INFRASTRUCTURE IMPROVEMENTS IN NEW HAVEN COUNTY

POTENTIAL BUILD-OUT STRATEGIES

A Dynamic Impact Analysis

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Executive Summary: New Haven Regional Transportation Improvements and Build-out Scenarios

The Regional Growth Partnership of New Haven has contracted the CCEA to review the economic impact of various transportation infrastructure improvements and build-out scenarios in New Haven County, several towns therein and the City of New Haven. Transportation infrastructure improvements include roadways, airports, seaports and railways. Specifically, we consider in this report the impact of Amtrak's high speed rail service from New York to Boston, enhancements to Metro-North and Shore Line East rail service, as well as the new Pearl Harbor Memorial Bridge and associated I-95 improvements. These investments total approximately $1.2 billion of which the latter project represents about 96% of the total investment. Table 1, Chart 1 and subsidiary tables detail the completed and in process transportation projects in the full report. We examine the impacts of five build-out scenarios on the New Haven region, New Haven County and the State.

With respect to air transport, Tweed New Haven Airport is updating its Master Plan and is seeking additional short haul business traffic. CCEA performed an analysis of several growth scenarios. By the year 2019, the analysis projects transportation benefits range from $6,467,635 under the *base case* scenario, to a high of $25,091,634 under the *no-constraint* scenario. Economic benefits range from a low of $57,315,850 under the *base case* scenario, to a high of $302,147,331 under the *no-constraint* scenario in the year 2019. Please see CCEA's report "Tweed-New Haven Airport: Master Plan Update: An Economic Evaluation-Phase 1", November 23, 1999. With respect to waterborne transport, the Connecticut Coastline Port Authority has proposed several capital improvements to the Ports of New Haven and Bridgeport. New Haven dominates as Connecticut's primary entry point for petroleum products. CCEA performed an analysis of the hypothetical disappearance of Connecticut's deepwater ports to assess the impact of current operations on the State's economy. Please see CCEA's report "The Economic Impact of Connecticut's Deepwater Ports: An IMPLAN and REMI Analysis", March 30, 2000.

Many studies have shown that economic growth and development depends heavily and positively on the growth and quality of the regional transportation infrastructure. As most of this infrastructure is provided by the public sector, the effects of public investment in infrastructure expansion and improvement lead to enhancement of private capital productivity, and, to substitution for private capital as well. This means that public sector investment obviates some private sector capital investment. The net effect is positive in general.

An efficient transportation infrastructure not only facilitates economic growth, it influences business location decisions. Firms can reach their output markets at lower cost and their workers enjoy lower transportation costs. Workers in efficient transportation environments may not require premiums that compensate them for lost time, increased fuel consumption and incidence of accidents, as well as reduced air quality, to induce them to commute to work.

Intermodal transportation is important in firm and worker location as well. Road and rail transport are complementary modes in their movement of goods, services and workers to and from firms. Air and water transport further facilitates movement of people and bulk goods. Efficient transportation reduces costs for employers and workers and is complementary to the production process of firms and adds to the amenity value of households in the region.

The high-speed train (HST) first introduced in Japan in 1964 and subsequently in France in 1981 has acted as an engine of growth in these countries. Several other European countries have implemented HST with similar positive results. There are several U.S. proposals for HST, but only Amtrak's *Acela* from Washington to Boston is in operation albeit without all new equipment and complete schedules. HST primarily moves people not cargo. The character of each country's implementation depends on its topography, and, to a large extent, on the distribution and density of its population centers. HST offers reduced travel times, increased amenities that lead to increased ridership for medium and short haul operations (50-100 miles between stations). The immediate consequence is a reduction in highway traffic and some diversion from air traffic. HST also induces new travelers to ride the system.

Among several other studies described in the report, one by Nakamura and Udea (1989) compares the economic effects of HST and expressways on per capita income, employment in retail, and, information industry growth. They show that per capita income increased by 2.6% due to HST station location effects, 6.4% due to expressway effects, and, 9.5% due to combined effects. Similarly, total employment rose by 0.4% due to HST station location effects, 1.2% due to expressway effects, and, 2.8% due to combined effects. Employment growth in the information industry sector increased by 22% for the combined HST station location and expressway effects and 7% for expressways only (Haynes, 1997).

Firms' profitability directly depends on their proximity and accessibility to their input (labor, materials and intermediate goods and services) and output (goods and services) markets. A location such as New Haven with good access to road, rail, air and sea transport modes, and with over 100 million people within a 150-mile radius, is posed for significant economic growth. HST provides a crucial linkage in this transportation network that is likely to attract and retain businesses in the region. We expect travel time-sensitive, and service industries to be attracted to the region, as well as to see growth in the retail and wholesale sectors. Travel and tourism will benefit, but with mixed results as reduced travel times mean fewer overnight stays. Land values in HST station locations are likely to increase, as are the tax proceeds that result from increased economic activity in the region. There would be reductions in highway and air travel resulting in lower fuel consumption and concomitant taxes. HST is likely to increase the amenity value of a region because of the reductions in airport wait time, roadway congestion, pollution and accidents. Thus any reductions in highway and air travel are likely to be offset by new economic activity and migrants. Hagiwara (1982) finds that HST is "a system that joins smaller communities to larger communities, rather than the reverse," and thereby improves the welfare of the former. In this context, the New Haven region benefits more than the

New York metropolitan area.

HST thus binds together cities and creates a new region formed like a string of pearls. Haynes (1997) calls this a functional region. Such a band of cities connected by HST, highways, airports, and, seaports is expected to have a higher competitive advantage over more isolated (less accessible) regions. These advantages accrue to firms and workers alike. Firms can recruit labor in wider circles with more suitable competency profiles. Workers can supply their labor in a larger geography. Firms enjoy greater contact with other firms, suppliers and customers. Thus, an efficient transportation network contributes to an agglomeration or clustering effect leading to increased efficiency (profitability) and economic growth. This is the emerging scenario in the biotech industry that is clustering in the Northeast corridor. Other clusters include arts and entertainment, photonics, microelectronics, software and telecommunications. Some of the best educational and research facilities in the world lie in this corridor from Washington D.C. to Boston, MA.

The HST is one of several transportation infrastructure improvements in the region. Metro-North and Shore Line East are improving service and accessibility as well with new stations and parking facilities. The Pearl Harbor Memorial Bridge and the I-95 approaches are being widened. There are capital improvements planned for the port of New Haven that will bring rail service closer to the docks. Tweed-New Haven Airport plans safety improvements and other site improvements in its ongoing efforts to its increase commuter and short-haul air traffic. Temporally following these infrastructure improvements, five build-out scenarios are analyzed for their economic impact on the region and fifteen towns in the Regional Growth Partnership (RGP).

The first three scenarios are scaled replicas of each other. These are the maximum, moderate, and, minimum build-out cases in which three-, two-, and, one-story labs and offices respectively are built on 40% of the land likely developable based on RGP estimates. These in turn are based on input from the towns in the Partnership. The fourth scenario extrapolates the “current office space growth trend” over the last five years, that is, a 1.92% average annual growth rate from 1994-1999. The same proportion of lab (40%) and office (60%) is used as in the first three scenarios. The last scenario, "new 2.5 million square feet of lab space" builds just that over five years commencing in 2001 (they all begin in 2001). In the first three scenarios, construction lasts ten years and employment ramps up in 2011 for ten years. Employment in the second scenario ramps up over ten years commencing in 2003. Employment in the last scenario ramps up over five years commencing in 2003. In each scenario we include the construction of a 700-room hotel and a 200,000 square foot convention center.

Results:

The dynamic impacts calculated by the REMI model of Connecticut and its counties are reported for each scenario for key economic variables in annual average terms in the tables below. For example, the annual changes in employment from the status quo forecast averaged over the study period appear in the second table below. We report the fiscal picture for each scenario in the first table below in annual average and present value terms. Induced government spending results from providing increased public services such as education and police as more population is attracted to the region.

AVERAGE ANNUAL CHANGES IN TAX REVENUES FOR NEW HAVEN COUNTY: 2000-2030
Reported in millions of nominal dollars

Tax Level Changes	Max Build-out Scenario	Minimum Build-out Scenario	Moderate Build-out Scenario	Current Office Space Scenario	2.5M additional Office Space Scenario
Average New State Tax Revenue	$923.74	$281.68	$592.80	$49.15	$72.33
Average New Local Property Taxes	$519.92	$161.39	$338.76	$33.64	$33.20
Average Total New Taxes	$1,443.66	$443.07	$931.56	$82.79	$105.53

PRESENT VALUE OF NEW TAX REVENUES: 2000-2030
Reported in billions of nominal dollars

Present Value of Taxes	Max Build-out Scenario	Minimum Build-out Scenario	Moderate Build-out Scenario	Current Office Space Scenario	2.5M additional Office Space Scenario
Present Value of Total New Taxes	$14.09	$4.46	$9.31	$1.01	$1.318
Present Value of Induced	$9.62	$2.98	$6.30	$0.74	$755.5

New govt. Spending					
Present Value of Net New Taxes	$4.47	$1.49	$3.02	$0.27	$562.3

CHANGES IN KEY ECONOMIC VARIABLES FOR NEW HAVEN COUNTY: 2000-2030

	Maximum Build-out Scenario		**Minimum Build-out Scenario**		**Moderate Build-out Scenario**		**Current Office Space Scenario**		**2.5M additional Office Space Scenario**	
Tax Level Changes	**Change in Levels**	**(%) Change**	**Change in Levels**	**(%) Change**	**Change in Levels**	**(%) Change**	**Change in Levels**	**(%) Change**	**Change in Levels**	**(%) Change**
Employment (Thousands)	145.01	28.70%	47.77	9.46%	96.63	19.13%	9.75	0.123%	10.72	0.205%
GRP (Billion Nominal $)	$20.28	28.47%	$6.21	9.12%	$13.04	18.71%	$1.06	0.087%	$1.89	0.151%
Personal Income (Billion Nominal $)	$15.86	25.82%	$4.81	7.88%	$10.16	16.56%	$0.86	0.171%	$0.97	0.244%
Population (Thousands)	163.73	18.84%	51.14	5.89%	106.80	12.29%	11.84	0.134%	11.93	0.196%
Future Housing Demand (Billion Nominal $)	$6.58	0.72%	$1.95	0.22%	$4.24	4.34%	$0.27	0.031%	$0.30	0.04%

Spillover Effects:

We estimate the effects of the increased economic activity in each scenario in eight neighboring towns based on their commuter share in New Haven and weighted by per capita income in each town. The **moderate** build-out scenario results are presented in the table below as perhaps the most illustrative.

Table 3: Net Changes in Selected Economic Variables
Moderate Build-out Scenario
Average Change over Baseline (2000-2030)

	New Haven Local	Hamden	West Haven	East Haven	North Haven	Branford	Guilford	Wallingford	Milford
Employment (Thousands)	3.4298	1.2048	0.7129	0.5209	0.3156	0.6721	0.4073	0.2546	0.2232
GRP (Bill. Nom $)	0.4628	0.1626	0.0962	0.0703	0.0426	0.0907	0.0550	0.0344	0.0301
Personal Income (Bill. Nom $)	0.3605	0.1266	0.0749	0.0548	0.0332	0.0706	0.0428	0.0268	0.0235
Population (Thousands)	3.7910	1.3316	0.7880	0.5758	0.3488	0.7428	0.4502	0.2814	0.2467
Housing Demand (Bill Nom $)	0.1503	0.0528	0.0312	0.0228	0.0138	0.0295	0.0179	0.0112	0.0098

Rail Ridership Effects:

We estimated short and long run changes in ridership on Metro-North, Shore Line East and Amtrak based on Amtrak, Shore Line East and Metro-North changes planned for the frequency of trains, speed and fare. Based on Voith (1995), we estimated the elasticities of ridership with respect to frequency, speed and fare. The table below presents the long run results (short run results are described in the report body).

LONG RUN Ridership Forecast

Variables	Elasticity	Current Level	Projected Change (%)	Current Ridership Level	Projected Ridership Level	Projected Change in Ridership (%)
SHORE LINE EAST						
No. of Trains(Units)	0.317	8	10 (25%)	272,624	291,713	+ 7%
Speed (MPH)	0.212	50	55 (10%)			
Round Trip Fare	-1.02	$ 7.75	$7.98 (3%)			
METRO-NORTH						
No. of Trains(Units)	0.317	244	260 (6.5%)	35,000,000	35,587,214	+ 1.6%
Speed (MPH)	0.212	80	90 (12.5%)			
Round Trip Fare	-1.02	$22.5	$23.20 (3%)			
AMTRAK						
No. of Trains(Units)	0.317	9	17 (89%)	884,860	1,201,642	+35.8%
Speed (MPH)	0.212	80	120 (50%)			
Round Trip Fare	-1.02	NA	3%			

The estimates of increased train ridership above are based on the improvements to rail service in New Haven County without respect of the build-out scenarios. The ridership estimates in the table below account for increases in employment that result from the five build-out scenarios. In each case, ridership is assumed to increase in proportion to the increases in employment. The baseline is the long-run projected ridership level that results from the enhanced rail service listed in the table above.

Rail Ridership Consequences of Build-out Scenarios

	Maximum Build- out Scenario		Minimum Build-out Scenario		Moderate Build-out Scenario		Current Office Space Scenario		2.5M additional Office Space Scenario	
Rail Service Provider (Baseline Ridership)	% Change	Projected Ridership	% Change	Projected Ridership	% Change	Projected Ridership	% Change	Projected Ridership	% Change	Projected Ridership
Shore Line East (291,713)	28.70%	375,435	9.46%	319,309	19.13%	347,518	0.123%	292,072	0.205%	292,311
Metro-North (35,587,214)	28.70%	45,800,744	9.46%	38,953,764	19.13%	42,395,048	0.123%	35,630,986	0.205%	35,660,168
Amtrak (1,201,642)	28.70%	1,546,513	9.46%	1,315,317	19.13%	1,431,516	0.123%	1,203,120	0.205%	1,204,105

Conclusion

The City of New Haven and New Haven County are poised for an economic boom. The unlocking of the human genome code will accelerate the growth of the biotech industry. Yale University has been helping to locate biotech firms to the greater New Haven area to participate with Yale in developing new drug therapies. A vibrant biotech cluster already stretches from Baltimore to Boston. Connecticut can be a prime location for growth in this cluster because of our highly educated and productive workforce, relatively uncongested coastline, and, a cluster of some of the best institutions of higher education in the country. In addition, the photonics, microelectronics and software industry clusters are growing in the tri-state region. Connecticut has much to offer and New Haven can lead the way with sensible office and laboratory development supported by adequate hotel and convention space, and, infrastructure development. This report has not dealt with communication infrastructure, but in the new economy, transportation infrastructure development must be complemented by communication infrastructure development. Policies to support these developments will ensure Connecticut's leadership in the new economy as its precision manufacturing capabilities have in the past.

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TRANSPORTATION INFRASTRUCTURE AND ECONOMIC DEVELOPMENT: POTENTIAL ECONOMIC IMPACT OF HIGH SPEED RAIL ON A REGIONAL ECONOMY

A Literature Review

Objective

This literature review provides regional development specialists some insight and intuition about the role of infrastructure development in regional economic growth. It explores earlier studies measuring the relationship between infrastructure development and economic growth. This literature review focuses specifically on the role of transportation infrastructure on the economic growth of a region. The first part of the literature review discusses the significance of public investment in infrastructure in general and provides some empirical evidence on infrastructure development and economic growth. This part discusses transportation infrastructure and its potential impact on the location decision of firms. Continuing the discussion of transportation infrastructure, the second part specifically focuses on the economic impact of high-speed rail transport in a regional economy.

INFRASTRUCTURE AND ECONOMIC DEVELOPMENT

There is no doubt that infrastructure is the most crucial part of economic growth, without which economic development effort is virtually impossible. Nearly two-thirds of non-military public capital consists of "core infrastructure" which includes highways, airports, and mass transit facilities, electric gas plants, water supply facilities, sewers, schools, hospitals, police and fire stations, courthouses, garages and passenger terminals. Currently, in the United States, about 90% of infrastructure capital is owned by state and local governments, although much of this was financed with federal intergovernment grants (Arsen, 1997).

The investment in infrastructure is a major input to regional economic growth. The investment decision by state and local governments to improve existing and provide new infrastructure should not be based only on their direct costs and benefits. In fact, the indirect benefits of infrastructure may be significantly high enough to justify any investment decisions on infrastructure by local and state government. Infrastructure can largely contribute to economic growth by inducing different kinds of private investments in the region that are directly or indirectly related to infrastructure. The economic significance of infrastructure should not be measured by its immediate impact on the local economy. Rather, it should be evaluated by measuring its ability to stimulate private investment and to affect the decisions of households and firms. Arsen (1997) appropriately argues:

"the economic significance of infrastructure investment lies not so much in the stock of physical capital per se as in the flow of services it provides to households and firms. Conceptually, it is the amount of services that affects decisions, represented, for instance, as a variable in an individual's utility function or a firm's production function."

Several studies suggest that public investment in infrastructure has a positive and significant impact on economic growth, and the total output and total productivity of a region. Two researchers, namely, David Aschauer and Alicia Munnell have made significant contributions to the literature on measuring the role of infrastructure on economic growth. Aschauer (1989) did the first major evaluation of the impact of public capital investment on economic performance. He argues that there is a shortfall substantial enough to justify a significant expansion of government investment in infrastructure in the United States. His study shows that investment in infrastructure was not only an important determinant of economic development but also that a decline in infrastructure stock relative to GNP was a primary cause of the disappointing downward shift in the nation's long run productivity trajectory after the early 1970s. In his earlier study, by adding public capital to the conventional production function and using aggregate time-series, Aschauer (1989) concludes that each additional $1 of public sector investment would yield approximately 60 cents in additional output for the economy. In a follow-up study he concludes "increases in GNP resulting from increased public infrastructure spending are estimated to exceed those from private investment by a factor of between two and five" (Aschauer, 1990, p.16).

Munnell (1990) examines the relationship between public capital and measures of economic activity at the state level using estimates of private and public capital stocks for each state. She finds that public capital has a positive impact on output, investment and employment growth at the state level, though the magnitudes of these effects are considerably smaller than at the national level, roughly half the estimate at the national level. Her study includes an examination of the relationship between public and private investment, where public capital can enhance the productivity of private capital but can also act as a substitute for it, or it "crowds out" private capital. Her results suggest that in general, the net effect is positive; that public investment stimulates private investment. Munnell's (1990) empirical work also indicates that those states that have invested more in infrastructure tend to have greater output, more private investment, and more employment growth.

Other than output and employment, infrastructure is likely to contribute to economic growth and social welfare through increases in productivity and efficiency. Increases in productivity not only lead to economic growth, but also improve the standard of living and overall welfare by increasing real wages. Several studies have attempted to examine the relation between public investment and productivity per worker. Ashchauer (1989) also examines the relation between the stock of public infrastructure as well as the stock of private capital and productivity in the private sector. His results show that there is a strong relationship between output per unit of private capital and the stock of public capital.

Aschauer (1989) finds a strong relationship between output per unit of private capital and the stock of public capital. He also finds a statistically significant relationship between the level of productivity and the stock of non-military capital.

From a production function that includes public as well as private capital, Munnell (1990) calculates multifactor productivity of private non-farm business sector for the period 1948-1987. She finds a 1.4 percentage point decline in labor productivity during the period 1948-69 and 1969-1987. However, she finds that only 0.3 percent can be attributed to slower productivity growth and 1.1 percent is due to the decline in the rate of growth in the public capital-labor ratio.

Eberts (1986, 1988), Eberts and Fogarty (1987), and Duffy-Deno and Eberts (1989) examine the relationship between public capital and productivity using data for metropolitan areas. They consistently find that public capital has a positive impact on output but it is much smaller than that from private capital and labor. More recent studies seem to confirm this: Harmatuck (1996), for example, finds that the change in output due to a unit change in infrastructure investment is 0.03, compared to the 0.3-0.6 range found in earlier studies. Among other regional studies, Garcia-Milla and McGuire (1992) results suggest that public capital has a positive impact on state- or metropolitan-level output, investment, and employment growth. Similarly, Morrison and Schwartz (1996) use data on the manufacturing sectors of the 48 contiguous states in the United States to estimate the relation between state infrastructure and productivity of manufacturing firms. They use state level data on the quantities and prices of output, non-production and production labor, energy, and private and public capital inputs for 1970-1987. Their results indicate that the return to infrastructure investment is positive and significant.

We next focus on transportation infrastructure rather than infrastructure in general, and its impact on the location decisions of firms.

Transportation Infrastructure, Economic Development and Industrial Location

The transportation system is the most crucial infrastructure component from an economic development point of view. The transportation system contributes not only to the growth of any particular sector but it has large multiplier effects on almost all sectors of the economy. As a result, regional planners are more interested in transportation infrastructure investment and its impact on regional economy than any other type of infrastructures.

Broadly speaking, there are two major approaches to estimate the impact of investments in transportation systems on the economic performance of a region. One is to treat infrastructure as input in a firm's production function, alongside inputs such as labor and private capital, and see if improvements in infrastructure increase the firm's output. The other is to look at the effects of infrastructure on the firm's cost functions, to see if such improvements reduce its costs. There are several studies that attempt to evaluate the significance of transportation in a regional economy.

Fox (1990) presents a general regional model where transportation infrastructure affects output through three channels. First, it can directly increase a firm's output as an input to its production process. Second, it can allow other inputs to be more productive. Third, it may attract inputs from other regions. Building transportation infrastructure therefore increases the demand for inputs and enhances multiplier effects in the economy.

Greater output in turn encourages more infrastructure investment as congestion occurs.

A 1992 study for the Federal Highway Administration (FHWA) extensively explores the indirect effects of public infrastructure investment. The primary purpose of this study was to evaluate the importance of transportation on the productivity of certain sectors of the economy. Using data from 226 manufacturing firms for the period 1969-86, the study looks at the net effects on these firms and the sources of their savings in costs. It finds three main sources of cost savings that arise from development of the transportation system. First, more frequent and reliable delivery lowered inventory costs. Second, access to wider markets meant economies of scale. Third, more frequent deliveries from plants to retailers reduced the need for warehousing operations. One major finding was that the net effects of cost savings grew smaller over time, indicating diminishing returns to scale.

Despite the fact that infrastructure facilitates economic growth, local economic development specialists may be more interested in the linkage between infrastructure and business location rather than overall economic growth. Transportation is one of the major factors that can largely determine the location decisions of firms. An efficient transportation system may significantly increase the competitiveness of a region relative to other regions in terms of quality of life for the workers, households and firms. Depending on other public policies, better transportation infrastructure further facilitates to create a favorable business climate for firms in the region. Consequently, it can affect the location decision of firms and workers in several ways.

Better infrastructure is likely to enhance the amenity value of a region that in turn makes the region more attractive to firms and households. These amenities manifested in reduced travel time and costs may include an efficient transportation system such as a good highway system, airports, railroad and mass transit, public parks, and, recreational facilities in the region. An efficient transportation infrastructure may attract firms to regions which provide the highest rate of return and which have lower production costs. The reduction in production costs of firms may arise from reduced transportation costs as well as reduced labor costs. Similarly, firms may not have to offer premiums to workers. Empirically, Beeson and Eberts (1987), show that wages are lower in areas that have a large bundle of amenities and a good transportation system.

Some studies also attempt to measure the relationship between firm locational choice and amenity factors. While evaluating the firms's location decisions, amenity factors are often ignored as they are assumed to attract only workers but not firms. However, Gottlieb (1995) argues that amenities not only attract workers but also attract firms. Using a sample of municipalities in northern New Jersey in a firm location model, Gottlieb (1995) argues that firms evaluate business factors as well as certain amenities with respect to the likely residential location of their employees. His study finds that amenities such as better transportation infrastructure, traffic congestion, public education, crime, recreation and public services is significantly related with employment in SIC category 87, engineering and management services.

If regional development specialists are to increase the comparative advantage of a region relative to other regions, they should focus on policies that make the region a profitable location for firms. Arsen (1997) argues that for a site advantage for business location, a region must either provide distinctive and attractive services or, more likely, offer standard public-capital services. In other words, regional development specialists should focus on policies that lower costs of doing business in the region. These policies may include investment in transportation infrastructure, subsidizing firms, and, lowering business taxes and fees in the region.

Although infrastructure services can serve as important "inputs" to the firms' production process, the effectiveness of such infrastructure services as a location incentive for firms depends on the burden of infrastructure services on firms. If the cost of infrastructure services is transferred to firms as business taxes and fees, even better infrastructure may not be successful to lure new business firms to the region. Eberts (1989) and Munnell (1990) provide some empirical evidence for this argument. Their studies examine the relationship between changes in metropolitan area capital stock and firm openings. They find that along with investment in infrastructure, total state and local tax is one of the significant factors that determines firms' openings and employment growth in the region. Their studies also find that cost, availability and quality of labor in a given state play a central role in the location decision and employment growth of firms. Similarly, higher energy costs tend to discourage the establishment of new firms and inhibit employment growth. Munnell (1990) finds that states with warmer climates tend to have greater employment growth, and, energy costs have a negative effect on employment growth.

Depending on the type of firm, the value of transportation infrastructure to the firm could be very significant. For instance, a large steel company in Pittsburgh estimated that it paid at least $1million a year in additional costs to detour its trucks 18 miles around a major bridge closed by the state for lack of repair (Eberts, 1991). Similarly, Keeler and Ying (1988) find that public investment on the highway system significantly improves the productivity of the trucking industry. Some other studies have attempted to model infrastructures such as interstate highways, in-county railroad lines and airports in firms' location choice. Fox and Murray (1990) use pooled time series-cross-section data on firms' entries into the 95 Tennessee counties for the period 1980 to 1986 to evaluate the effects of local public policies on the location of business activity. They find that interstate highways are statistically significant for the location of firms, as the entry rate of firms is higher in locations close to interstate highways. However, they also argue that this relationship may not be interpreted as indicating that many new firms would be attracted to the state or new firms started in the state if another interstate highway were built. Rather, the new interstate highways may shift the location of economic activity from one place to another in the region. Similarly, they also find that an in-county railroad line is related with higher entry rates for small firms. However, Fox and Murray did not find access to an airport to be a significant variable in locating firms. It is important though to keep the limitations of their study in mind in interpreting this result. It is likely that the limited geography (one state) and the short time period (six years) used are insufficient to draw a reliable conclusion on this matter. A 1999 study by Freidheim and Hansson for Booz-Allen & Hamilton Associates describe how airports have fuelled regional economic growth. Over the past two decades, the airline industry has developed from point-to-point air travel to hub-and-spoke operations, where a high volume of air traffic is concentrated in a few large hub airports with spoke connections to many lower-volume destinations. This has benefited almost all parties involved. Airlines have gained economic benefits of scope and scale; consumers have obtained a greater choice of flights and destinations, lowering of related costs and greater flexibility; and local economies of hub cities have profited through increased employment, more visitors who spend locally, and business location. According to Freidheim and Hansson, "Airports are magnets for business and trade. Extensive and frequent air services are critical to attracting trade shows, and play a major role in the location of corporate and regional headquarters, service companies, research and development facilities and manufacturing sites." (1999, p.3) Major airports that have gained such benefits include Amsterdam and Singapore. They point out that smaller airports located close to existing hubs can contribute significantly to the local economy and encourage price competition. Midway Airport, for example, which is Chicago's second airport, focuses on local point-to-point, not connecting, air travel demand. Lower-priced airlines such as Southwest that base their operations at Midway stimulate such demand and impose price discipline on Chicago's O'Hare Airport. A Booz-Allen & Hamilton study on Chicago's airports recommends that the city continue to develop point-to-point traffic by adding capacity at Midway and other regional airports (1999, p.7).

Santini (1978) did an early study of transportation infrastructure as a determinant of residential and employment relocation. He expands a theoretical model to include the accessibility to transportation and tests it in the Chicago and Gary-Hammond urbanized areas. He finds that adding accessibility to water and air transportation improves the model's estimates of employment locations and levels. Rail transportation, which is mostly used for non-manufacturing employee work trips to the Chicago business district, played a significant role in household and employment relocation decisions. The results from these studies suggest that the decline in highway infrastructure spending is a leading cause of the nation's diminished economic growth (Harmutuck, 1996).

Erickson and Wasylenko (1980) develop a model of the site choice decision of relocating firms in seven, single-digit SIC industries, which have moved from Milwaukee to its suburbs between 1964 and 1974. The firms belong to seven industries: construction, manufacturing, transportation, communications and public utilities, wholesale and retail trade, finance, insurance, and real estate and services. They find that most firms are attracted to regions that have a high concentration of firms in the same industry clustering and which have an available supply of labor. Similarly, firms in construction, wholesale, and to some extent, transportation, retail trade, finance, and services seem to relocate on sites that are farther from the central city. However, their results show that manufacturing firms relocate to regions that are near highways and have a relatively high proportion of vacant land. Their results show that firms in retail trade, finance, and services tend to agglomerate and do not appear to relocate with respect to local market potential. Thus, the empirical evidence suggests that high quality transportation infrastructure is complementary to the production process of many types of firms and improves the amenity value of regions for households.

Of several transportation infrastructures such as airports, ports, highways, railroads, the high-speed train, the fastest mode of ground transportation, has been extremely popular in Japan and Europe. Because of its success in Europe and Japan, the United States will be introducing a high-speed train in different parts of the country[1]. As a result, there has been increasing interest among regional planners in potential economic impact of a high-speed train in regional economic development. The next section focuses on the high-speed train and discusses its potential economic impact on a regional economy.

[1] Florida did an extensive analysis in preparation for high-speed rail service. The newly elected governor killed the project in 1999.

THE HIGH SPEED TRAIN: A MAJOR TRANSPORTATION INFRASTRUCTURE OF THE 21ST CENTURY

The High Speed Train (HST) is a major innovation in ground transportation that directly competes with air and auto transportation. The HST not only competes for existing passengers with other modes of transportation, but it has a tremendous potential to induce its own demand. Moreover, the HST can also serve as a major catalyst for the economic development and revitalization of a region. It can also increase the competitiveness of a region by enhancing its transportation. The contribution of the HST to economic development of a region arises primarily from increases in economic and business activities in the region that are directly or indirectly related to the HST.

The HST is the fastest mode of ground transportation that carries passengers from one city to another at speeds of up to 200 miles per hour. The HST links major cities that are between 100 and 500 miles apart. Japan was the first to introduce HST in 1964. In Europe, France introduced the HST in 1981. Japan and France have the most successful HST operation in the world. Following France, other European countries such as Germany, Britain, Italy, Spain, Belgium, and Netherlands also have launched HST. Other countries that have already launched or are planning to launch HST include Australia, Korea, and Taiwan.

The United States is no exception. The United States is well underway to introduce HST in different parts of the country in the near future. The HST has been proposed in California along the North-South corridor (Los Angeles-San Diego), the Chicago Hub (Chicago-Detroit, Milwaukee, and St. Louis), the Florida corridor (Tampa-Orlando-Miami), the Northeast corridor (Washington-New York-Boston), the Pacific Northwest corridor (Seattle-Vancouver), and, the Texas Triangle (Dallas-Houston-San Antonio). Among these proposed plans, Amtrak has recently unveiled its plan to launch the ultramodern, high-speed train service called *Acela* in late 1999 in the Northeast Corridor. The proposed HST in the Northeast corridor will have speeds of 150 mph which reduces the New York-Washington trip to two and half hours and New York- Boston to three hours. If HST succeeds in the Northeast corridor, Amtrak is likely to implement proposed HST plans in other parts of the country.

The HST not only reduces travel time between cities, however, it could have significant impact on the economic development and revitalization of a region. The potential economic impacts of HST connections on the regional economy have drawn the attention of local regional economic planners. Economic planners often question whether HST connections could have any significant economic impact on the regional economy. What are the kinds of economic impacts of HST on the local economy? Which sectors of the regional economy are the HST connections most likely to affect? What are the spillover effects of HST on other sectors of the local economy? What are the costs and benefits of HST for a region? This study will attempt to address these issues by an extensive literature review of the economic impact of HST. The objective of this review is to provide some insight to local regional economic planners in terms of the potential of HST connections in economic revitalization and development of a region. Initially, the literature review will provide brief discussions of high-speed trains in France, Japan, Germany, Italy, and Spain and then shift the focus to the economic impacts of HST on the Connecticut regional economy.

France: TGV

The French high-speed train called the TGV (*Train a Grande Vitesse*) was opened to the public in 1981. The TGV operation is one of the most successful and profitable railroad operations in the world. Within a decade, it not only earned a significant amount of profit, but also covered its original costs of construction. The TGV earned net profit margins of 22% - 38% in its first full year of operation. France has developed a genuine network approach to high-speed rail. The French system has three major lines radiating out of Paris which ultimately connect to locations all over Europe. Among these, Paris-Lyon is the ideal route for a high-speed line. To some extent, it has the character of a long distance commuter line. The French TGV Paris-Lyon was financed entirely by the French government on the basis of an expected minimum financial rate of return of 12% which has already been surpassed. The early success of TGV lines spurred the construction of more lines: TGV Sud Est, and, TGV-Atlantic in France. Because of the explicit recognition of TGV potential for regional development, the French government contributed 30% to the construction of TGV-Atlantic in 1990. There have been more proposals for developing a

European high-speed rail network that would link different countries and cities in Europe.

Japan: Shinkansen

Japan is one of the most densely populated countries in the world, especially on habitable land. The three largest metropolitan areas, Tokyo, Osaka, and Nagoya account for over 45% of the population. The Japanese high-speed train system, developed in the 1960s, mainly connects the other cities of Japan to these three metropolitan areas. The Japanese high-speed rail line, *Shinkansen*, is characterized by shorter distances between stations relative to the European routes, and higher frequency of train trips (one every 6 minutes or less in Tokyo during rush hours)[2]. This can be attributed to the structure of cities in Japan. Many core cities in Japan are located fairly close to one another (approx. 35km or 21.7 miles), and the population density is very large in these cities. As in Europe, railway transportation in general is very popular in Japan. In Japan, railway transportation accounts for approximately 30% of the entire transportation volume.

The construction cost for the Japanese *Shinkansen* was much higher than that of the French TGV lines and other European rapid-transit lines. The higher costs of construction of high-speed rail lines in Japan arise primarily from the higher civil engineering costs. The civil engineering costs (building bridges, digging tunnels and banking or elevating tracks) usually account for approximately 70% of the total construction costs of high-speed rail lines. The Japanese system was therefore more expensive because it required more tunnels due to its mountainous topography (30.8% of total lines are in tunnels), more elevated tracks, and, higher costs for sound pollution-reducing measures.

Germany: ICE

The introduction of high-speed train in Germany aims at overcoming particular bottlenecks in its existing railroad network. Unlike in France, the railroad system in Germany involves mix of upgrading and new construction. There have been several improved routes in addition to new railway lines. Germany is also planning to introduce magnetic levitation system, Maglev[3], which requires a completely new infrastructure that is incompatible with the existing rail lines.

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[2] The frequency indicates the number of trains that depart from a station in a given time period.

[3] Maglev is an advanced transport technology in which magnetic forces lift, propel, and guide a vehicle over a specially designed guideway. It eliminates the need for wheels and many other mechanical parts, thereby minimizing resistance and permitting excellent acceleration, with cruising speeds on the order of 300 mph or more.

As in Japan, because of difficult terrain, and the requirement of more tunnels, the new railway lines in Germany have been more expensive than in France. Moreover, the new railway lines in Germany have been designed for multi-purpose use. The new railway lines can operate different kinds of trains such as, very high speed ICE trains at 250km/hr, traditional IC trains running at 200km/hr, and freight trains running at lower speeds.

Italy: Direttissima

As in Germany, Italy's new investment in railway lines aims to overcome particularly difficult stretches of their rail route. Initially, Italy tried to use an active tilting train, ETR 450/460, *Pendolino*, which enables higher speeds on existing track. This kind of train was used to overcome the need for constructing new lines. However, due to technical problems and discomfort for passengers, this system has been abandoned. Instead, Italy constructed new tracks for the high-speed train ETR500.

Britain and Switzerland also tried active tilting technology in the 1970s to overcome the construction of new lines. This technology turned out to be troublesome because of more frequent and tighter curve routes.

Spain: AVE

Spain introduced AVE, a single high-speed rail route between Madrid and Sevilla in 1992. The AVE has substantially reduced the distance between Madrid and Sevilla because of the more direct route than existing routes. As in Germany, the new route in Spain is used by conventional trains running at 200km/hr (134 mph), as well as the new high-speed train AVE, running at 280 km/hr (174 mph). There have been more proposals for the construction of new railway lines for the high-speed train between Madrid and Barcelona.

THE ECONOMIC IMPACTS OF HIGH-SPEED TRAIN: PAST EXPERIENCE AND FUTURE POTENTIAL

Apparently, the major impacts of HST are the reduction in travel time, and traffic diversion from conventional modes, and induced new travelers. However, the economic impacts of HST, and its potential to revitalize the regional economy are equally important. The major contributions of HST to the regional economy are increases in efficiency, productivity and employment, an increase in economic activity in the region, and the spillover effects on different sectors of the regional economy. The economic impacts of HST in a particular region are measured by the change in the level of employment, wages, income and output, and, tax revenues in that region.

One of the major impacts of HST is an increase in amenity value. The amenity value includes the value of time saved, reduction in car use, reduction in traffic accidents, road congestion, and environmental impacts. The literature review addresses the economic impacts of HST on the regional economy in different parts of the world, primarily Europe and Japan. This review focuses on the impacts of HST on employment, income, production, tax revenues, regional competitiveness, amenity values, and, the potential for revitalization and redevelopment of a region.

(1) Impacts on Employment, Production, and Population

The HST could have significant impact on the level of employment in a region. The HST creates not only short-term employment during its construction phase but also considerable amount of long-term employment. The long-term employment from HST comes from maintenance and daily operation of the trains and related services. Other than the direct HST related employment, HST is also likely to have spillover effects on employment in different sectors by inducing different kinds of economic activities which may not be directly related to HST. The HST may contribute to employment in the region by inducing new business activities such as retail sales, service industries, and back office operations, which include sales, marketing, framing, printing and satellite operations.

The employment generation from HST comes from mainly two sources: the construction phase, and daily maintenance and operation. The French experience shows that, during the construction of TGV, the HST is estimated to have created 3500 to 4000 short-term jobs over six years, which was, however, lower than the projection. On the operational side, the number of employees required to operate HST is lower than for the traditional train. Similarly, the Japanese experience from *Shinkansen* shows that currently, about 15,000 employees operate 275 trains a day over a total distance of 112,599 miles.

The impact of HST can be observed by comparing the employment level in high-speed station locations and non-station locations. Because of the increase in business activities, it is reasonable to assume that the high-speed route of the train generates higher employment in station locations than in non-station locations. However, in the ex-coal town of Le Creusot (85 min from Paris), a new TGV station had almost no local economic impact in terms of new jobs, firms or commercial expansion. This is attributed to its isolated station location, poor road access and historical change.

Haynes (1997) provides a summary of some earlier studies on the impact of high-speed train *Shinkansen* in Japan. The *Shinkansen* experience show that population growth is higher on the route of high-speed train station than on the non-station routes (Amano and Nakagawa, 1990). Brotchie (1991) records that the population in station locations along the high-speed train route was 22 percent higher than in non-HST station locations. However, a heavy concentration in manufacturing industry and an aged population tend to limit local urban growth. On the other hand, presence of information exchange industry such as business services, banking and real estate development, access to higher education and expressway access are the key variables for local urban growth (Nakamura and Ueda, 1989).

The *Shinkansen* experience shows that employment in retail, construction and wholesaling is 16 percent to 34 percent higher in HST station than in non-HST station locations (Hirota, 1984). Similarly, Amano and Nakagawa (1990) find that employment growth in food and accommodation sectors is 26 percent higher in *Shinkansen* station than in non- *Shinkansen* station locations (1.8 to 1.3 percent respectively).

Nakamura and Udea (1989) compare the economic effects of the high-speed train and expressways on per capita income, employment in retail, and information industry growth. They show that per capita income increased by 2.6 percent due to station location effects, 6.4 percent due to expressway effects, and 9.5 percent due to combined effects. Similarly, total employment rose by 0.4 percent due to station location effects, 1.2 percent due to expressway effects and 2.8 percent due to combined effects. On the other hand, the employment growth in the information industry sector was up by 22 percent for the combined station location and expressway effects and 7 percent for expressways only (Haynes, 1997).

(2) Types of Business stimulated by HST

While the HST can significantly contribute to increased levels of employment, and population growth in the region, its ability to attract new businesses, and the expansion and retention of existing businesses are of the paramount importance. The potential increase in business activities in the region is the strongest justification for investing in HST.

Because the profitability of a firm largely depends upon its market proximity and accessibility, its location choice becomes quite important. Any location with a better transportation network such as access to highways, airports, railroads, and ports is likely to attract firms over other locations with very limited transportation networks and accessibility. The high-speed train provides a crucial transportation linkage and its presence is likely to attract more new businesses in the region. The types of businesses the HST is likely to attract to the region are primarily travel-time sensitive industries and service industries. Similarly, the presence of the HST connection also has the potential to attract retail and wholesale businesses to the region.

(i) Service Industries

In particular, the HST is likely to attract businesses such as retail sales, financial firms, insurance companies, banking firms, and retail sales. These industries benefit directly by the increased inflows and outflows of people to the region. The need for more garages, hotels and convention centers can be included in service industry growth. Similarly, an increase in population in the region due to the presence of HST may spur more service-oriented business activities in the region.

The French experience with TGV shows that an increase in consultancy business activities in the region is the predominant impact of the HST. In France, the proportion of journeys with the object of purchasing or selling services rose from 18 percent to 22 percent during in 1980-1985 as a result of TGV (Bonnafus, 1987). The French experience also shows that more diversified enterprises, rather than specialized industries have benefited more from TGV. Similarly, the experience with the Japanese HST, *Shinkansen*, has shown that the HST also has potential to attract large department stores, urban hotels, and convention centers to the region. Both intermediate stations and termination stations showed significant growth in food and accommodation sectors (Brotchie 1991, Hirota 1984).

(ii) Travel and Tourism Industry

The introduction of the high-speed train is likely to have a significant impact on the travel and tourism industry. Because the tourism industry is sensitive to accessibility and travel time, the HST can contribute to the industry in a particular region by further reducing travel time to and increasing the accessibility of the region. However, the HST is likely to have two contradictory effects on tourism. First, because of the reduction in travel time and increase in accessibility, the presence of HST is likely to increase the number of tourists in the region. Secondly, it also reduces the number of overnight stays in hotels as HST makes more day-return journeys possible. From the Japanese experience, the rise in tourism had mixed effects for HST station locations. Overnight stays at local stations did not increase proportionately for intermediate stops due to the expansion of same-day travel (Obate, 1979). Similarly, the TGV in France resulted in an expansion of summer tourism, but overnight stays dropped due to same-day travel and winter tourism levels did not change (Haynes, 1997). The presence of TGV in France resulted in increased in business travel by 56 percent and services travel by 112 percent (Pieda, 1991). Similarly, TGV seems to have had no significant effect on winter sports tourism.

(iii) Real Estate Market

The high-speed train is likely to have a significant impact on land values and the real estate market. Increases in population growth and business activities put pressure on the real estate market. Ernst and Young (1990) find that accessibility to a high-speed train would cause a localized increase in land values in the areas close to HST stations. This is due to increased demand for services such as hotels and restaurants, and partly due to increased demand for residential property. In Japan, *Shinkansen* has increased commercial land values by 67 percent while the expressway alone increased the land values by 42 percent in high-speed train station locations (Haynes, 1997). Similarly, in France, land values rose markedly and office space declined due to access-related demand that rose by over 43 percent between 1983-1990 (5.2 percent per year). Le Mans on TGV Atlantic was already an active center (55 min from Paris) with an expanded business base, and, complementary transport highway investment was expected in 1996 to link it to Belgium. Land values, raw and built, increased 100 percent in three years in Le Mans.

Similarly, Vendome also on TGV Atlantic is 42 min from Paris (*vs* 2hr and 15 min) showed only marginal pre-TGV growth. After TGV, the property values increased by 35 percent and real estate exchanges have increased by 22 percent with an indication that Vendome may become a Paris commuter suburb. Nantes, another connecting point on TGV Atlantic, from which travel time to Paris was reduced to 3 hr from 2 hr, already had a strong and diversified local economy and played a dominant regional role. It had good transport links, a ring road, tramlines, and a strong publicly assisted business location program. Some relocation from Paris to Nantes has occurred at both the business production and headquarters levels. Similarly, since the start of the operation of the high-speed train in Germany, with magnetic levitation technology (Maglev) in 1992, office demand and retail space increased by 20 percent in Kassel-Wilhelmshone station which is located on the Hannover-Wurzburg segment.

(3) Impact on Tax Revenues

The HST may not have significant impact on government revenues. However, there are two competing effects of HST on tax revenues. Local governments may have increases in total tax revenues if HST significantly increases business activity, and promotes inflows of people into the region. The increase in tax revenue for the government is likely to result from the increase in spending in the tourism industry, and in the service and retail trades such as, hotels, and entertainment. On the contrary, the possible traffic diversion from air and auto may decrease consumption of gasoline and reduce related the tax revenues. Because of this offsetting effect, HST may not largely affect government net tax revenue.

(4) Impact on Amenity Values

With respect to amenity values, time saving and the increase in efficiency are the most valuable and direct impacts of HST. If the saved time is converted to production time, the value of time saved is enormous. Sanuki (1979) estimates that in between 1964-1976, *Shinkansen* saved in aggregate 2246 million hours and if this time were allocated to working the effect would be to create one full year of work-time for 1.22 million people with two days off per week.

Some studies compute the value of time by estimating the time wasted by airline delays. Chicago's O'Hare Airport alone tallied more than 12 million hours of passenger delays annually which is equivalent to 1400 people standing idle 24 hours a day for an entire year (Reistrup, 1986, Johnson, 1990). The costs of air delays for passenger and airlines nationwide in the U.S. has been estimated at $5 billion in 1986, of which $2 billion (7 percent of the airline's total operating costs) was spent on extra fuel and labor. Unlike airlines, HST would be virtually immune to adverse weather that is the single largest cause of airline delays. The benefits of HST in terms of timesaving can come through reduction in travel in ground transportation and the potential decrease in air travel delays.

The cost of social impacts due to the lack of reduction in road and air congestion could be significant in the absence of HST. Thompson and Bawden (1992) argue that car trips in Southern California are expected to jump by 42 percent, and the cost of rush hour congestion in that area will soar to $26 billion - most in lost production - by the year 2010. Similarly, the Federal Railroad Administration (FRA, 1990) estimates that nationwide two billion production hours per annum are lost already because of highway congestion, costing about $80 billion per year.

High-speed trains have a positive and noticeable effect on air pollution reduction. High-speed trains create pollution approximately 1/6 of the pollution per person transported by a car. However, there are increased concerns about the noise pollution of HST. Despite availability of new technologies to reduce noise pollution, the cost of noise pollution reduction is extremely high. In Japan, because of the proximity of railway lines to residential areas, civil engineering costs were significantly higher to account for increased noise pollution reduction measures.

The presence of HST is also likely to affect the welfare of a local community. In general, communities with large service sectors would benefit the most, although Hagiwara (1982) notes that the impact on medium-sized communities would be larger than the impact on large cities on the route. Hagiwara (1982) finds that the high-speed rail system is "a system which joins smaller communities to larger communities, rather than the reverse". For this reason, it is most likely that the impact would be larger on smaller communities than on larger ones. However, Hagiwara (1982) notes that in small communities that are already very close to a large community, the impact would be very small.

(6) Diverted Travelers and Induced Travelers

Demand for high-speed rail primarily arises from two sources: transfers of passengers from other modes of transportation, and new passengers. Specifically, high-speed rail demand can be separated into three groups: (1) passengers who switch from commuter air trips to high-speed rail; (2) automobile and bus passengers who switch to the high speed rail; and, (3) induced demand, that is, those who would not have traveled in the absence of the high-speed rail.

Traffic diversion has been one of the major and important impacts of HST connections. Diverted traffic not only positively affects the environment but also contributes to economic growth by releasing resources to produce things elsewhere in the economy. Because it directly competes with auto and air travel, the HST is likely to divert a significant amount of traffic depending on the relative fare, travel time, and quality of service of HST. Similarly, new travelers or "induced travelers" largely contribute to the increases in the number of travelers. The increase in the number of travelers, however, depends on the reduction in travel time, increased accessibility, and relative costs of traveling.

Vickerman (1997) examines the impact of French TGV on traffic diversion and trip generation. In France, the total rail passengers on the Paris-Lyon corridor increased from 12.5 million in 1980 to 22.9 million in 1992, of which 18.9 million were TGV passengers. Most of the increase came in the first few years with 20 million rail passengers (15 million by TGV) by 1985. Most of the diverted passengers came from air traffic. Paris-Lyon air traffic halved between 1980 and 1984, and Paris-Geneva air traffic fell by around 20 percent. The air traffic on Paris-Sud Est in general grew at less than half the rate of other radial routes from Paris.

In France, the impact of HST on the growth of traffic volume in other transportation modes has been significant. All transportation experienced a general slow- down in traffic volume growth from 1989 onwards. The overall increase in train traffic between French cities is attributed to the TGV lines. Bonnafus (1987) estimates that 51 percent of the total increase in train traffic in France can be attributed to diverted traffic of which 33 percent comes from airplanes and 18 percent from roads, and 49 percent to induced traffic.

The HST affected the traffic volume significantly in the other parts of Europe as well. In Germany, during the first five years of its operation, ICE induced a significant number of passengers to travel by HST. ICE passengers more than doubled, from just over 10 million to nearly 23 million over the first five year period, of which some 12 percent of the traffic is estimated to be diverted from road and air. Similarly, the ICE traffic accounts for 28 percent of long-distance passenger revenues. In Spain, the high-speed train (AVE) has been remarkably successful in diverting and inducing new traffic. Within diverted traffic, about 32 percent of travelers is estimated to have come from air transport, and 25 percent from the roads. About 26 percent of the total travelers has been considered as newly generated (i.e., induced). Existing train services have suffered from the presence of AVE. About 14 percent of AVE passengers are considered to come from existing train service.

(5) Potential Urban Redevelopment, and Revitalization

Past experience shows that HST can play a significant role in the redevelopment of an urban area. The Japanese experience in Kakegawa, midway between Tokyo and Osaka, has proved that the HST has tremendous potential to revitalize urban areas. Okada (1994) discusses the redevelopment of Kakegawa, which is on the Tokaido *Shinkansen* line and has a population of approximately 72 thousand. Initially, Kakegawa did not have a *Shinkansen* connection. In 1988, a station was built in Kakegawa. The *Shinkansen* connection in Kakegawa led to an increase in urban hotels, conference centers, and convenience stores. Since the connection of *Shinkansen*, Kakegawa has experienced increases in employment, production, sales, the number of tourists, and the number of conferences. Okada (1994) argues that the impact of *Shinkansen* on urban growth was further supported by the presence of an information exchange industry. This industry includes business services, banking and real estate development, access to higher education (universities), and expressway access (Nakamura and Ueda, 1989).

(i) Relocation of Firms and Economic Growth

Relocation of firms due to the presence of HST is another important impact of the high-speed train. For firms in larger urban regions with land consuming activities, a new high-speed train line may make it profitable to relocate business activities to one of the smaller, outlying regions within the corridor that now has higher accessibility. The HST connection makes it possible for firms to keep personal contact with many of their existing suppliers and customers. At the same time, they can take advantage of cheaper land and lower wages in such regions. In this case, the smaller outlying region might gain employment while the larger region loses employment. This implies that the establishment of the high-speed train link may change the mix of inputs for firms. Similarly, firms can extend their markets and relocate activities to advantageous regions within the corridor. The relocation of firms due to the presence of the high-speed train connection is likely to stimulate production and increase economic growth in the high-speed train corridor.

Similarly, HST might contribute to regional economic growth by giving rise to an inflow of firms from other regions outside the corridor. If HST connects corridor regions with international airports, seaports and highways, the corridor becomes even more attractive for firms outside the region.

(ii) Improved Accessibility and Economic Growth

The HST can substantially increase the economic growth of a region by improving the accessibility of the region. The HST addresses accessibility problems in two ways. First, where a point to point link is dominant, each train is a potential substitute for an air connection between two cities, that is, it connects cities at long distance with a direct train connection. The HST can directly compete with air transportation by supplying a large number of trips in more efficient, more comfortable and more environmentally friendly ways, and, without regard for the weather.

Second, HST binds cities together and creates a new region formed like a string of pearls. This type of region is known as a functional region[4] (Haynes, 1997). Such a band of cities connected by HST and combined with a highway is expected to have a higher competitive advantage over other, more isolated regions.

Improved accessibility favors firms as well as workers. The improved accessibility leads to a widening of regional labor markets, and allows firms to recruit labor with more suitable competence profiles. It also provides larger contacts with other firms, suppliers, and customers. While firms can search for labor in wider circles, people in the labor force can also supply their labor within a larger geographical area. The larger labor market created by HST connections implies more frequent and longer commuting trips. Moreover, improved accessibility also gives rise to increased business trips. The increase in travel intensity as a result of extension of the labor or service market, and more business trips would stimulate economic growth in the region. Some studies show that a corridor with a combination of highway linkage and high-speed train access, and well-functioning feeder systems, has higher potential for economic growth than regions lacking such infrastructure (Cheshire, 1995).

(7) Prospect of HST in Northeast Corridor

The success of HST depends upon its ability to attract new travelers as well as to

[4] A Functional Region is a geographical area that shares a common labor market and a common market for household

divert travelers from other modes. Most importantly, the ability of HST to compete with other modes of transportation could largely determine the success or failure of HST in the Northeast corridor. If HST provides competitive fares, better quality of service, more trips, and reduces travel time significantly relative to other modes of transportation, the HST can succeed in the Northeast corridor. The population density is significantly higher in the Northeast relative to other parts of the country. The Northeast corridor could be an appropriate market for HST as it consists of total population over 35.8 million and several large metropolitan areas, Washington, Baltimore, Philadelphia, New York, and Boston.

The U.S. Department of Transportation has projected that passenger-miles in the Northeast corridor will be over 1.3 billion for 1997. The revenues are projected to cover all expenses, continuing investment, and over half of the initial infrastructure investment. Similarly, in terms of traffic diversion, the National Railroad Passenger Corporation estimates that the HST could attract 1.6 million highway travelers and 1.4 million air travelers in Northeast corridor alone.

There is, however, also some skepticism about the success of HST in the United States. Because of other competitive transportation modes, and lower population density in the Northeast relative to Japan and France, the impact of HST on traffic volume may not be as high as in Japan and France. Moreover, because travelers in the U.S. are more dependent on automobiles, the relatively cheaper gasoline prices in the U.S. compared to Europe and Japan may provide less incentive for travelers to switch from automobiles to HST.

(8) Prospects for Greater New Haven

The introduction of HST in the Northeast corridor and infrastructure improvements in New Haven could have a significant impact on the revitalization of the New Haven area and its vicinity. The other infrastructure improvements include construction of Pearl Harbor Memorial Bridge, parking garages, Church Street bridge, and enhancement of Metro-North and Shore Line East rail services. Following the completion of these projects, New Haven is likely to be a prime location for business expansion and relocation. Because the proposed HST is expected to cut the current travel time between

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and business services.

New York and New Haven, and, Boston and New Haven significantly, business activities that are sensitive to travel time will most likely be attracted to New Haven. Moreover, because of the existing infrastructure such as Tweed Airport, seaports, its proximity to New York, Boston, and Hartford, these improvements may attract a diversity of businesses to New Haven. Similarly, quicker access to New York and Boston, and relatively lower costs of doing business in the New Haven area may persuade some businesses to locate in the corridor rather than at the end points.

Similarly, the tourism industry is also likely to flourish in the New Haven area following the HST connection. Because of reduced travel time increase in accessibility, the number of tourists in Connecticut is likely to increase significantly. Mystic Aquarium and Seaport, and, Foxwoods Resort and the Mohegan Sun Casinos draw large numbers of tourists from Boston, New York and other parts of the Northeast. Cultural tourism will benefit as Connecticut's museums and New Haven's arts and cultural activities grow. Cultural tourists usually stay longer and spend more money than recreational tourists.

TRANSPORTATION SECTOR IMPROVEMENTS IN NEW HAVEN COUNTY: AN ECONOMIC IMPACT AND BUILD-OUT ANALYSIS

Introduction

This report presents the results of a dynamic analysis of the economic impact of ongoing and proposed enhanced infrastructure developments in New Haven County. This analysis covers investments in Connecticut's infrastructure, including improvements to the State's commuter railway system (Metro-North and Shore Line East), its highway system (I-95), and the introduction of high-speed train service linking Connecticut to Boston and New York, and subsequent developments in the County in the professional services and biotechnology sectors. The Regional Growth Partnership requested the Connecticut Center for Economic Analysis (CCEA) at the University of Connecticut to conduct this study. The Center houses the State Economic Model, (the REMI model), a sophisticated 53-sector replication of the State's economic structure that can project economic impacts out to the year 2035. The analysis presented here looks at the impacts over a period of thirty-two years, with the year 1999 as the starting point. The objective is to determine the net benefits to New Haven County, in terms of increased employment, gross regional product (GRP), personal income, and net tax revenues, as these investments in the County's infrastructure take place.

This analysis focuses on both the construction of new infrastructure and on potential benefits such as business expansion and attraction that may accrue once the new infrastructure is in place. The construction phase is based on available data on current and future highway and rail development projects. The potential business expansions are modeled on the availability of land suited for development. The latter phase is essentially a "build-out" approach based on the area of land available, in which five possible scenarios are considered; a "maximum build-out", a "minimum build-out", an "moderate build-out", a "current office space growth trend", and a "new 2.5 million square feet lab space" scenario. These are explained in detail below.

PHASE I: INFRASTRUCTURE CONSTRUCTION PHASE

The construction projects included here come from two sources: the Connecticut Department of Transportation (ConnDOT) and Amtrak. The analysis looks only at ongoing and future investments; completed projects are not included. Table I below lists the construction projects and their estimated costs.

TABLE I: PROSPECTIVE PROJECTS	Estimated Cost Millions of Nominal $
ConnDOT projects	
Pearl Harbor Memorial Bridge (Q Bridge) recommended action design/reconstruction projects	$979
Church Street South Extension	$ 33
Shore Line East Station Enhancements: Westbrook	$2.6*
Guilford	$2.6*
Madison	$2**
Branford	$3.4**
Amtrak Projects	
Guilford Sidings	$13
New Haven Yard Modernization	$75

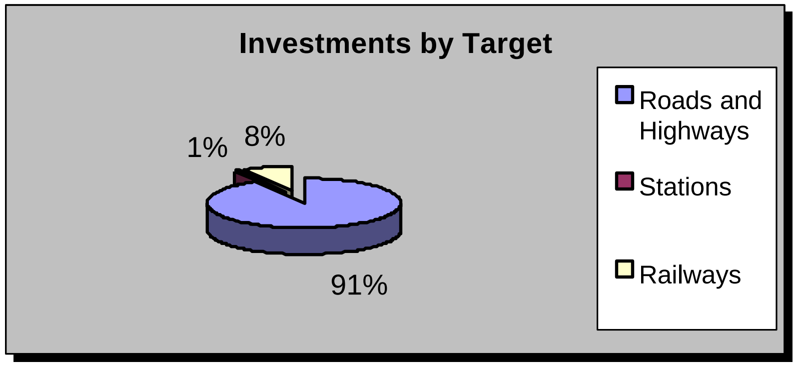
*station only **station and parking

These investments include both the construction of new facilities and the enhancement of existing facilities. For instance, they include new stations (e.g., a new passenger station on State Street in New Haven as a component of the Pearl Harbor Memorial Bridge development package), and the improvement of existing ones (e.g., Shore Line East stations). They include the construction of new rail lines as well as improvements to existing ones. And they include the construction of new roads and bridges (e.g., the new Pearl Harbor Memorial Bridge (Q Bridge) in New Haven) and the enhancement of existing roads and bridges (e.g., widening portions of I-95 under the Pearl Harbor Memorial Bridge (Q Bridge) project). Amtrak, the federal government, and the State's transportation fund will presumably provide funding for these projects, resulting in no extraordinary State spending.

The infrastructure investments considered in this study fall into three main categories; railroads, railway stations, and roads and highways[4]. Chart 1 shows funding for each category as a fraction of the whole.

[4] The new State Street Station is included in the Pearl Harbor Memorial Bridge (Q Bridge) Development construction as separate estimates are not available at this point.

CHART 1



SCHEDULE OF PROJECTS:

1. New Haven Infrastructure Improvement

PROJECTS	BEGINNING DATE	EXPECTED COMPLETION DATE
State Street Station-A	SPRING 2000	FALL 2001
Pearl Harbor Memorial Bridge - B	SUMMER 2002	FALL 2010
East Haven-C	FALL 2000	SPRING 2003
Branford-D	FALL 2000	FALL 2003
E-I-95/I-91/Rt.34 Intersection-E	SPRING 2003	SUMMER 2010
Branford Station and Parking	FALL 1999	FALL 2001
New Shore Line East passenger stations	FALL 1999	BY 2003

A- New Passenger station on State Street, New Haven.
B- New I-95 Pearl Harbor Memorial (Q) Bridge over New Haven Harbor, New Haven.
C- Widen I-95: Woodward Ave. New Haven Lake Saltonstall Bridge, East Haven.
D- Widen I-95: Lake Saltonstall Bridge- Interchange #54, Branford.
E- Reconstruction of the I-95/I-91/Rt. 34 Interchange, New Haven.

2. Amtrak Investments in Connecticut

PRJOECTS	AMOUNT OF INVESTMENT (Mill. $)	EXPECTED COMPLETION YEAR
New Haven Yard Modernization	$75	In progress
Stamford Center Island Platform	$35	In progress
Track 2 (Norwalk-Devon) and Other NH-NY Border Improvements	$27	In progress- 2000
Old Saybrook Center Island Platform and Freight Improvements	$20	In progress
New London Station and Platforms	$8	2001
Guilford Sidings	$13	2002
Clinton Sidings	$2	Completed
Pine Orchard Sidings	$6	Completed
Tilcon Sidings	$1	Completed
Niantic River Bridge Replacement	$35	2003
Connecticut River Draw Upgrades	$10	Completed
Bridges/Rail/Track/Signal Upgrades NH-NL	$75	Completed
Thames River Draw Span Replacement	$30	2001
Bridges/Rail/Track/Signal upgrades NL-Westerly	$60	Completed
CT Electrification	$150	Completed
TOTAL INVESTMENT	$545	

PHASE II: POTENTIAL EXPANSION PHASE

Phase II models the potential developments following the infrastructure improvements of Phase I. Two sectors were considered as candidates for expansion – professional services and biotechnology. Accordingly, the land is used for the construction of offices and laboratories. We needed two estimates to be used as inputs to the REMI model – the total construction and equipment costs for the buildings, and the potential employment that results from the completed projects. Our assumptions and estimates are explained in detail below.

The total amount of land likely developable based on RGP estimates in New Haven County was the starting point for the "maximum build-out", "minimum build-out", and "moderate build-out" strategies. The total available land area was first converted from acres into square feet (at 40,000 square feet per builder's acre). Of the total, 30% was regarded as potential land for Class A office space and laboratories (after allowing for roads, driveways, parking lots and gardens). This area is divided into 60% Class A office space and 40% laboratory buildings. Each building has a maximum of three floors (for the maximum build-out, with one and two floors for the minimum and moderate build-outs, respectively), and on each floor, 60% is designated "work space". The remaining space (40% of the total building area) allows for hallways, stairways, storage space and conference areas. Construction costs of $122.50 per square foot of Class A office space[5] and $290 per square foot of lab space[6] were used to estimate total construction costs. Equipment costs were obtained by using $20.38 per square foot for office fixtures and furniture, $9.73 per square foot for computers for office space, and $60 per square foot for lab machinery and equipment. We assume 300 square feet per office worker and 500 square feet per lab worker to estimate potential employment in each sector. All fractions above and the number of floors are parameters that are easily changed for alternative scenarios.

The "maximum build-out" scenario assumes three-story buildings on 40% of the available land. The "minimum build-out" scenario assumes one-story buildings, thereby reducing the construction and equipment costs and employment to one-third of the above values. The "moderate build-out" scenario assumes two-story buildings, hence the costs and employment values amount to two-thirds of the maximum values. In all these cases the construction and equipment of the offices and labs take place over ten years beginning in 2001, and the employment of workers in these offices and labs take place over the next 10 years, beginning in 2011.

The "current office space growth trend" scenario takes into consideration the growth of class A office space in New Haven Country during the last five years, which amounted to an annual growth rate of 1.92% from 1994-1999. Potential expansion of office and lab space is then based on this growth rate, using the available office space in 1999 as the starting point. As before, 60% of the expansion will be new office space, and 40% will be new lab space. Construction takes place over ten years beginning in 2001,

[5] *Source:* www.Saylor.com
[6] *Source:* UConn Chemistry Building

and employment opportunities are filled over ten years beginning in 2003. Employment is estimated based on the area of office and lab space using the same numbers as above.

The "new 2.5 million square feet of lab space" scenario assumes the construction of a total of 2.5 million square feet of lab space in New Haven County over five years beginning in 2001. Employment opportunities are filled over five years beginning in 2003. Equipment costs for the labs are estimated using the same number as above, as is the estimated employment.

In each of the above scenarios we included the construction of 700 new hotel rooms and 200,000 square feet of convention and entertainment space in New Haven County. The construction of the new hotels is estimated to cost $180.4 million, beginning in 2002 and completed by 2004. Once completed, we assume an occupancy rate of 70% that generates $31.5 million in sales per year. The convention and entertainment space is estimated to cost $51.7 million to construct, beginning in 2002 and ending in 2004. Beyond that, these centers will incur operating costs of $3 million per year. We assume that attendance at the centers will equal 210,375 event days (number of events * number of participants) and each visitor will spend an average of $200 per day while in the New Haven area. This amounts to $42.075 million new spending per year. All estimates for hotels and convention/entertainment centers were based on calculations obtained for similar construction proposals under the Adriaen's Landing project in Hartford, and scaled up or down according to size.

All estimates are listed in Table IIA and IIB, with the actual inputs used in the model in bold text.

TABLE II A - INPUT DATA	Maximum Build-out	Minimum Build-out	Moderate Build-out	Current Office Space Growth Trend	2.5 M Sq. Feet Additional Lab Space
Total available land	114,350,800 sq. ft.	114,350,800 sq. ft.	114,350,800 sq. ft.		
Total building area (outside space) (30% of total land) includes 160,000 sq. ft. pre-designated for development	34,465,240 sq. ft.	34,465,240 sq. ft.	34,465,240 sq. ft.	183,689 sq. ft*	
	Three-story buildings	*One-story buildings*	*Two-story buildings*		
Total Class A office space (60% of total building area)	62,037,432 sq. ft.	20,679,144 sq. ft	41,358,288 sq. ft	110,213 sq. ft	
Total Lab space (40% of total building area)	41,358,288 sq. ft.	13,786,096 sq. ft	27,572,192 sq. ft	73,475 sq. ft	
Construction costs of Office space ($122.50/sq.ft)	$7,599,585,420	$2,533,195,140	$5,066,390,280	$13,501,123	
Construction costs of Lab space ($290/sq.ft)	$11,993,903,520	$3,997,967,840	$7,995,935,680	$21,307,894	$725,000,000
Total Building Construction Costs	**$19,593,488,940**	**$6,531,162,980**	**$13,062,325,960**	**$34,809,017**	**$725,000,000**
Furniture and Fixture costs for Offices ($20.83/sq.ft)	**$ 775,343,825**	**$258,447,941**	**$516,895,883**	**$2,295,742**	**-**
Computers and Elec. Equipment costs for Offices ($9.73/sq.ft)	**$ 362,174,528**	**$120,724,842**	**$241,449,685**	**$1,072,375**	**-**
Machinery and Equipment for Labs ($60/sq.ft)	**$1,488,898,368**	**$496,299,456**	**$992,598,912**	**$4,408,530**	**$150,000,000**
Space available for Office workers (60% of office space)	37,222,459 sq. ft	12,407,486 sq. ft	24,814,973 sq. ft	110,213 sq. ft	**-**
Number of Office workers (300 sq. ft/worker)	**124,075**	**41,358**	**82,717**	**5,367**	**-**
Space available for Lab workers (40% of lab space)	24,814,973 sq. ft.	8,271,658 sq. ft	16,543,315	73,475 sq. ft	-
Number of Lab workers (500 sq. ft/ worker)	**49,630**	**16,543**	**33,087**	**2,147**	**5000**
Total Number of Workers	**173,705**	**57,901**	**115,803**	**7,513**	**5000**

***** Net new space projected for year 2000 using 1.92 % annual growth of Office Space.

TABLE II B - INPUT	
Hotel and Convention Center: Included in All Scenarios	
Construction Cost of Hotels – 700 rooms ($257,671 per room)	$180,369,700
Total Construction Costs for Hotels	**$180.369,700**
Hotel Sales per Year (70% room occupancy)	**$31,500,000**
Construction Cost for Convention/Entertainment Centers ($258.52/sq.ft)	$51,700,000
Total Construction Costs for Convention/Entertainment Centers	**$51,700,000**
Operating Costs for Convention/Entertainment Centers per Year	**$3,000,000**
Event Days per Year (Number of Events * Number of Participants)	210,375
Spending per Day per Visitor	$200
New Spending by Visitors per Year	**$42,075,000**

Methodology

The lack of data for some of the projects limits the analysis. Even for the construction phase, most of the available data is lump sum funding allocated for an entire project, not broken down into estimated expenses by category, for instance equipment purchases or miscellaneous professional services. Data for some projects, such as planned parking garages, is not yet available, and thus could not be included in the analysis.

This study therefore must be viewed keeping the following conditions in mind:

- It incorporates investments (construction and enhancement) in three main transportation components - roads and highways, railways, and railway stations - and *estimates* of subsequent investments in the professional services and biotechnology sectors.
- The investments are timed using their estimated costs and duration of construction, often simply estimated by dividing the total cost equally among the number of years designated for the project except in the cases where more detailed data is available. Most of these investments occur from 1999-2002, with the Pearl Harbor Memorial Bridge expansion continuing until 2010. The subsequent investments are timed such that the construction takes place over *ten years* beginning in 2001, after which employment is gradually phased in over ten years beginning in 2011.
- The results reflect the estimated benefits of *construction only* in the case of rail and highway improvements, and not the returns from the operation of the investments once they are in place. This should be kept in mind when interpreting the results. A

drop in employment, for example, will typically reflect completion of a construction project, not a negative longer run economic impact of the project itself.

- CCEA assumed all funding for these projects is "external". This is because presumably the investments in the transportation sector are funded federally or by Amtrak, along with contributions from the State's "Special Transportation Fund". We assume that subsequent investments are funded by the private sector. This implies that the State does not cut spending elsewhere, raise taxes, or issue bonds to pay for its share of expenses for these projects.

Results

This analysis identifies the impact of the proposed construction projects and subsequent developments on a variety of economic variables, of which the most significant are employment, gross regional product (GRP), personal income and population. The following tables present the results for each of these variables in terms of their net impact on the New Haven County economy over the period 2000-2030 under each investment scenario. The tables that depict net increases in selected economic variables show the average of the annual increases (or decreases) of these aggregate levels that flow directly and indirectly from the proposed investment over thirty-two years compared to a baseline (status quo) forecast of the (County) economy's performance.

Scenario I - Maximum Build-out

TABLE III: Net Increases in Selected Economic Variables for New Haven County
Maximum Build-out Strategy
2000-2030

	Average Incremental Level Change over Baseline	Average Percentage Change over Baseline	Average Baseline Level
Employment (Thousands)	145.01	28.70%	487.766
GRP (Billions Nominal $)	$20.28	28.47%	$56.187
Personal Income (Billions Nominal $)	$15.86	25.82%	$49.653
Population (Thousands)	163.73	18.84%	834.514
Future Housing Demand (Bill Nominal $)	$6.58	0.72%	$10.371

Each of the values in Table III shows the change in the relevant variable that flows from completion of all components shown in Tables I and II compared to a baseline forecast of the County's economy. According to the *maximum build-out approach* adopted in this analysis, the average annual increase in employment in New Haven County above the status quo forecast due to the investments in transportation, professional services and biotech industries is about 145,010 jobs. Figure 1, which shows the annual changes of the above variables, illustrates how employment picks up in year 2000 when the construction of the Pearl Harbor Memorial Bridge and the industrial complexes begin. Employment gradually decreases as the construction projects are completed, then increases sharply from 2011 to 2020 as the employment opportunities created by the construction expansion are filled. It peaks in year 2020 then settles to a stable level of approximately 266,000 jobs above the baseline forecast. Thus at the end of the thirty-year period New Haven County would have 270,000 additional permanent jobs in this scenario. Therefore, on average, each year approximately 9,000 jobs are added cumulatively to the economy for thirty-two years.

The average annual increase in GRP is $20.28 billion. Personal income in the County increases by an average of $15.86 billion, and the average annual increase in the County's population over the thirty years is 163,732 people. GRP follows the same pattern as employment - it first increases then decreases slightly as construction winds down, before rising again with new employment. Personal income follows the GRP movement as well, as workers are hired as construction increases, then furloughed as it is gradually completed, before employment rises again in the expanded sectors. Population in the County increases as the State's new infrastructure and employment opportunities attracts more residents. Future housing demand rises to a peak of $15.78 billion in 2020 as employment in the County increases, and then decreases as employment stabilizes beyond that as shown in Figure 1.

The study also evaluated the effects of the proposed investments in New Haven County on State and local tax revenues. State taxes consist of income taxes, sales and use taxes, and corporate profit taxes. Local property taxes are in New Haven County. Table IV shows the average annual increase in tax revenues for the State and local governments for the thirty one-year period beginning in 2000.

TABLE IV: Average Changes in Tax Revenues for New Haven County
Maximum Build-out Strategy
(Millions Nominal $)
2000-2030

	Average Tax Revenue Change
Average New State Tax Revenue	$923.74
Average New Local Property Taxes	$519.92
Average Total New Taxes	$1,443.66

State taxes increase by an annual average of $924 million due to the proposed infrastructure developments and potential industry expansions. Local property taxes increase by an average of $520 million. This is likely reflects the increase in population as the improved transportation infrastructure, increased job opportunities, and increasing investment in biotech industries attract more residents to the County. Figure 2 shows the annual increases in tax revenues over the relevant time period, and that total tax revenue follows the pattern of employment during the construction and expansion phase. To look at the net gains in taxes for the State, total taxes are offset against induced government spending. Induced government spending includes any expenses the State or Connecticut towns incur as a *result* of the proposed investments. The most common reason for such expenses is the increased spending for public services that arises because of an increase in the County's population. As expected, induced government spending closely follows the population change pattern during the period of the study, resulting in a gradual decline in net returns to the State as the County's population increases.

The net gains to the State can also be evaluated using the present values of the tax revenues offset against the present value of net expenditures. Table V gives the present values of both future tax collections and induced spending (over thirty-two years). The present value of new taxes includes future income taxes, sales and use taxes, corporate profit taxes, and local property taxes, which the project generates directly and indirectly. These are then offset against the present value of induced government spending to compute net tax revenues.

TABLE V: Present Value of New Tax Revenues and New Expenditures
Maximum Build-out Strategy
(Billions Nominal $)

REVENUES AND RELATED EXPENDITURES	PRESENT VALUE
PRESENT VALUE OF TOTAL NEW TAXES	$14.09
PRESENT VALUE OF INDUCED NEW GOVT. SPENDING	$9.62
PRESENT VALUE OF NET NEW TAXES	$4.47

Because of the potential investments that can occur once the necessary infrastructure is in place, the State benefits overall with the implementation of these projects. Any additional spending induced by an increase in the County's population is accounted for in the form of new tax revenues. The State thus earns net taxes with a present value of $4.47 billion over the thirty-year period studied in this first scenario.

Scenario II - Minimum Build-out

TABLE VI: Net Increases in Selected Economic Variables for New Haven County
Minimum Build-out Strategy
2000-2030

	Average Incremental Level Change over Baseline	Average Percentage Change Over Baseline	Average Baseline Level
Employment (Thousands)	47.77	9.46%	487.766
GRP (Billions Nominal $)	$6.21	9.12%	$56.187
Personal Income (Billions Nominal $)	$4.81	7.88%	$49.653
Population (Thousands)	51.14	5.89%	834.514
Future Housing Demand (Bill Nominal $)	$1.95	0.22%	$10.371

Each of the values in Table VI shows the change in the relevant variable that flows from completion of all components shown in Tables I and II compared to a baseline forecast of the County's economy. According to the *minimum build-out approach* adopted in this analysis, the average increase in employment in New Haven County above the status quo forecast due to the investments in transportation, professional services and biotech industries is about 47,766 jobs. Figure 3 shows the annual changes of the above variables and that there is an initial increase in employment that peaks in 2002, which is when most construction projects are underway. This is followed by a gradual decline until 2010 as most of these projects are completed. Starting in 2011 there is a steady rise in employment, which reflects the newly created jobs in the professional services and biotechnology sectors. Employment peaks in 2020 then declines to a stable level when all construction is complete, settling at an average of 87,000 jobs over the baseline forecast. Thus at the end of the thirty-two year period New Haven County would have 87,850 additional permanent jobs in this scenario. Therefore, on average, each year approximately 2,834 jobs are added to the economy for thirty-one years.

The average increase in GRP is $6.21 billion. Personal income in the County increases by an average of $4.81 billion, and the average increase in the County's population is 51,142 people. GRP follows the same pattern as employment - it first increases then decreases slightly as construction winds down, before rising with new employment. Personal income follows the GRP movement as well, as workers are hired as construction increases, then furloughed as it is gradually completed, before employment rises again with the expanded sectors. Population in the County increases as the State's new infrastructure and employment opportunities attract more residents. Demand for housing follows the same pattern as employment as the new workers seek residences in the County, peaking at $4.54 billion over the baseline then decreasing to $3.12 billion by 2030.

We evaluated the effects of the proposed investments in New Haven County on state and local tax revenues for the minimum build-out scenario. State taxes and local taxes are as above. Table VII shows the average annual increase (above the status quo forecast) in tax revenues for the State and local governments for the thirty one-year period beginning in 2000.

TABLE VII: Average Changes in Tax Revenues for New Haven County
Minimum Build-out Strategy
(Millions Nominal $)
2000-2030

	Average Tax Revenue Change
Average New State Tax Revenue	$281.68
Average New Local Property Taxes	$161.39
Average Total New Taxes	$443.07

State taxes increase by an average of $282 million due to the proposed infrastructure developments and potential industry expansions. Local property taxes increase by an average of $161 million. This is likely to reflect the increase in population as the improved transportation infrastructure, increased job opportunities, and increasing investment in biotech industries attract more residents to the County. Figure 4 shows the annual change in tax revenues over the relevant time period and that total tax revenue follows the pattern of employment during the construction and expansion phase. To look at the net gains in taxes for the State, total taxes are offset against induced government spending. Induced government spending includes any expenses the State or Connecticut towns incur as a *result* of the proposed investments. The most common reason for such expenses is the increased spending that arises because of an increase in the County's population. As expected, induced government spending closely follows the population change pattern during the period of the study, resulting in a gradual decline in net returns to the State as the County's population increases.

The net gains to the State can be evaluated using the present values of the tax revenues offset against the present value of net expenditures. Table VIII gives the present values of both future tax collections and induced spending (over thirty-one years). The present value of new taxes includes future income taxes, sales and use taxes, corporate profit taxes, and local property taxes, which the project generates directly and indirectly. These are then offset against the present value of induced government spending to compute net tax revenues.

TABLE VIII: Present Value of New Tax Revenues and New Expenditures
Minimum Build-out Strategy
(Billions Nominal $)

REVENUES AND RELATED EXPENDITURES	PRESENT VALUE
PRESENT VALUE OF TOTAL NEW TAXES	$4.46
PRESENT VALUE OF INDUCED NEW GOVT. SPENDING	$2.98
PRESENT VALUE OF NET NEW TAXES	$1.49

As a result of the potential investments that can occur once the necessary infrastructure is in place, the State benefits overall with the implementation of these projects in the minimum build-out scenario. Any additional spending induced by an increase in the County's population is accounted for in the form of new tax revenues. The State thus earns net taxes with a present value of $1.49 billion over the thirty one-year period studied in this scenario.

Scenario III - Moderate Build-out

TABLE IX: Net Increases in Selected Economic Variables for New Haven County
Moderate Build-out Strategy
2000-2030

	Average Incremental Change over Baseline	Average Percentage Change Over Baseline	Average Baseline Level
Employment (Thousands)	96.63	19.13%	487.766
GRP (Billions Nominal $)	$13.04	18.71%	$56.187
Personal Income (Billions Nominal $)	$10.16	16.56%	$49.653
Population (Thousands)	106.80	12.29%	834.514
Future Housing Demand (Bill Nominal $)	$4.24	4.34%	$10.371

Each of the values in Table IX shows the average annual change in the relevant variable that flows from completion of all components shown in Tables I and II compared to a baseline (status quo) forecast of the County's economy. According to the *moderate build-out approach* adopted in this analysis, the average increase in employment in New Haven County above the status quo forecast due to the investments in transportation, professional services and biotech industries is about 96,630 jobs. Figure 5 shows the annual changes of the above variables and shows that there is an initial increase in employment that peaks in 2002, which is when most construction projects are underway. This is followed by a gradual decline until 2010 as these projects are completed. Starting in 2011 there is a steady rise in employment, which reflects the newly created jobs in the professional services and biotechnology sectors. Employment peaks in 2020 then declines to a stable level when all construction is complete, settling at an average increase of 178,000 jobs over the baseline. Thus at the end of the study period New Haven County would have nearly 181,000 permanent new jobs. Therefore, on average, each year approximately 5,839 jobs are added to the economy for thirty-one years.

The average annual increase in GRP is $13.04 billion. Personal income in the County increases by an average of $10.16 billion, and the average increase in the County's population is 106,800 people. GRP follows the same pattern as employment - it first increases then decreases slightly as construction winds down, before rising with the new employment level. Personal income follows the GRP movement as well, as workers are hired as construction increases, then furloughed as it is gradually completed, before employment rises again with the expanded sectors. Population in the County increases as the State's new infrastructure and employment opportunities attracts more residents. Demand for housing follows the same pattern as employment as the new workers seek residences in the County, peaking at $9.97 billion over the baseline then decreasing to $6.82 billion by 2030.

We evaluated the effects of the proposed investments in New Haven County on State and local tax revenues as above. Table X shows the average annual increase in tax revenues for the State and local governments for the thirty one-year period beginning in 2000.

TABLE X: Average Changes in Tax Revenues for New Haven County
Moderate Build-out Strategy
(Millions Nominal $)
2000-2030

	Average Tax Revenue Changes
Average New State Tax Revenue	$592.80
Average New Local Property Taxes	$338.76
Average Total New Taxes	$931.56

State taxes increase by an average of $592.8 million due to the proposed infrastructure developments and potential industry expansion. Local property taxes increase by an average of $338.8 million. This is likely to reflect the increased population as the improved transportation infrastructure, increased job opportunities, and increasing investment in biotech industries attract more residents to the County. Figure 6 shows that total tax revenues follow the pattern of employment during the construction and expansion phase. Total taxes offset against induced government yield net gains in taxes for the State. Induced government spending includes any expenses the State or Connecticut towns incur as a *result* of the proposed investments. The most common reason for such expenses is the increased spending that arises because of an increase in the County's population. As expected, induced government spending closely follows the population change pattern during the period of the study, resulting in a gradual decline in net returns to the State as the County's population increases.

The net gains to the State can be evaluated using the present values of the tax revenues offset against the present value of net expenditures as above. Table XI gives the present values of both future tax collections and induced spending (over thirty-one years). The present value of new taxes includes future income taxes, sales and use taxes, corporate profit taxes, and local property taxes, which the project generates directly and indirectly. These are then offset against the present value of induced government spending to compute net tax revenues.

TABLE XI: Present Value of New Tax Revenues and New Expenditures
Moderate Build-out Strategy
(Billions Nominal $)

REVENUES AND RELATED EXPENDITURES	PRESENT VALUE
PRESENT VALUE OF TOTAL NEW TAXES	$9.31
PRESENT VALUE OF INDUCED NEW GOVT. SPENDING	$6.30
PRESENT VALUE OF NET NEW TAXES	$3.02

Because of the potential investments that can occur once the necessary infrastructure is in place, the State again benefits overall with the implementation of these projects. Any additional spending induced by an increase in the County's population is accounted for in the form of new tax revenues. The State thus earns net taxes with a present value of $3.02 billion over the thirty-year period studied in this scenario.

Scenario IV - Current Office Space Growth Trend

TABLE XII: Net Increases in Selected Economic Variables for New Haven County
Current Office Space Growth Trend
2000-2030

	Average Incremental Change over Baseline	Average Percentage Change Over Baseline	Average Baseline Level
Employment (Thousands)	9.75	0.123%	487.766
GRP (Billions Nominal $)	$1.06	0.087%	$56.187
Personal Income (Billions Nominal $)	$0.86	0.171%	$49.653
Population (Thousands)	11.84	0.134%	834.514
Future Housing Demand (Bill Nominal $)	$0.27	0.031%	$10.371

Each of the values in Table XII shows the average annual change in the relevant variable that flows from completion of all components shown in Tables I and II compared to a baseline (status quo) forecast of the County's economy. According to the *current office space growth trend approach* adopted in this analysis, the average increase in employment in New Haven County above the status quo forecast due to the investments in transportation, professional services and biotech industries is about 9,750 jobs. Figure 7 shows the annual changes of the above variables and shows that starting in 2000 there is a steady rise in employment that peaks in 2010 and drops off indicating the completion of the Pearl Harbor Memorial Bridge project in that year. Employment increases again in 2012 and remains stable through the end of the study period. Thus in 2030 New Haven County would have nearly 12,030 permanent new jobs. Therefore, on average, each year approximately 388 jobs are added to the economy for thirty-one years.

The average increase in GRP is $1.06 billion. Personal income in the County increases by an average of $0.86 billion, and the average increase in the County's population is 11,841 people. GRP follows the same pattern as employment. Personal income follows the GRP movement as well, as workers are hired as construction increases, then furloughed as it is completed, before employment rises again with the expanded office and lab space. Population in the County increases as the State's new infrastructure and employment opportunities attract more residents. Housing demand increases to a peak of $360 million in 2012 and remains stable after that, reflecting the stable employment patterns generated by the expanded professional and biotech sectors.

We evaluated the effects of the proposed investments in New Haven County on State and local tax revenues as above. Table XIII shows the average annual increase in tax revenues for the State and local governments for the thirty one-year period beginning in 2000.

TABLE XIII: Average Changes in Tax Revenues for New Haven County
Current Office Space Growth Trend
(Millions Nominal $)
2000-2030

	Average Tax Revenue Changes
Average New State Tax Revenue	$49.15
Average New Local Property Taxes	$33.64
Average Total New Taxes	$82.79

State taxes increase by an average of $49.15 million due to the proposed infrastructure developments and potential industry expansion. Local property taxes increase by an average of $33.64 million. This reflects the increased population as the improved transportation infrastructure, and increased job opportunities attract more residents to the County. Figure 8 shows that total tax revenue follow the pattern of employment during the construction phase then continues to increase. Total taxes offset against induced government yield net gains in taxes for the State. Induced government spending includes any expenses the State or Connecticut towns incur as a *result* of the proposed investments. The most common reason for such expenses is the increased spending that arises because of an increase in the County's population. As expected, induced government spending closely follows the population change pattern during the period of the study. As a result of increasing tax revenues net taxes remain stable in the State with only slight increases and decreases periodically.

The net gains to the State can be evaluated using the present values of the tax revenues offset against the present value of net expenditures as above. Table XIV gives the present values of both future tax collections and induced spending (over thirty-one years). The present value of new taxes includes future income taxes, sales and use taxes, corporate profit taxes, and local property taxes, which the project generates directly and indirectly.

These are then offset against the present value of induced government spending to compute net tax revenues.

TABLE XIV: Present Value of New Tax Revenues and New Expenditures
Current Office Space Growth Trend
(Billions Nominal $)

REVENUES AND RELATED EXPENDITURES	PRESENT VALUE
PRESENT VALUE OF TOTAL NEW TAXES	$1.01
PRESENT VALUE OF INDUCED NEW GOVT. SPENDING	$0.74
PRESENT VALUE OF NET NEW TAXES	$0.27

The State benefits overall if the current growth trend continues with the infrastructure investments. Any additional spending induced by an increase in the County's population is accounted for in the form of new tax revenues. The State thus earns net taxes with a present value of $268 million over the thirty one-year period studied in this scenario.

Scenario V - 2.5 Million Square Feet Lab Space

TABLE XV: Net Increases in Selected Economic Variables for New Haven County
2.5 Million Sq. Ft. Lab Space Strategy
2000-2030

	Average Incremental Change over Baseline	Average Percentage Change Over Baseline	Average Baseline Level
Employment (Thousands)	10.72	0.205%	487.766
GRP (Billions Nominal $)	$1.89	0.151%	$56.187
Personal Income (Billions Nominal $)	$0.97	0.244%	$49.653
Population (Thousands)	11.93	0.196%	834.514
Future Housing Demand (Bill Nominal $)	$0.30	0.04%	$10.371

Each of the values in Table XV shows the average annual change in the relevant variable that flows from completion of all components shown in Tables I and II compared to a baseline (status quo) forecast of the County's economy. According to the *additional 2.5 million square feet lab space approach* adopted in this analysis, the average increase in employment in New Haven County above the status quo forecast due to the investments in transportation and biotech industries is about 10,720 jobs. Figure 9 shows the annual changes of the above variables and shows that there is an initial increase in employment that peaks at 13,380 in 2007, after which there is a gradual decline until 2011, when the Pearl Harbor Memorial Bridge is completed. Employment remains stable and gradually increases after 2011. Thus at the end of the study period New Haven County would have nearly 12,890 permanent new jobs. Therefore, on average, each year approximately 416 jobs are added to the economy for thirty-one years.

The average annual increase in GRP is $1.89 billion. Personal income in the County increases by an average of $0.97 billion, and the average increase in the County's population is 11,930 people. GRP follows the same pattern as employment through 2011, after which it increases to $3.5 billion in 2030. Personal income follows the GRP movement as well, rising as the biotech sector expands. Population in the County increases as the State's new infrastructure and employment opportunities attracts more residents. Housing demand closely follows the employment trend as workers new to the state seek residences, and it reaches a level of $352 million in 2030.

We evaluated the effects of the proposed investments in New Haven County on State and local tax revenues as above. Table XVI shows the average annual increase in tax revenues for the State and local governments for the thirty one-year period beginning in 2000.

TABLE XVI: Average Changes in Tax Revenues for New Haven County
2.5 Million Sq. Ft. Lab Space Strategy
(Millions Nominal $)
2000-2030

	Average Tax Revenue Changes
Average New State Tax Revenue	$72.33
Average New Local Property Taxes	$33.20
Average Total New Taxes	$105.53

State taxes increase by an average of $72.33 million due to the proposed infrastructure developments and potential industry expansion. Local property taxes increase by an average of $33.2 million. This is likely to reflect the increased population as the improved transportation infrastructure, increased job opportunities, and increasing investment in biotech industries attract more residents to the County. Figure 10 shows that total tax revenues follow the pattern of employment during the initial construction and expansion phase. Total taxes offset against induced government yield net gains in taxes for the State. Induced government spending includes any expenses the State or Connecticut towns incur as a *result* of the proposed investments. The most common reason for such expenses is the increased spending that arises because of an increase in the County's population. As expected, induced government spending closely follows the population change pattern during the period of the study. As a result of increasing tax revenues net taxes remain stable in the State with only slight increases and decreases periodically.

The net gains to the State can be evaluated using the present values of the tax revenues offset against the present value of net expenditures as above. Table XVII gives the present values of both future tax collections and induced spending (over thirty-one years). The present value of new taxes includes future income taxes, sales and use taxes, corporate profit taxes, and local property taxes, which the project generates directly and indirectly. These are then offset against the present value of induced government spending to compute net tax revenues.

TABLE XI: Present Value of New Tax Revenues and New Expenditures
2.5 Million Sq. Ft. Lab Space Strategy
(Billions Nominal $)

REVENUES AND RELATED EXPENDITURES	PRESENT VALUE
PRESENT VALUE OF TOTAL NEW TAXES	$1.318
PRESENT VALUE OF INDUCED NEW GOVT. SPENDING	$755.5
PRESENT VALUE OF NET NEW TAXES	$562.3

Because of the potential investments that can occur once the necessary infrastructure is in place, the State again benefits overall with the implementation of these projects. Any additional spending induced by an increase in the County's population is accounted for in the form of new tax revenues. The State thus earns net taxes with a present value of $562.3 million over the thirty-year period studied in this scenario.

SPILLOVER EFFECTS OF INFRASTRUCTURE DEVELOPMENTS IN NEW HAVEN REGION

This analysis also presents the economic impacts of infrastructure improvements on the local area of New Haven and its surrounding towns under each scenario mentioned above. Based on the commuter share of each town in total employment in New Haven weighted by per capita income in each town, this analysis computes the spillover effect of infrastructure improvements in New Haven on the towns of Hamden, West Haven, East Haven, North Haven, Branford, Guilford, Wallingford, and, Milford. These eight towns were selected as they have the largest number of workers commuting into New Haven City of all the fifteen towns in the County. The spillover effects are measured in terms of employment, GRP, personal income, population, and housing demand in each town. The following tables present the spillover effects under the five different scenarios.

(1) *Maximum Build-out Scenario*

Table 1: Net Changes in Selected Economic Variables
Maximum Build-out Scenario
Average Change over Baseline (2000-2030)

	New Haven Local	Hamden	West Haven	East Haven	North Haven	Branford	Guilford	Wallingford	Milford
Employment (Thousands)	5.1471	1.8080	1.0699	0.7818	0.4736	1.0086	0.6113	0.3821	0.3349
GRP (Mill. Nom $)	719.8	252.8	149.6	109.3	66.2	141.0	85.5	53.4	46.8
Personal Income (Mill. Nom $)	563.0	197.7	117.0	85.5	51.8	110.3	66.9	41.8	36.6
Population (Thousands)	5.8117	2.0414	1.2080	0.8827	0.5347	1.1388	0.6902	0.4314	0.3781
Housing Demand (Mill Nom $)	233.6	82.1	48.6	35.5	21.5	45.8	27.7	17.3	15.2

(2) *Minimum Build-out Scenario*

Table 2: Net Changes in Selected Economic Variables
<u>Minimum Build-out Scenario</u>
Average Change over Baseline (2000-2030)

	New Haven Local	Hamden	West Haven	East Haven	North Haven	Branford	Guilford	Wallingford	Milford
Employment (Thousands)	1.6954	0.5955	0.3524	0.2575	0.1560	0.3322	0.2014	0.1259	0.1103
GRP (Mill. Nom $)	220.6	77.5	45.9	33.5	20.3	43.2	26.2	16.4	14.4
Personal Income (Bill. Nom $)	170.7	60.0	35.5	25.9	15.7	33.4	20.3	12.7	11.1
Population (Thousands)	1.8153	0.6376	0.3773	0.2757	0.1670	0.3557	0.2156	0.1347	0.1181
Housing Demand (Mill Nom $)	69.3	24.3	14.4	10.5	6.4	13.6	8.2	5.1	4.5

(3) *Moderate Build-out Scenario*

Table 3: Net Changes in Selected Economic Variables
<u>Moderate Build-out Scenario</u>
Average Change over Baseline (2000-2030)

	New Haven Local	Hamden	West Haven	East Haven	North Haven	Branford	Guilford	Wallingford	Milford
Employment (Thousands)	3.4298	1.2048	0.7129	0.5209	0.3156	0.6721	0.4073	0.2546	0.2232
GRP (Mill. Nom $)	462.8	162.6	96.2	70.3	42.6	90.7	55.0	34.4	30.1
Personal Income (Mill. Nom $)	360.5	126.6	74.9	54.8	33.2	70.6	42.8	26.8	23.5
Population (Thousands)	3.7910	1.3316	0.7880	0.5758	0.3488	0.7428	0.4502	0.2814	0.2467
Housing Demand (Mill Nom $)	150.3	52.8	31.2	22.8	13.8	29.5	17.9	11.2	9.8

(4) *Current Office Space Growth Trend Approach*

Table 4: Net Changes in Selected Economic Variables
Current Office Space Growth Trend Approach
Average Change over Baseline (2000-2030)

	New Haven Local	Hamden	West Haven	East Haven	North Haven	Branford	Guilford	Wallingford	Milford
Employment (Thousands)	0.3462	0.1216	0.0720	0.0526	0.0318	0.0678	0.0411	0.0257	0.0225
GRP (Mill. Nom $)	37.8	13.3	7.9	5.7	3.5	7.4	4.5	2.8	2.5
Personal Income (Mill. Nom $)	30.4	10.7	6.3	4.6	2.8	6.0	3.6	2.3	2.0
Population (Thousands)	0.4203	0.1476	0.0874	0.0638	0.0387	0.0824	0.0499	0.0312	0.0273
Housing Demand (Mill Nom $)	9.4	3.3	2.0	1.4	0.9	1.8	1.1	0.7	0.6

(5) *2.5 Million Square Feet Lab Space Approach*

Table 5: Net Changes in Selected Economic Variables
2.5 Million Square Feet Lab Space Approach
Average Change over Baseline (2000-2030)

	New Haven Local	Hamden	West Haven	East Haven	North Haven	Branford	Guilford	Wallingford	Milford
Employment (Thousands)	0.3806	0.1337	0.0791	0.0578	0.0350	0.0746	0.0452	0.0283	0.0248
GRP (Mill. Nom $)	67.1	23.6	14.0	10.2	6.2	13.2	8.0	5.0	4.4
Personal Income (Mill. Nom $)	34.3	12.1	7.1	5.2	3.2	6.7	4.1	2.5	2.2
Population (Thousands)	0.4236	0.1488	0.0880	0.0643	0.0390	0.0830	0.0503	0.0314	0.0276
Housing Demand (Mill Nom $)	10.6	3.7	2.2	1.6	1.0	2.1	1.3	0.8	0.7

IMPACT OF ENHANCED RAIL SERVICE ON TRAIN RIDERSHIP IN CONNECTICUT

The next step of the analysis is to project the change in commuter rail ridership in Connecticut induced by the increased investment in rail infrastructure in New Haven County. The ridership projection is based on the assumptions that the infrastructure improvement in New Haven County would improve the quality of service, travel time, and frequency of trips of all three rail service providers; Shore Line East, Metro-North, and Amtrak. It is reasonable to assume that improvement in rail service and frequency of train trips would stimulate additional demand for rail service in Connecticut.

In order to estimate the potential change in train ridership in Connecticut following the completion of rail infrastructure improvements in New Haven County, we take into account primarily three factors: change in travel time; additional number of trains or frequency of service; and rail fares. Using an elasticity of ridership with respect to train speed, fares, and the number of trains (frequency), CCEA projects the change in ridership for Amtrak, Metro-North and Shore Line East[7]. CCEA also projects the increase in train ridership in Connecticut in the short and long runs. The short run forecast is considered to be within the first two years after completion of all rail infrastructure development projects in New Haven County. The long run can be considered as the period beyond the first two years after completion of the projects. Estimated train ridership in Connecticut is based on the following assumptions.

Assumptions:

(1) Shore Line East will increase the current number of trains by 25%. This information was provided by Shore Line East Rail Operation. Similarly, Metro-North will increase the number of trains by 6.5% and Amtrak will double the current number of trains from 9 (7 Northeast direct and 2 Acela Express) to 17 (7 Northeast and 10 Acela Express). Any changes in these numbers will change the ridership estimates.

(2) Following the rail infrastructure improvements in New Haven County, the speed of Shore Line East trains will increase their current average speed from 50 to 55 mph. Similarly, the average speed of Metro-North will increase from 80 mph to 90 mph.

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[7] The computation of elasticity for the number of trains, speed, and fare is based on Voith (1995).

The average speed of Amtrak trains will increase from 80 mph to 120 mph, primarily due to Acela.

(3) Finally, this analysis assumes that there will be an average increase in the fares of all the three train services by 3%.

Table A below shows the short run results of infrastructure improvements on ridership based on Voith (1995). Table B depicts the long run results. Charts 1 through 3 show the ridership forecasts for Shore Line East, Metro-North and Amtrak.

Table. A

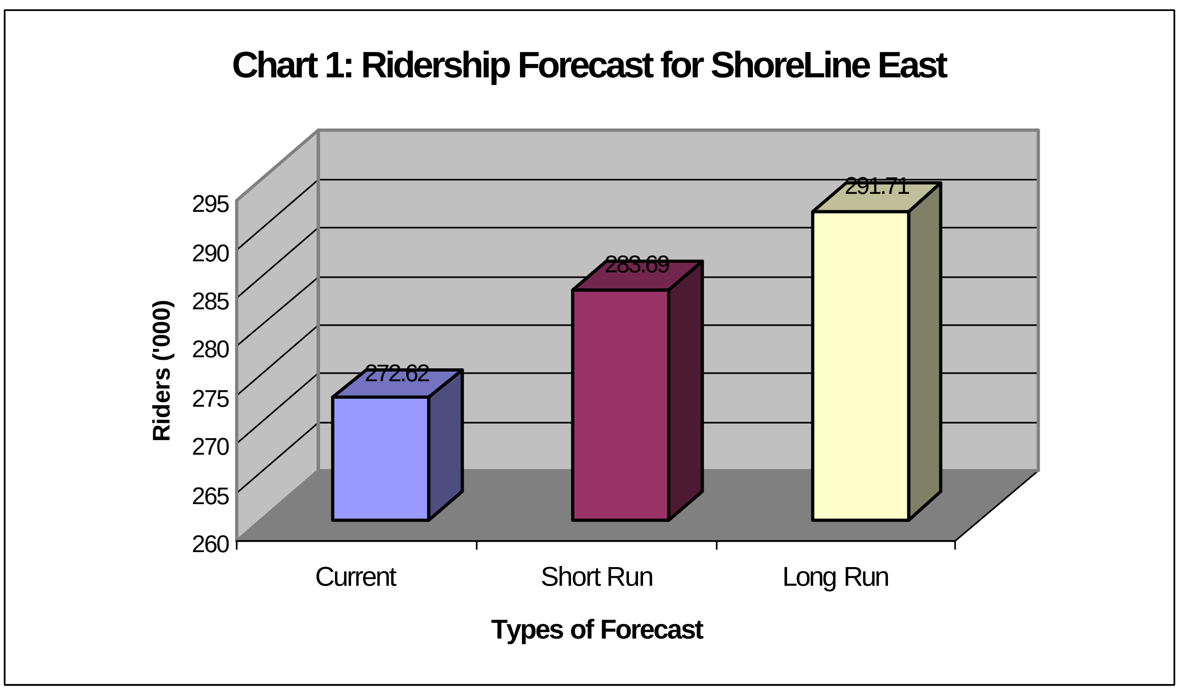
SHORT RUN (first 2 years) Ridership Forecast

Variables	Elasticity	Current Level	Projected (Change %)	Current Ridership Level	Projected Ridership Level	Projected Change in Ridership (%)
SHORE LINE EAST						
No. of Trains(Units)	0.184	8	10 (25%)	272,624	283,695	+ 4.06%
Speed (MPH)	0.123	50	55 (10%)			
Round Trip Fare	-0.592	$ 7.75	$7.98 (3%)			
METRO-NORTH						
No. of Trains(Units)	0.184	244	260 (6.5%)	35,000,000	35,340,584	+ 0.90%
Speed (MPH)	0.123	80	90 (12.5%)			
Round Trip Fare	-0.592	$22.5	$23.20 (3%)			
AMTRAK						
No. of Trains(Units)	0.184	9	17 (89%)	884,860	1,068, 593	+20.07%
Speed (MPH)	0.123	80	120 (50%)			
Round Trip Fare	-0.592	NA	3%			

Table. B

LONG RUN (beyond 2 years) Ridership Forecast

Variables	Elasticity	Current Level	Projected Change (%)	Current Ridership Level	Projected Ridership Level	Projected Change in Ridership (%)
SHORE LINE EAST						
No. of Trains(Units)	0.317	8	10 (25%)	272,624	291,713	+ 7%
Speed (MPH)	0.212	50	55 (10%)			
Round Trip Fare	-1.02	$ 7.75	$7.98 (3%)			
METRO-NORTH						
No. of Trains(Units)	0.317	244	260 (6.5%)	35,000,000	35,587,214	+ 1.6%
Speed (MPH)	0.212	80	90 (12.5%)			
Round Trip Fare	-1.02	$22.5	$23.20 (3%)			
AMTRAK						
No. of Trains(Units)	0.317	9	17 (89%)	884,860	1,201,642	+35.8%
Speed (MPH)	0.212	80	120 (50%)			
Round Trip Fare	-1.02	NA	3%			



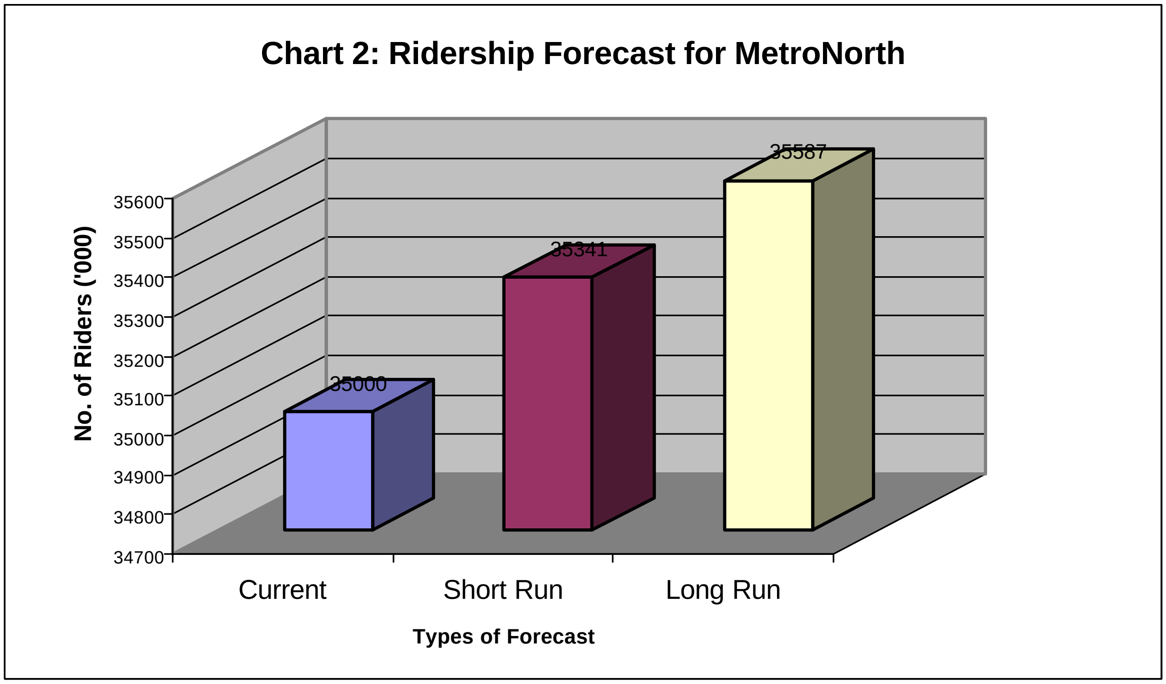


Chart 2: Ridership Forecast for MetroNorth
No. of Riders ('000)
35600
35500
35400
35300
35200
35100
35000
34900
34800
34700
35000
35341
35587
Current
Short Run
Long Run
Types of Forecast

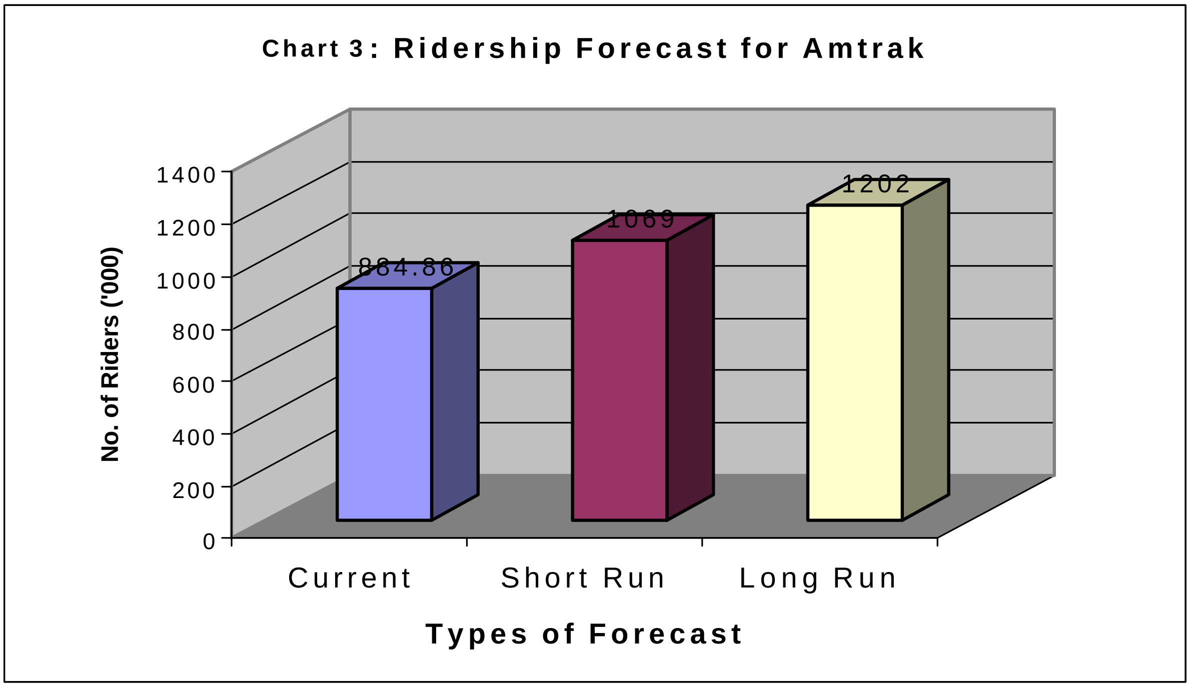


Chart 3: Ridership Forecast for Amtrak
No. of Riders ('000)
1400
1200
1000
800
600
400
200
0
864.86
1069
1202
Current
Short Run
Long Run
Types of Forecast

IMPACT OF ENHANCED RAIL SERVICE AND BUILD-OUT SCENARIOS ON TRAIN RIDERSHIP IN NEW HAVEN COUNTY

The estimates of increased train ridership in the above section are based on the improvements to rail service in New Haven County without respect of the build-out scenarios. The ridership estimates in this section account for the increases in employment that result from the five build-out scenarios. In each case, ridership is assumed to increase in proportion to the increases in employment. The baseline is the long-run projected ridership level that results from the enhanced rail service listed in Table B above.

Table C: Rail Ridership Consequences of Build-out Scenarios

	Maximum Build- out Scenario		Minimum Build-out Scenario		Moderate Build-out Scenario		Current Office Space Scenario		2.5M additional Office Space Scenario	
Rail Service Provider (Baseline Ridership)	% Change	Projected Ridership	% Change	Projected Ridership	% Change	Projected Ridership	% Change	Projected Ridership	% Change	Projected Ridership
Shore Line East (291,713)	28.70%	375,435	9.46%	319,309	19.13%	347,518	0.123%	292,072	0.205%	292,311
Metro-North (35,587,214)	28.70%	45,800,744	9.46%	38,953,764	19.13%	42,395,048	0.123%	35,630,986	0.205%	35,660,168
Amtrak (1,201,642)	28.70%	1,546,513	9.46%	1,315,317	19.13%	1,431,516	0.123%	1,203,120	0.205%	1,204,105

RESULTS:

Our analysis estimates that the total train ridership in Connecticut will increase by 535,389 in the short run and 923,084 in the long run following the completion of infrastructure improvements in New Haven County. Of the total increase, the ridership on Shore Line East will increase by 4.06% from current annual ridership of 272,624 to 283,695 in the short run. In the long run, the ridership on Shore Line East will increase by 7%. The estimates show that the total annual ridership for Shore Line East will be approximately 291,713 in the long run. Under the five build-out scenarios, long run ridership on Shore Line East increases to a minimum level of 292,072 under the "current office space growth trend" scenario, to a maximum level of 375, 435 under the "maximum build-out" scenario. As mentioned earlier, these results are based on the assumption that

Shore Line East increases its speed from 50 mph to 55 mph. In addition, we assume Shore Line East also increases the frequency of trips by increasing the current number of trains from 8 trains to 10 trains per day.

Our estimates show that the train ridership of Metro-North will increase by 0.90% in the short run currently from 35 million to 35.4 million. In the long run, Metro-North's ridership will increase by 1.6% to approximately 35.587 million per year. Under the five build-out scenarios, long run ridership on Metro-North increases to a minimum level of 35,630,986 under the "current office space growth trend" scenario, to a maximum level of 45,800,744 under the "maximum build-out" scenario. These estimates are based on the assumptions that the infrastructure improvements in New Haven will allow Metro-North to increase its current speed of 80 mph to 90 mph and to increase the number of trains from 244 to 260 per day.

Our estimate also shows that the infrastructure improvements in New Haven have a significant impact on Amtrak's ridership. Our analysis shows that Amtrak's ridership will increase from the current level of 884,860 to 1.068 million in the short run, or approximately 20%. Similarly, in the long run, Amtrak's ridership of Amtrak will increase almost by 36% to 1,201,642. Under the five build-out scenarios, long run ridership on Amtrak increases to a minimum level of 1,203,120 under the "current office space growth trend" scenario, to a maximum level of 1,546,513 under the "maximum build-out" scenario. This relatively higher increase in Amtrak's ridership can be attributed to Amtrak's plan to increase the number of trains and the speed relatively higher than that of Shore Line East and Metro-North. Amtrak plans to double the number of trains from 9 to 17 and increase the speed almost by 50% from 80 mph to 120 mph in near future.

TRANSPORTATION AND LOCAL ECONOMIC DEVELOPMENT

This section looks at whether transportation sector improvements serve as an engine of growth for economic development. There are a number of empirical studies that have been undertaken to examine the effects of the transportation sector on local economic developments, and Button, Leitham, McQuaid and Nelson (1995) summarize several of these studies. Based mainly in the United Kingdom and the United States, these studies cover many types of transportation improvements, ranging from expansions on existing highways to high-speed rail. The results are mixed, and range from little or no significant effects to some increases in employment and positive effects on real estate and firm location decisions. For example, Eagle and Stephanedes (1987) found no increase in employment in their study on new highway expenditures in eighty-seven U.S. counties. Langley (1981) found that highway corridors devalued residential property in the area, compared to residential property located further from the highway. His study was based on residential property in North Springfield, Virginia, and it concluded that highway-originated environmental externalities were the major cause of an inverse relationship between increases in North Springfield property resale values and proximity to I-495. On the other hand, Forrest et al (1992) found that light rapid transit developments in metropolitan areas in the U.S. stimulated urban renewal. Pickett (1984) found that light rapid transit developments in local districts in the U.K. benefited properties in the area.

Hansen (1965) argued that the impacts of transportation sector improvements depend on the type of area under consideration. He classifies regions into three categories in terms of the level of benefits they are likely to obtain. Infrastructure spending has the greatest potential to improve conditions in areas he terms "intermediate". These are areas that already have other development characteristics in place and operating, and lack only adequate infrastructure. Transportation sector improvements in such areas are therefore likely to benefit the local economy by increasing efficiency without incurring high congestion costs. Areas he terms "congested" can see some improvement, mostly in terms of higher productivity or increased local incomes during construction, but will also increase population and congestion, so the benefits must outweigh these costs. He terms areas that will benefit the least from infrastructure developments as "lagging" regions.

These are areas that lack a variety of other components needed for economic development, such as a skilled labor force and proximity to markets. Transportation sector improvements are unlikely to be enough to overcome these inadequacies and therefore will have a minimal impact on the local economy.

While it is appealing to classify regions into one of these three categories to gauge possible impacts before undertaking any infrastructure developments, it is difficult to tell with certainty what category a region may fall in to. It is also hard to define the size of the appropriate region in the first place. Another limit to this theory is that it does not acknowledge some types of investment that may attract missing development components to an area that is lacking them, or ease congestion in an already congested area. High-speed rail can be an example of such an investment (Thompson and Bawden, 1992). Some transportation sector improvements may therefore break through restrictions in the area under consideration, such as congestion or underdevelopment, and result in higher-than-expected economic growth.

Princeton Corridor Economic Development

The Route 1 highway in New Jersey that connects New Brunswick to Trenton through Princeton, also known as the Princeton Corridor, is an example of an area that has seen major transportation improvements in recent years. This stretch of highway covers approximately 30 miles. Most improvements in this area have been in highway access, with little rail development. The region has seen a large number of firms locate along the improved highway, including retail, commercial office space and the pharmaceutical sector, with many more pending. A partial list of these developments in Mercer County (which includes Princeton and Trenton) is shown in the table below.

Name of Development	Type	Size (square feet)	Status
The Square at West Windsor	Shopping Center	216,700	Proposed
Carnegie Center II Building 502 for Raytheon Corp.	Office Park	106,500	Built
Carnegie Center West Building 901	Office Park	130,000	Approved
Marriott Towne Place Suites	Hotel	143 rooms	Approved

Other developments include a proposed hotel on Route 1, the Lawrence Auto Mall (includes three large auto campuses featuring three auto companies), four existing shopping centers, and the proposed 500,000 square foot expansion of an existing office park into seven floors.

CONCLUSIONS

This study is an analysis of the economic impact of the railway and highway infrastructure developments and industry investments, specifically in biotech and professional services, for the State of Connecticut and New Haven County. The developments in the professional services and biotechnology sectors serve to illustrate the economic potential of such investments and the benefits to the State and County once they are in place.

Once completed, the enhanced rail and highway system will dramatically improve Connecticut's infrastructure. The economic benefits of an improved transportation system will be numerous. For example, highway developments will increase trucking efficiency, reduce commuter travel time and congestion, and reduce accidents and pollution. Rail investments will decrease travel time and costs by diverting passengers from auto and air travel, increase productivity, and reduce air and road congestion and pollution. Overall, improvements in the existing transportation system will create job opportunities, encourage tourism, increase transportation capacity, and create an environment more inviting to business retention, expansion and the attraction of new businesses to New Haven County. The subsequent investments included in this report demonstrate this potential.

APPENDIX

Spillover Effect Methodology

More than fifty percent of employees in New Haven consists of commuters from its surrounding towns. These towns include Hamden, West Haven, East Haven, Branford, North Haven, Guilford, North Haven, Wallingford, Milford, and, North Branford. This analysis presents a simple methodology to measure the spillover effects of railroad infrastructure improvement in New Haven on its neighboring towns. The change in income of a town may reflect the spillover effect or economic impact in that town induced by any external or internal economic shocks. This analysis uses commuter share of each town in the total employment in New Haven as a basis to measure the spillover effects in that town. To avoid income bias, the share of each town in total employment in New Haven is weighted by per capita income of that town.

Mathematically,

$$\Delta Y_i = \frac{S_i * Y_i}{\sum_j (S_j * Yj)} * \Delta Y_{NH}$$

where,

DY_i = Spillover effect in town *i* represented by change in income

DY_{NH} = Change in income in New Haven
S_i = Commuter share of town *i* in total employment in New Haven
S_j = Commuter share of town *j* in total employment in New Haven
Y_i = Per capita income in town *i*
Y_j = Per capita income in town *j*

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