Chicago. And, in fact, if the frequency of the proposed service is reduced below 15 trips per day, our methodology shows that the auto mode would remain best in the Kankakee area. Thus, Kankakee stands to gain less than the other linked communities. Further, it is not clear this community is well-matched for the HSR proposal. While their beautiful existing station is located downtown, most of their recent growth and new industry has occurred on the outskirts of town. Substantial infill development

may be required to bring the benefits possible via HSR, and it is not clear there is a planning effort in this regard. It is also possible some of the Kankakee area's assets could be siphoned off not only to Chicago but to Champaign-Urbana.

Therefore, it appears that the most advantaged outlying cities upon installation of a HSR line will be Coimbra and Champaign-Urbana. These communities move from outside the commuter shed to within the functional metropolitan area of the principal cities in their region. And they do so with an existing knowledge-based economy conducive to agglomerative transfer via HSR. The prospects for Leiria and Kankakee appear more mixed. Overall, the HSR systems proposed bring an obvious improvement in accessibility over any existing mode. This will bring metropolitan form changes and shift the market within each of these megapolitan regions. Development will follow these investments, and the combination of well-planned land use and these transportation endeavors will serve to bring new opportunities to the regions.

6.2.2 Broader Regional Planning Conclusions

Furthermore, these types of linked communities may be harbingers of the type of regional development more commonplace in the 21st century. The type of clustered dense development we have reflected fits well with HSR development matches the vision for future growth some experts foresee. Observers predict that "...the suburban tract house and the shopping mall will have gone the way of the dinosaurs, and a generation of workers in the knowledge-based economy will flock to high-density, walkable urban mixed-use neighborhoods."³¹⁵ Much of this growth will come in principal metropolitan areas, but some will also occur in "...lower-density "micro urban" communities [where people can] enjoy the same economic opportunities and cultural amenities of urban areas while savoring the pleasures of living close to nature."³¹⁶ These different settings have the common theme of densification and walkable communities, whether they take the form of megacities or dispersed micro-urban centers.

Places such as our case cities, especially Coimbra and Champaign-Urbana, have the opportunity to serve as regional micro-urban prototypes located at the new growing discontinuous edge of larger metropolitan areas. In an uncertain future with ongoing societal shifts featuring social and demographic changes such as the urbanization we have noted, along with a transformative millennial generation and global aging, there are further trends pointing to demand for this type of progression. Advances in technology continue to transform business and government while growing concerns over climate change drive pursuit of sustainability. Advocates claim "...we will see that small cities offer many assets for sustainable living... population density (and the capacity for more); fertile, nearby farmland available for local agriculture, windmills, and solar farms; and manufacturing infrastructure and workforce skills that can be repurposed for the production of renewable-energy technology." They believe these places should position themselves as "...appropriate to the low-carbon twenty-first century: [with] compact, transit-oriented, pedestrian-friendly urbanism..." and surrounding land preserved reminiscent of the Garden Cities design form.³¹⁷

The outlying cities in any region have always played a key role in the overall region's success. Scottish biologist Patrick Geddes introduced the idea of a regional transect that suggests each place in a region is dependent on the others, and the city on the hinterlands. He stated, "In short, it takes the whole region

³¹⁵ Kiger, "Imagining Land Use in 2063".

³¹⁶ Ibid.

³¹⁷ Tumber, *Small, Gritty, and Green*.

to make the city.”³¹⁸ New urbanists have adopted this transect zone idea to illustrate the range of development form across areas. Figure 6.2 shows this concept.

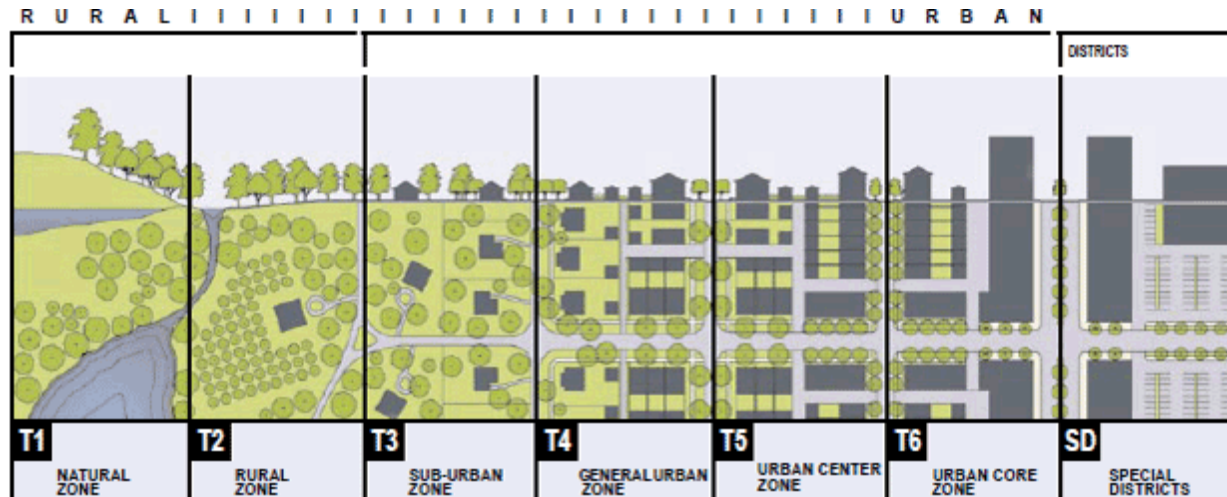


Figure 6.2. Urban Transect Zones (Source: Duany Plater-Zyberk & Company)

Interestingly, recent research has indicated that part of the reason³¹⁹ many megacities in developing countries may not be realizing the agglomerative growth one might expect is due to the broken link between these places and a supportive hinterland.³²⁰ In essence, they have grown despite having the appropriate surrounding natural resources to support them. This again affirms the important role the areas of agriculture, decentralized manufacturing, and knowledge hotspots lying outside Chicago and Lisbon have. An added HSR link that reinforces these symbiotic relationships will support the development essential to continued megapolitan growth, and can transform the planning perspective leaders take.

6.2.3 Realizing This Vision

6.2.3.1 The Potential for Micro-urban Intermediate Points

To actuate the vision for micro-urban garden cities that are now part of the functional metropolitan regions for Lisbon and Chicago, respectively, the case communities must develop parallel planning visions that outline guidelines for all their community growth matching these concepts. Compact development that focuses the community on its economic centers and HSR stations can help build the micro-urban nature that may be desired. The path towards this is clearest in Coimbra and Champaign-Urbana.

In Coimbra, the urbanization plan being developed in conjunction with the new station holds potential to help establish these concepts. In Champaign-Urbana, the existing Champaign downtown around the HSR station can be strengthened, and continued focus on infill development, as opposed to sprawl, could bring returns. In both locations, pathways to the other centers of economic activity (Coimbra's historic downtown and downtown Urbana in Champaign-Urbana) as well as the universities should be made priorities.

³¹⁸ Ibid.

³¹⁹ Another important reason may be the insufficient intracity transportation available in many of these places.

³²⁰ Glaeser, *A World of Cities*.

In Leiria and Kankakee the path towards micro-urban potential is trickier. In Leiria, they are collaborating with the neighboring Marinha Grande on a station between the communities, but somewhat distant from their city center. Emphasizing their urban character simultaneously to developing such a far-flung station will be challenging. In Kankakee, while the station is central, most recent development has occurred at the city fringe, in neighboring villages. Turning back to infill development patterns would represent a pivot in their development strategy. In both Leiria and Kankakee, while being home to industry that benefits from agglomeration like manufacturing, they exhibit less knowledge economy characteristics, which will make positioning themselves in this way more difficult.

For any of these communities to position themselves as a small city with the positive characteristics urban life can bring will take a dedicated planning effort at a metropolitan scale.

6.2.3.2 HSR Alone Does Not Achieve Growth

This metropolitan planning is necessary because, although the addition of a HSR station would induce some redevelopment on its own, HSR alone would not bring the change needed to transform these communities as envisioned. In other words, "...the mere presence of the train is not enough to promote significant economic and territorial improvements."³²¹ Any HSR implementation must be coupled with land and development policies supportive of the growth anticipated in these areas. Various such policies or bundles of policies will exert differing effects on the regions. The case communities must choose their focus wisely, then implementing the proper goals and policies to meet this vision. As Stein observes, "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."³²²

As we noted, with easy access to the HSR station important, a shared planning vision between developers, each city, and the HSR planners must be attained. The policies implemented locally, within each connected city, are important. Best practices here point to integration of the HSR within the area comprehensive plan, with zoning and development incentives pointed towards promoting compact central development with efficient mobility patterns. And this could even mean collaborative measures between the HSR operator and communities to promote a new image that can help bring added tourism and the promotion of new industry can be valuable.³²³ In the end, we do not invest in infrastructure as an end in itself. We do it for the benefits it brings, and with the benefits we have shown for these HSR systems, planners must accommodate this investment in a fashion that further leverages their potential.

6.3 RECOMMENDATIONS

With these findings and conclusions, there are several areas where additional action by the HSR authorities or the case communities may be necessary.

6.3.1 Thinking Broadly

As decision makers approach planning towards making a vision such as that cast above reality, it is helpful to keep several useful lessons in mind. First, it is important to consider all the stakeholders involved in each location. In Chapter 3, we highlighted the various institutions present in each case community. At all these institutions there will be people who care about the outcome of their city and

³²¹ Bellet, Alonso, and Casellas, "Transport Infrastructure and Territory".

³²² Stein, "Spatial Dimensions of High-Speed Rail".

³²³ Bellet, Alonso, and Casellas, "Transport Infrastructure and Territory".

these proposals, and these interested parties must be engaged with. With the opportunity to engage, key stakeholders will help develop and enrich the vision each community strives for. Second, within this thesis, we have elucidated a systems approach. The various systems and subsystems in each geography as well as the institutions managing these places are interconnected in complex ways. Understanding how they interact and affect their surroundings is an important step towards understanding how a new component such as a HSR system will affect its surroundings. Maintaining this systems thinking is fundamental, and reductionist thinking could cause oversights. Finally, we must recognize that the future is quite uncertain. Understanding future scenarios is fraught with error, and the decision makers will be well served to keep options open as they plan for HSR implementation in their communities.

6.3.2 Community Next Steps

Each case community faces challenges in realizing the potential gains made possible by the addition of the proposed HSR systems. Leaders in these communities may be searching for pragmatic next steps to take as they continue planning for the future HSR system in their city. We offer the following ideas:

- Coimbra, Portugal: Two key endeavors seem worthwhile. First, the city should continue development of its urbanization plan and it should be implemented, even prior to HSR construction. This station-surrounding growth will be important to the future HSR success. Establishment of a greenbelt or growth boundary surrounding the city should also be explored. Second, the city should continue planning its local transit upgrades. Access between the new station and two important areas—the historic downtown and the University of Coimbra—must be planned. New examination of the potential for the potential subway, Ramal da Lousã , and commuter rail plan, Metro Mondego, could be worthwhile. As well, the Municipal Urban Transportation Services of Coimbra (SMTUC) must continue to modernize the trolley bus system. Lastly, Coimbra should partner with the University of Coimbra, strengthening their relationship, to build around the intellectual context the presence of this university provides. The university is a key differentiator for Coimbra, and building on this strength is an important part of leveraging what HSR can bring to this city.
- Leiria, Portugal: The ongoing delay in HSR implementation in Portugal may provide an opportunity for Leiria. Their planned regional station between Leiria and Marinha Grande should either have a corollary urbanization plan surrounding or its location should be reconsidered. Exploration of whether a new track and station could be run through Leiria’s historic downtown should be made. While undoubtedly increasing costs, it could bring significant urban benefit. Additionally, branding efforts to focus attention at the proposed station on Leiria’s strengths will be valuable. The manufacturing and industrial zones in the area can be advertised with local transportation provided to these areas. And the tourist destinations should be emphasized, perhaps with images in the station and a dedicated section of the station devoted to guiding people to these destinations. Building on these existing economic strengths will help leverage the potential HSR brings.
- Champaign-Urbana, IL: Champaign-Urbana’s focus should be trifold. First, metropolitan governance is more important than ever. Champaign and Urbana must operate as a close team, making site development location selections based on what is best for the community as a whole. Second, planning efforts must be focused on infill development. There are several parcels around the train station with development potential, and the communities would be well-served by adding growth in this area. Additionally, further outward expansion should be discouraged. Despite an overall character that was noted as the fifth least sprawling nationally, development along its fringe has looked that way over the past 20 years. Establishment of a

greenbelt or growth boundary should be explored. Third, as in Coimbra, transportation connections to key city destinations should be strengthened. Frequent bus service via the Champaign-Urbana Mass Transit District (CUMTD) should be added from the downtown Champaign and station area to locales such as downtown Urbana, the University of Illinois, and the technology research park. Lastly, as was the case in Coimbra, Champaign and Urbana should work together with the University of Illinois to build on the intellectual context the presence of the university provides. The presence of this university is a key differentiator for Champaign-Urbana, and building on this strength is an important part of leveraging what HSR can bring to this city.

- Kankakee, IL: The main challenge in Kankakee is to focus growth within the downtown area. Planning efforts must be focused on infill development, and metropolitan cooperation will be important. The newer neighboring communities where much recent growth has happened may resist this focus, and sound leadership must cast the vision for a stronger metropolitan area as a whole. These neighbors will also grow economically if Kankakee is strengthened. To bring this growth, Kankakee must cast itself as a 21st century innovative manufacturing cluster, building on its existing economic strengths, and a newly close commuting home for Chicago workers. Creating a business-friendly environment, taking advantage of Kankakee’s proximity to the growing freight intermodal facilities in neighboring Will County, will be key.

6.3.3 Regional Next Steps

One challenge facing both our locations is that the economic regions do not necessarily match nation or state boundaries. This means that there is often not a joint planning body from which cohesive planning policy can flow. In Portugal, control is strongest at the national and municipal levels. There is not a strong regional authority with the influence that could be necessary. In the United States and Illinois, both the federal and state governments have jurisdiction. And while each metropolitan area does have a form of governance in an MPO, there is no agency or organization with jurisdiction over the megapolitan regions or megaregions as a whole. Thus, while the borders may not entirely match, the units of government with most control over the entire area of the proposed HSR systems are Portugal and Illinois as a whole. Each faces unique challenges, and we offer the following ideas:

- Portugal: Lacking strong regional governance bodies, the nation must step in, focusing on its areas of competitiveness³²⁴, and help guide development surrounding each of the HSR stops, working to make each metropolitan area as strong as it can. Past research indicates returns for Portugal from infrastructure investment.^{325 326} Strengthening each community’s development standards and planning, leading to more robust developments that will leverage the HSR investment, will strengthen the country’s stature as a whole.

Additionally, these efforts could serve as impetus to merge the metropolitan governance and transportation authorities in Lisbon and Porto, as well as forming similar combined organizations in Leiria, Coimbra, and Aveiro. As we have observed, the nation will be as strong as its regions and cities. With this new linkage forming a stronger Lisbon-Porto megapolitan region, additional connections to both the north (Braga) and south (Setúbal and Faro) and east (Évora) will help solidify the economic status of the entire Portuguese megaregion. Perhaps Portugal can begin to consider itself as a single regional “city” that can compete globally with

³²⁴ Porter, “Portuguese Competitiveness”.

³²⁵ Melo, Graham, and Noland, “Impact of Transport Infrastructure on Firm Formation”.

³²⁶ Pereira and Andraz, “On the Economic Effects of Investment in Railroad Infrastructures in Portugal”.

larger global cities. Furthermore, broader international/interregional cooperation is important. Portuguese HSR investment should happen in concert with development of HSR connections to Spain, to capitalize on Iberian-wide growth prospects.

- Illinois: Illinois must seek to build cooperation amongst metropolitan areas connected by the proposed HSR system. The MPOs at each of the station stops should be communicating with each other and utilizing best practices that will lift the region as a whole. Furthermore, the state could seek to provide incentive for metropolitan areas to develop in a fashion that promotes micro-urban form.

An important component of the state's efforts must be to innovate with their Department of Transportation (IDOT). This statewide transportation agency must be transformed to being a true multimodal agency that discourages sprawl and unnecessary highway investment. Its focus should move to providing a framework for multimodal investment that guides the state's growth and development of vital infrastructure in a manner that will capitalize on this HSR investment to meet 21st century needs. Furthermore, the State must encourage megaregional cooperation across state lines. The recently formed Tri-State Alliance for Regional Development (hoping to foster cooperation between Wisconsin, Illinois, and Indiana)³²⁷ is a step in the right direction, and this effort must be encouraged. Such initiatives cannot be slow to proceed if hoped for future megaregional growth is to occur.

6.3.4 HSR Planning

Based on the agglomerative potential brought by HSR, planners for the Portugal and Illinois HSR systems should endeavor to consider any route improvements or system adjustments that can improve the proposals currently laid forth. Route and station decisions based on the ideas offered in this thesis could add value for each of these planning efforts.

Past literature points to several key factors that can positively influence development potential. Notably, the specific layout of the HSR system and its station nodes is important. Available multimodal connections and local accessibility within cities are important design considerations. Additionally, the characteristics of the service offered, including the available timetable and fare, matter immensely.³²⁸

Ultimately, the case for these proposed HSR systems must be made by the HSR authorities in each venue. To facilitate the ultimate construction of these proposals, a strong economic case for their value must be made, and their potential advantage versus other modes for these routes shown. In both Portugal and Illinois an updated overall cost estimate should be prepared. But that can only be a first step. As well, leaders must quantify the benefits possible, utilizing latest best practices to include the wider economic impacts brought by these lines. With both the costs and benefits summarized, a more complete picture of whether either of these projects are worthwhile can be completed.

6.4 DIRECTIONS FOR FUTURE RESEARCH

In concluding this thesis work, there are several areas that should be noted for future research direction. These next steps would expand upon the research laid forth in this thesis and offer further potential for multiplied findings.

³²⁷ Cahill, "How the Midwest Is Frittering Away Its Shot at Economic Development".

³²⁸ Bellet, Alonso, and Casellas, "Transport Infrastructure and Territory".

6.4.1 Methodological Refinements

As laid forth in Chapter 5, a plethora of assumptions went into creating our methodology. We believe this proof of concept shows the value in assessing agglomerative benefits and provides a useful first step towards more directly monetizing these benefits. However, certain additional exploration in terms of the methodological makeup could be worthwhile. Some items worth noting include:

- The approach we took to determining the value of agglomeration within each industry is unique. Based on our own weighting of the importance of each of the three pillars of agglomeration to each industry category we determined the number of agglomerative employees in each city. This does not produce the overall value of agglomeration (productivity growth beyond population growth) but does produce an estimate of which industries it matters most for. Most past literature has focused on broader industrial categories, namely manufacturing and services.^{329 330} This more nuanced approach holds promise for understanding the specifics of agglomerative benefits at a more detailed level, and thus further exploration is valuable.
- The inclusion of frequency in available transport via each mode within the accessibility indicator framework is important to refine. Further exploration of the functional form this term should take, as well as its interaction with the overall indicator function could be worthwhile. Intuitively we understand that the available frequency of a trip matters for accessibility, but work in this realm continues to be needed. Perhaps further exploration of past literature³³¹ and the overlap between work done in the realm of discrete-choice modeling in regard to headway differentiation and the interaction between related concepts such as wait time, schedule delays, and displacement would be useful.
- Similar further exploration as to the appropriateness of the rate of decline for the distance decay gradient term would also be worthwhile. Here, we would like to examine the potential for a piecewise function that illustrates the drop-off in accessibility that occurs past a daily commuting range. Though our case communities did not require this specificity, communities outside this range may not realize the same benefits. This would help make this concept more completely transferrable.
- Finally, exploration of further connections between this conceptual framework and other past efforts at varying geographic levels would be worthwhile. Past efforts range from national to regional (megaregional and megapolitan) to local (metropolitan or within individual cities). As we have outlined, the extent to which findings at one level hold true at the others remains an evolving question. Furthermore, recent research on intracity transit has shown agglomerative benefits from transit line extensions.³³² In beginning to consider HSR as transit within a commuting region, further examination of the overlap between these research directions is advisable.

6.4.2 Demand and Mode Share Considerations

Further, as noted within Chapter 5's results, this methodology could serve as the basis for additional thinking about existing mode share and refine our ability to project proposed mode shares, and thus demand. In combination with other variables (such as fares/costs), this measure of agglomeration growth potential would be a powerful indicator of perceived user value for transportation. We should expect that this agglomerative value via transportation combined with the price points available would

³²⁹ Kolko, "Chapter 5: Urbanization, Agglomeration, and Coagglomeration of Service Industries".

³³⁰ Melo, Graham, and Noland, "A Meta-Analysis of Estimates of Urban Agglomeration Economies".

³³¹ Fosgerau, "The Marginal Social Cost of Headway for a Scheduled Service".

³³² Chatman and Noland, "Transit Service, Physical Agglomeration and Productivity in US Metropolitan Areas".

be correlated with the existing mode share between travel modes. We could regress AGP for existing modes with existing mode share to help improve the precision of agglomerative benefit weights. Lessons from this analysis would further then inform projections. These additional considerations would be important elements within the benefit-cost analysis framework in a HSR project evaluation.

6.4.3 Empirical Analysis and Reference Cities

Part of the usefulness in comparing these Portuguese and Illinois systems does lie in the similarities we have seen between the linked cities. Even more useful could be comparisons to similar existing cities on HSR systems already built, to see whether there are measurable effects apparent when comparing these cities before and after HSR linkage. We are hopeful that the methodology concept we present within this thesis could serve as a useful tool by which such empirical assessments could be completed.

In order for that to be the case, however, an analogous set of comparison cities must be found. A set of cities that are of similar size to our subject cohort, in similar regional settings whereby they move from a largely unconnected area to the commuting region of a principal city's metropolitan area, and at a similar population proportion to that principal city, with existing HSR service surely exists. With this goal of finding global cities akin to our subject cities, a database of potential equivalent cities was created.

To create this list, various parameters were chosen. Based on our understanding of the similarities between our case cities, we went searching for cities with similar populations, at a similar distance from a major metropolitan area, and a relatively similar proportion of their population to the principal city's. Additionally, to be comparable cities for our HSR-based cities, we wanted cities that were on an existing or planned HSR line. If we found comparable cities that were similar in all these ways, we would find cities that were very similar to Coimbra and Champaign-Urbana or Leiria and Kankakee. In other words, we set out on a search for more cities around the world that have or will have moved from outside a metropolitan commuting region to within it based on the addition of HSR. From amongst these close matches, various comparisons could be made. For instance, before/after effects could be examined to see what measurable changes our cities might realize.

With these characteristics in mind, a list of cities was prepared from global HSR systems. From this list, all cities were compared to see whether the following criteria were met:

- A population within 25% of the subject city
- A distance from the principal city³³³ within 50%
- A population proportion +/- 15%

In Table 6.1, we see in the last four columns whether that row's city is comparable to each of our case cities based on these criteria. Earlier columns provide the distance from the principal city (in km and mi), the intermediate city's population, the major city and its population, the population proportion between these two cities, the location's continent, and the status of the HSR project at this location.

³³³ Considered a metropolitan center city with population greater than 500,000.

Table 6.1. HSR Intermediate City Prototypes (Source: author)

| Intermediate city | Dist. (km) | Dist. (mi) | Population | Major City | Major City Population | Population Proportion | Continent | Project Status? | Co. Comp | Le. ? | C-U ? | Ka. ? |
|---------------------------------------|------------|------------|------------|------------|-----------------------|-----------------------|---------------|--------------------|----------|-------|-------|-------|
| A Coruña, Spain | 590.6 | 367.0 | 246,056 | Madrid | 3,215,633 | 0.077 | Europe | Proposed | No | No | No | No |
| Annaka, Japan | 101.2 | 62.9 | 59,000 | Omiya | 1,250,000 | 0.047 | Asia | Existing | No | Yes | No | No |
| Auxerre, France | 169.0 | 105.0 | 38,800 | Paris | 2,243,833 | 0.017 | Europe | Existing | No | Yes | No | No |
| Caen, France | 234.2 | 145.5 | 112,790 | Paris | 2,243,833 | 0.050 | Europe | Under construction | Yes | No | Yes | No |
| Calatayud, Spain | 85.5 | 53.1 | 21,174 | Zaragoza | 701,090 | 0.030 | Europe | Existing | No | No | No | Yes |
| Champaign-Urbana, IL | 207.6 | 129.0 | 122,305 | Chicago | 2,695,598 | 0.045 | North America | Proposed | Yes | No | Yes | No |
| Chartres, France | 89.8 | 55.8 | 39,159 | Paris | 2,243,833 | 0.017 | Europe | Existing | No | Yes | No | Yes |
| Ciudad Real, Spain | 186.2 | 115.7 | 75,000 | Madrid | 3,215,633 | 0.023 | Europe | Existing | No | Yes | No | No |
| Coimbra, Portugal | 204.4 | 127.0 | 102,455 | Lisbon | 547,361 | 0.187 | Europe | Proposed | Yes | No | Yes | No |
| Cottbus, Germany | 125.0 | 77.7 | 99,913 | Berlin | 3,401,147 | 0.029 | Europe | Existing | No | No | Yes | No |
| Cuenca, Spain | 165.8 | 103.0 | 57,032 | Madrid | 3,215,633 | 0.018 | Europe | Existing | No | Yes | No | No |
| Guelph, ON | 95.1 | 59.1 | 121,688 | Toronto | 2,791,140 | 0.044 | North America | Proposed | No | No | No | No |
| Igualada, Spain | 65.0 | 40.0 | 38,918 | Barcelona | 1,620,943 | 0.024 | Europe | Proposed | No | No | No | Yes |
| Itapetininga, Brazil | 185.4 | 115.2 | 144,000 | São Paulo | 11,316,149 | 0.013 | South America | Proposed | No | No | Yes | No |
| Kankakee, IL | 90.1 | 56.0 | 27,537 | Chicago | 2,695,598 | 0.010 | North America | Proposed | No | Yes | No | Yes |
| Karuizawa, Japan | 140.7 | 87.4 | 19,000 | Omiya | 1,250,000 | 0.015 | Asia | Existing | No | No | No | No |
| Kitchener*/Waterloo/ Cambridge, ON | 106.5 | 66.2 | 444,681 | Toronto | 2,791,140 | 0.159 | North America | Proposed | No | No | No | No |
| Koblenz, Germany | 196.0 | 121.8 | 109,779 | Dortmund | 527,087 | 0.208 | Europe | Existing | Yes | No | No | No |
| Lancaster, England | 74.9 | 46.5 | 133,914 | Manchester | 510,700 | 0.262 | Europe | Proposed | No | No | No | No |
| Le Mans, France | 207.8 | 129.1 | 148,196 | Paris | 2,243,833 | 0.066 | Europe | Proposed | No | No | Yes | No |
| Leiria, Portugal | 149.0 | 92.6 | 50,200 | Lisbon | 547,361 | 0.092 | Europe | Proposed | No | Yes | No | No |
| Minakami, Japan | 132.6 | 82.4 | 20,000 | Omiya | 1,250,000 | 0.016 | Asia | Existing | No | No | No | Yes |
| Minami-Uonuma, Japan | 110.9 | 68.9 | 60,000 | Nigata | 810,000 | 0.074 | Asia | Existing | No | Yes | No | No |

| Intermediate city | Dist. (km) | Dist. (mi) | Population | Major City | Major City Population | Population Proportion | Continent | Project Status? | Co. Comp | Le. ? | C-U ? | Ka. ? |
|-------------------------|------------|------------|------------|----------------|-----------------------|-----------------------|---------------|--------------------|----------|-------|-------|-------|
| New Haven, CT | 130.4 | 81.0 | 129,758 | NYC | 8,175,133 | 0.016 | North America | Existing | No | No | Yes | No |
| Nottingham, England | 84.0 | 52.2 | 305,700 | Birmingham | 1,085,400 | 0.282 | Europe | Proposed | No | No | No | No |
| Orléans, France | 130.4 | 81.0 | 113,224 | Paris | 2,243,833 | 0.050 | Europe | Under construction | Yes | No | Yes | No |
| Osnabrück, Germany | 110.0 | 68.4 | 154,513 | Dortmund | 527,087 | 0.293 | Europe | Existing | No | No | No | No |
| Ourense, Spain | 498.4 | 309.7 | 108,002 | Madrid | 3,215,633 | 0.034 | Europe | Proposed | No | No | No | No |
| Oxford, England | 83.0 | 51.6 | 150,200 | London | 8,308,369 | 0.018 | Europe | Proposed | No | No | No | No |
| Poços de Caldas, Brazil | 163.0 | 101.3 | 151,000 | Campinas | 1,080,999 | 0.140 | South America | Proposed | No | No | Yes | No |
| Regensburg, Germany | 88.7 | 55.1 | 138,296 | Nuremberg | 495,121 | 0.279 | Europe | Existing | No | No | No | No |
| Rennes, France | 347.8 | 216.1 | 206,604 | Paris | 2,243,833 | 0.092 | Europe | Under construction | No | No | No | No |
| Requena-Utiel, Spain | 88.2 | 54.8 | 39,053 | Valencia | 809,267 | 0.048 | Europe | Existing | No | Yes | No | Yes |
| Rostock, Germany | 229.8 | 142.8 | 202,887 | Berlin | 3,401,147 | 0.060 | Europe | Existing | No | No | No | No |
| Rouen, France | 135.2 | 84.0 | 110,276 | Paris | 2,243,833 | 0.049 | Europe | Under construction | Yes | No | Yes | No |
| Saku, Japan | 151.6 | 94.2 | 100,000 | Omiya | 1,250,000 | 0.080 | Asia | Existing | Yes | No | Yes | No |
| San Pedro, Argentina | 164 | 101.9 | 42,152 | Buenos Aires | 2,890,151 | 0.015 | South America | Proposed | No | Yes | No | No |
| Stamford, CT | 66.0 | 41 | 122,839 | NYC | 8,175,133 | 0.015 | North America | Existing | No | No | No | No |
| Ulm, Germany | 144.2 | 89.6 | 117,977 | Munich | 1,388,308 | 0.085 | Europe | Existing | Yes | No | Yes | No |
| Valladolid, Spain | 286.0 | 177.7 | 311,501 | Madrid | 3,215,633 | 0.097 | Europe | Existing | No | No | No | No |
| Varginha, Brazil | 313.0 | 194.5 | 123,000 | Belo Horizonte | 2,479,175 | 0.050 | South America | Proposed | No | No | No | No |
| Vernon, France | 74.0 | 46.0 | 24,998 | Paris | 2,243,833 | 0.011 | Europe | Existing | No | No | No | Yes |
| Villa Maria, Argentina | 145 | 90.1 | 72,162 | Córdoba | 1,309,536 | 0.055 | South America | Proposed | No | Yes | No | No |

*All distances may be approximate

** Population sources: 2010 U.S. Census, 2001 Argentina Census, 2011 UK Census, 2013 Brazil Census, 2012 Germany Census, 2011 Spain Census, etc.

*** Populations are for cities themselves unless otherwise noted and may be approximate

From this list of potential comparable cities, several rise to the top. Based on this initial analysis, the following cities are especially comparable to the subject cities of this thesis:

- Comparable to Coimbra and Champaign-Urbana
 - Caen, France
 - Orléans, France*
 - Rouen, France*
 - Saku, Japan*
 - Ulm, Germany*
- Comparable to Leiria and Kankakee³³⁴
 - Chartres, France
 - Requena-Utiel, Spain

Several other cities are also comparable to one of these four cities, but initial comparative analysis could begin with these close matches. And interestingly, several cities on this list are micro-urban in nature, as those marked with an asterisk are also found on the list of micro-urban cities presented in Section 4.3.2.1. Like Coimbra and Champaign-Urbana, these cities also feature local universities in addition to the similar demographics and regional location. Simply finding such comparable cities speaks to the reoccurring nature of this regional transition. Their further examination would be worthwhile.

6.4.4 Increasing Granularity

Lastly, we would note that further refining the scale at which we can show specific agglomerative benefits could be useful. Through the combination of this methodology and GIS-enabled geographic splitting, one could more narrowly define influenced areas—by neighborhood or even by census tract. This focus would add greater micro-level accessibility variation granularity, which would show the variations in added accessibility to agglomeration within each affected community.

So, for instance, we might find that those living in Coimbra’s new urbanized area around the proposed HSR station benefit more than those living in the old downtown. Or that those living in downtown Champaign benefit more than those in downtown Urbana. This added depth would allow visual mapping of agglomeration growth potential within each community. Additionally, as noted in Section 5.1.2, a full analysis using GIS and parcel level data with full consideration of the transportation networks and land use planning in each of our case communities may provide better information on the equity impacts of the proposed system by highlighting the specific neighborhoods with most impact. Thus, while our work will begin to inform the effects at the regional level,³³⁵ further analysis and research could expand these findings to the local level.

³³⁴ This list is not surprisingly shorter as these cities fall below the size of city typically selected for HSR stations.

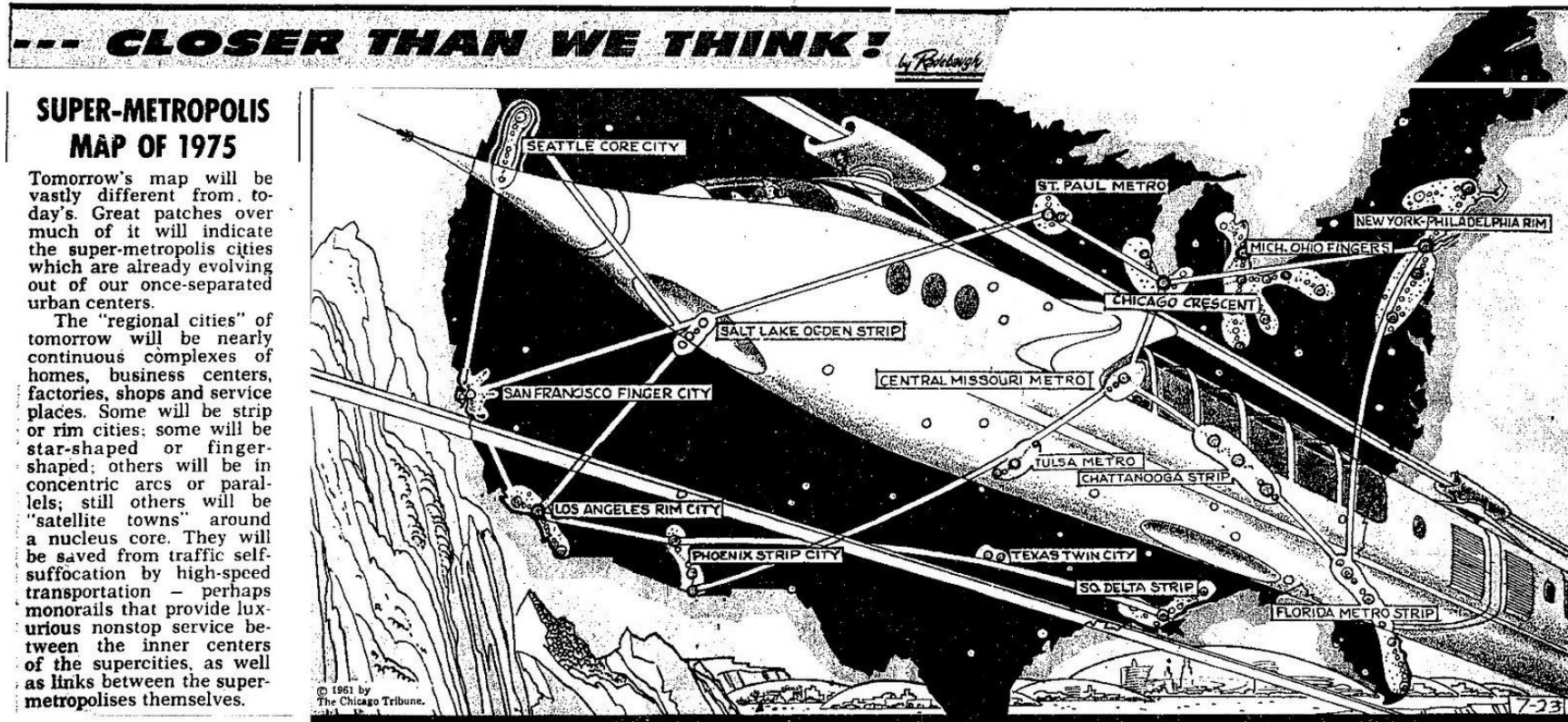
³³⁵ Our work generally falls at the meso- level, as outlined in Section 4.2.1, with extensive macro- level consideration as well. The focus proposed here would broaden the perspective at the micro- level.

6.5 PARTING WORDS

This thesis shows that continued exploration of HSR investment holds promise for extending the spread of agglomeration in ways prior existing transportation linkages do not. We have shown a proof of concept methodology, both for determining the number of agglomeration-affected employees in a metropolitan center and for measuring the accessibility to these agglomerative centers from outlying cities, which provides a helpful quantification of these effects. While next steps remain, we are hopeful that portions of this work can prove insightful to the intersection between transportation and economics. Ultimately, we hope this helps propel development of HSR forward in our case countries of Portugal and the United States.

We part by thanking the reader for their engagement and interest. Conducting this work has been extraordinarily valuable for me, and I hope the reader finds it of value as well. May you leave this treatise enlightened in some way, and may this effort enlighten future policy for countries, regions, and cities.

APPENDIX A



Appendix A. Super-Metropolis Map [of the Future] (Radebaugh, Arthur, "...Closer Than We Think!", Chicago Tribune, July 23, 1961.)

APPENDIX B

Appendix B-1. Complete Demographic Information (Source: as noted in the thesis; see Table 1.5)

| <i>Locale</i> | <i>City Population</i> | <i>Metropolitan Population</i> | <i>GDP[#]</i> | <i>GDP/capita</i> | <i>Unemployment Rate[%]</i> |
|--------------------|------------------------|--------------------------------|------------------------|--------------------|--------------------------------------|
| Chicago | 2,695,598 | 9,461,105 | \$571.0 | \$60,352.36 | 8.9% |
| Kankakee | 27,537 | 113,449 | \$3.5 | \$30,674.58 | 10.8% |
| Champaign-Urbana | 122,305 | 231,891 | \$9.5 | \$40,967.52 | 7.5% |
| Bloomington-Normal | 129,107 | 169,572 | \$10.6 | \$62,510.32 | 6.6% |
| Decatur | 76,122 | 110,768 | \$5.7 | \$51,179.04 | 11.9% |
| Springfield | 117,400 | 210,170 | \$10.0 | \$47,437.79 | 7.6% |
| St. Louis | 319,294 | 2,787,701 | \$136.7 | \$49,026.06 | 7.2% |
| <i>Illinois</i> | <i>12,830,632</i> | | <i>\$695.2</i> | <i>\$54,182.83</i> | <i>9.1%</i> |
| | | | | | |
| Lisbon | 547,361 | 3,035,000 | \$95.2 | \$31,367.38 | 11.7 |
| Leiria | 50,200 | 126,879 | \$2.3 | \$18,113.00 | 10.7 |
| Coimbra | 102,455 | 435,900 | \$7.8 | \$17,926.00 | 12.4 |
| Aveiro | 78,463 | 460,495 | \$7.4 | \$16,077.00 | 11.2 |
| Porto | 237,591 | 1,817,172 | \$41.6 | \$22,892.71 | 16.5 |
| <i>Portugal</i> | <i>10,562,178</i> | | <i>\$237.6</i> | <i>\$22,495.36</i> | <i>12.3</i> |

Appendix B-2. Complete Workforce Size Estimate (Source: as noted in the thesis; see Table 5.3)

| <i>Metropolitan area</i> | <i>Metro Population</i> | <i>Unemployment</i> | <i>Estimated Workforce</i> |
|--------------------------|-------------------------|---------------------|----------------------------|
| Chicago | 9,461,105 | 8.9% | 4,309,533 |
| Kankakee | 113,449 | 10.8% | 50,598 |
| Champaign-Urbana | 231,891 | 7.5% | 107,250 |
| Bloomington-Normal | 169,572 | 6.6% | 79,190 |
| Decatur | 110,768 | 11.9% | 48,793 |
| Springfield | 210,170 | 7.6% | 97,099 |
| St. Louis | 2,787,701 | 7.2% | 1,293,493 |
| Lisbon | 3,035,000 | 11.7% | 1,339,953 |
| Leiria | 126,879 | 10.7% | 56,651 |
| Coimbra | 435,900 | 12.4% | 190,924 |
| Aveiro | 460,495 | 11.2% | 204,460 |
| Porto | 1,817,172 | 16.5% | 758,669 |

Appendix B-3. Agglomerative Employment by Additional Cities (Source: as noted in the thesis; see Table 5.5)

| Total Employment | Aggl. Ben. Wt. | St. Louis | | | Springfield | | | Decatur | | |
|--|----------------|-----------|-----------|----------------|-------------|-----------|----------------|---------|-----------|----------------|
| | | % | Tot. Emp. | E _A | % | Tot. Emp. | E _A | % | Tot. Emp. | E _A |
| <i>Accommodations/Food Services</i> | 0.47 | 11.3% | 145,639 | 67,965 | 10.2% | 9,880 | 4,611 | 10.1% | 4,928 | 2,300 |
| <i>Agriculture</i> | 0.23 | 0.1% | 1,404 | 328 | 0.1% | 85 | 20 | 0.2% | 85 | 20 |
| <i>Construction</i> | 0.43 | 4.8% | 61,477 | 26,640 | 4.2% | 4,088 | 1,772 | 6.8% | 3,317 | 1,437 |
| <i>Finance/Insurance/Real Estate</i> | 0.43 | 6.6% | 84,948 | 36,811 | 6.6% | 6,388 | 2,768 | 3.7% | 1,800 | 780 |
| <i>Government</i> | 0.20 | 10.8% | 139,845 | 27,969 | 25.9% | 25,126 | 5,025 | 9.6% | 4,700 | 940 |
| <i>Health Care</i> | 0.60 | 11.9% | 153,309 | 91,985 | 11.6% | 11,249 | 6,749 | 10.8% | 5,246 | 3,148 |
| <i>Manufacturing</i> | 0.50 | 8.7% | 111,954 | 55,977 | 2.6% | 2,555 | 1,278 | 20.0% | 9,761 | 4,880 |
| <i>Professional/Technical Services</i> | 0.77 | 17.5% | 226,167 | 173,395 | 11.2% | 10,902 | 8,358 | 7.4% | 3,601 | 2,761 |
| <i>Retail and Trade</i> | 0.47 | 17.6% | 227,763 | 106,289 | 17.2% | 16,737 | 7,810 | 20.2% | 9,855 | 4,599 |
| <i>Transportation and Utilities</i> | 0.50 | 4.7% | 60,765 | 30,382 | 3.8% | 3,705 | 1,853 | 5.2% | 2,559 | 1,279 |
| <i>Universities/Education</i> | 0.77 | 6.2% | 80,224 | 61,505 | 6.6% | 6,382 | 4,893 | 6.0% | 2,941 | 2,255 |
| E _A % of Total | | 100% | 1,293,493 | 679,246 | 100% | 97,099 | 45,137 | 100% | 48,793 | 24,399 |
| | | | | 52.5% | | | 46.5% | | | 50.0% |

| Total Employment | Aggl. Ben. Wt. | Porto | | | Aveiro | | | Bloomington-Normal | | |
|--|----------------|-------|-----------|----------------|--------|-----------|----------------|--------------------|-----------|----------------|
| | | % | Tot. Emp. | E _A | % | Tot. Emp. | E _A | % | Tot. Emp. | E _A |
| <i>Accommodations/Food Services</i> | 0.47 | 9.7% | 73,584 | 34,339 | 9.6% | 19,702 | 9,194 | 12.2% | 9,636 | 4,497 |
| <i>Agriculture</i> | 0.23 | 0.1% | 759 | 177 | 0.5% | 1,022 | 239 | 0.1% | 71 | 17 |
| <i>Construction</i> | 0.43 | 6.1% | 46,279 | 20,054 | 6.4% | 13,085 | 5,670 | 2.9% | 2,298 | 996 |
| <i>Finance/Insurance/Real Estate</i> | 0.43 | 15.4% | 116,456 | 50,464 | 7.7% | 15,641 | 6,778 | 14.3% | 11,315 | 4,903 |
| <i>Government</i> | 0.20 | 6.5% | 49,309 | 9,862 | 4.0% | 8,097 | 1,619 | 11.1% | 8,752 | 1,750 |
| <i>Health Care</i> | 0.60 | 9.8% | 73,970 | 44,382 | 6.0% | 12,268 | 7,361 | 7.5% | 5,955 | 3,573 |
| <i>Manufacturing</i> | 0.50 | 6.9% | 52,348 | 26,174 | 30.1% | 61,542 | 30,771 | 4.9% | 3,890 | 1,945 |
| <i>Professional/Technical Services</i> | 0.77 | 15.4% | 116,456 | 89,283 | 7.7% | 15,641 | 11,992 | 20.4% | 16,177 | 12,403 |
| <i>Retail and Trade</i> | 0.47 | 19.4% | 147,189 | 68,688 | 19.6% | 40,001 | 18,667 | 15.1% | 11,978 | 5,590 |
| <i>Transportation and Utilities</i> | 0.50 | 7.7% | 58,418 | 29,209 | 6.4% | 13,085 | 6,543 | 3.7% | 2,961 | 1,481 |
| <i>Universities/Education</i> | 0.77 | 3.3% | 24,657 | 18,904 | 2.0% | 4,097 | 3,141 | 7.8% | 6,156 | 4,719 |
| E _A % of Total | | 100% | 758,669 | 391,536 | 100% | 204,460 | 101,974 | 100% | 79,190 | 41,874 |
| | | | | 51.6% | | | 49.9% | | | 52.9% |

Appendix B-4. Complete Agglomeration Growth Potential (AGP) economic mass variable values (Source: as noted in the thesis; see Table 5.6)

| <i>Metropolitan Area</i> | <i>GDP (billions)</i> | <i>Metropolitan Population</i> | <i>GDP/capita (1000s of \$)</i> | <i>E_A (millions of people)</i> |
|--------------------------|-----------------------|--------------------------------|---------------------------------|---|
| Chicago | \$571.0 | 9,461,105 | \$60.35 | 2.277623 |
| Kankakee | \$3.5 | 113,449 | \$30.67 | 0.024606 |
| Champaign-Urbana | \$9.5 | 231,891 | \$40.97 | 0.051322 |
| Bloomington-Normal | \$10.6 | 169,572 | \$62.51 | 0.041874 |
| Decatur | \$5.7 | 110,768 | \$51.18 | 0.024399 |
| Springfield | \$10.0 | 210,170 | \$47.44 | 0.045137 |
| St. Louis | \$136.7 | 2,787,701 | \$49.03 | 0.679246 |
| Lisbon | \$95.2 | 3,035,000 | \$31.37 | 0.705203 |
| Leiria | \$2.3 | 126,879 | \$18.11 | 0.027658 |
| Coimbra | \$7.8 | 435,900 | \$17.93 | 0.095050 |
| Aveiro | \$7.4 | 460,495 | \$16.08 | 0.101974 |
| Porto | \$41.6 | 1,817,172 | \$22.89 | 0.391536 |

Appendix B-5. Additional Travel Times (Source: as noted in the thesis; see Tables 1.2 and 1.3)

| <i>Locale</i> | <i>Proposed Rail Distance (mi.)</i> | <i>Existing Highway Travel Time</i> | <i>Existing Rail Travel Time</i> | <i>Existing Flight Travel Time</i> | <i>Proposed HSR Travel Time</i> | <i>Proposed Lower Speed HSR Travel Time</i> |
|--------------------|-------------------------------------|-------------------------------------|----------------------------------|------------------------------------|---------------------------------|---|
| Lisbon | - | - | - | - | - | - |
| Aveiro | 151.0 | 142 | 123 | - | 65 | - |
| Chicago | - | - | - | - | - | - |
| Bloomington-Normal | 124 | 132 | 149 | 135 | - | 107 |
| Decatur | 177 | 172 | - | 170 | 74 | - |
| Springfield | 185/217 | 191 | 208 | 145 | 92 | 149 |
| St. Louis | 284 | <i>listed in Table 1.3</i> | | | | 230 |

| <i>Locale</i> | <i>Existing IC Train Travel Time</i> |
|---------------|--------------------------------------|
| Lisbon | - |
| Leiria | 175 |
| Coimbra | 111 |
| Aveiro | 142 |
| Porto | 180 |

Appendix B-6. Additional AGP Results (Source: author; see Table 5.10a)

IL Existing AGP by City - Auto

| Community | Chicago | Kankakee | C-U | Decatur | Springfield | St. Louis | Total |
|--------------------|---------|----------|-------|---------|-------------|-----------|-------|
| Bloomington-Normal | 51.572 | 0.656 | 3.986 | 2.230 | 3.459 | 4.596 | 66.50 |

Appendix B-7. Additional AGP Improvement Results (Source: as noted in the thesis; see Tables 5.11 and 5.12)

| City | Best Existing Mode | % improvement w/ HSR |
|---------|--------------------|----------------------|
| Lisbon | Auto | 126.95% |
| Leiria | Auto | 28.25% |
| Coimbra | Auto | 30.22% |
| Aveiro | Auto | 28.69% |
| Porto | Auto | 86.79% |

| City | Best Existing Mode | % improvement w/ HSR |
|------------------|--------------------|----------------------|
| Chicago | Air | 137.76% |
| Kankakee | Auto | 14.40% |
| Champaign-Urbana | Auto | 154.76% |
| Decatur | Auto | 192.32% |
| Springfield | Auto | 140.07% |
| St. Louis | Air | 78.86% |

Appendix B-8. City Economic Mass Components Ranked by Magnitude (Source: author)

| Metropolitan Area | GDP/capita * E _A |
|--------------------|-----------------------------|
| Chicago | 137.46 |
| St. Louis | 33.30 |
| Lisbon | 22.12 |
| Porto | 8.96 |
| Bloomington-Normal | 2.62 |
| Springfield | 2.14 |
| Champaign-Urbana | 2.10 |
| Coimbra | 1.70 |
| Aveiro | 1.64 |
| Decatur | 1.25 |
| Kankakee | 0.75 |
| Leiria | 0.50 |

APPENDIX C

NATIONAL RAILROAD PASSENGER CORPORATION

60 Massachusetts Avenue, NE, Washington, DC 20002



November 21, 2013

Ryan J. Westrom
westrom@MIT.edu

Re: Freedom of Information Act Request
Tracking Number: 14-FOI-00049

Dear Mr. Westrom:

We are further responding to your November 19, 2013 request for information made under the Freedom of Information Act (FOIA), which was received via e-mail by Amtrak's FOIA Office on the same date.

Amtrak's origin/destination ridership (station pair) data is considered proprietary and commercially-sensitive. Amtrak must compete with other railroads as well as other modes of transportation and the disclosure of such information would put Amtrak at a competitive disadvantage. This information is therefore being withheld pursuant to the commercial privilege of Exemption 5 of FOIA.

Pursuant to Amtrak's FOIA regulations (49CFR 701.10), if you wish to appeal the withholding of the above-mentioned information, you may file an appeal with Eleanor D. Acheson, Vice President, General Counsel and Corporate Secretary, within thirty days of the date of this letter, specifying the relevant facts and the basis for your appeal. Your appeal may be sent to Ms. Acheson at the above address. The President and CEO of Amtrak have delegated authority to the General Counsel and Corporate Secretary for the rules and compliance to the FOIA.

We are releasing in full, the enclosed Fiscal Year 2013 ridership by station information for the requested stations. There is no charge for processing your request

If you have any questions regarding your request, please feel free to contact me at (202) 906-3741 or via e-mail at Hawkins@amtrak.com.

Sincerely,

A handwritten signature in black ink, appearing to read "Sharron Hawkins".

Sharron Hawkins
FOIA Officer

Enclosures

IM-181550

Amtrak Fiscal Year 2013 Station Ridership by Route

| <u>Station</u> | <u>Amtrak Route Number and Name</u> | <u>Boardings</u> | <u>Alightings</u> | <u>Total</u> |
|----------------|---|------------------|-------------------|----------------|
| Chicago, IL | 18 - Cardinal | 26,946 | 28,785 | 55,731 |
| | 20 - Chicago-St. Louis (Lincoln Service) | 241,010 | 247,292 | 488,302 |
| | 21 - Hiawatha | 374,383 | 380,705 | 755,088 |
| | 22 - Wolverine | 211,312 | 207,691 | 419,003 |
| | 23 - Chicago-Carbondale (Illini/Saluki) | 124,461 | 129,094 | 253,555 |
| | 24 - Chicago-Quincy (IL Zephyr/Carl Sandburg) | 75,333 | 82,506 | 157,839 |
| | 25 - Empire Builder | 85,460 | 83,206 | 168,666 |
| | 26 - Capitol Ltd. | 79,382 | 70,481 | 149,863 |
| | 27 - California Zephyr | 72,986 | 59,385 | 132,371 |
| | 28 - Southwest Chief | 72,965 | 73,174 | 146,139 |
| | 30 - City of New Orleans | 69,916 | 65,637 | 135,553 |
| | 32 - Texas Eagle | 80,749 | 73,533 | 154,282 |
| | 41 - Blue Water | 81,419 | 85,909 | 167,328 |
| | 45 - Lake Shore Ltd. | 95,990 | 104,323 | 200,313 |
| | 54 - Hoosier State | 18,434 | 16,752 | 35,186 |
| | 65 - Pere Marquette | 51,251 | 51,288 | 102,539 |
| | 96 - Special/Charter Trains | 320 | 310 | 630 |
| Total | 1,762,317 | 1,760,071 | 3,522,388 | |
| Champaign, IL | 20 - Chicago-St. Louis (Lincoln Service)* | 655 | 183 | 838 |
| | 23 - Chicago-Carbondale (Illini/Saluki) | 80,177 | 79,197 | 159,374 |
| | 30 - City of New Orleans | 14,200 | 16,439 | 30,639 |
| | Total | 95,032 | 95,819 | 190,851 |
| Kankakee, IL | 23 - Chicago-Carbondale (Illini/Saluki) | 8,779 | 10,018 | 18,797 |
| | 30 - City of New Orleans | 2,765 | 2,505 | 5,270 |
| | Total | 11,544 | 12,523 | 24,067 |

* Special bus transfer due to trackwork on Chicago-St. Louis corridor.

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