7 ECONOMIC RENT ANALYSIS AND RESULTS

Model Calibration: In Ohio Hub networks we have four modes *m* (auto, bus, rail and air) and two types of trip purposes *p* (business and non-business). For each zone *i* of the super zone system, the accessibility, measured in generalized cost is estimated as follows –

$$GC_i = \sum_p \sum_m \sum_i GC_{ij}^{mp} * T_{ij}^{mp}, \; j=1,N \qquad (10)$$

Where:

GC_{ij}^{mp} - generalized cost of travel from zone *i* to zone *j* by mode *m* for purpose *p;*

T_{ij}^{mp} - number of trips from zone *i* to zone *j* by mode *m* for purpose *p;*

N - total number of transportation zones in network.

The Economic Rent function (6) shown in Chapter 4 can be transformed into a linear function by applying natural log (Ln) to both parts of the original Economic Rent function:

$$Ln\,(SE_i) = Ln\,(\beta_o) + \beta_1\, Ln\,(GC_i) \qquad (11)$$

or simply:

$$Ln\,(SE_i) = \tilde{\beta}_o + \beta_1\, Ln\,(GC_i) \qquad (12)$$

Application of regression analysis to the function (12) allowed developing the Ohio Hub Passenger Rail Economic Rent Model. In this process we established the mathematical relationship between the measure of accessibility (generalized cost of travel) and the Economic Rent socio-economic variables (employment, household income and property value) for each transportation zone. Exhibits 7.1 through 7.3 show the observed values for employment, income, and property value versus generalized cost of travel. The regression line reflects the relationship between socio-economic indicators in each transportation zone included in the super zone system and corresponding generalized costs, calculated using formula (10). By the tight clustering of data points around the regression line, it can be seen in each case that a very strong relationship was identified[37].

[37] Presented results were obtained by applying the Economic Rent Model to the Option 1 in the Ohio Hub Network. Option 1 assumes that the railroad goes via Warren, Youngstown, New Castle (Cleveland-Pittsburgh corridor) and via Dearborn, Detroit Metro Airport (Detroit-Toledo corridor). Economic Rent analysis was also performed for all other options.

Exhibit 7.1: Employment as a Function of Accessibility

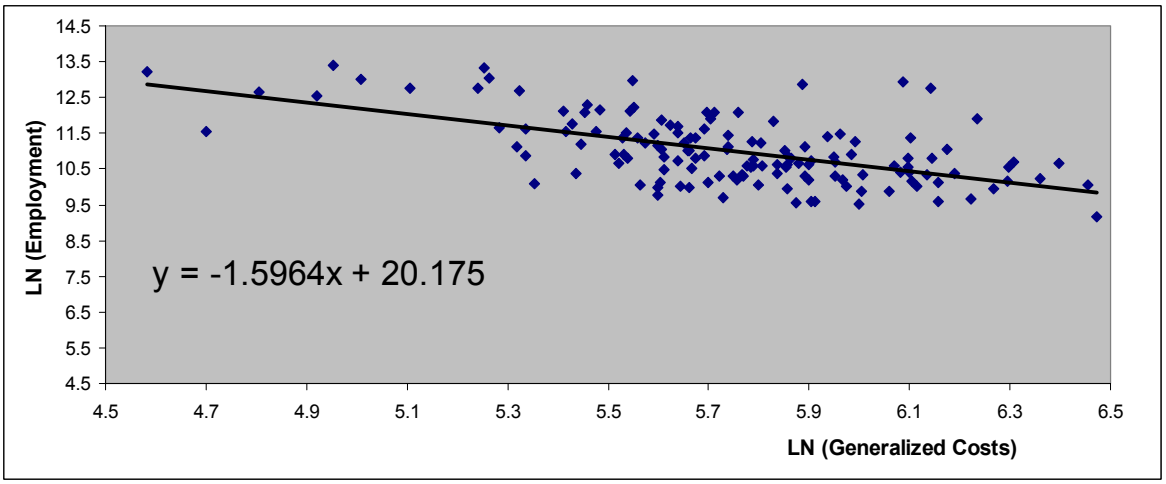


Exhibit 7.2: Household Income as a Function of Accessibility

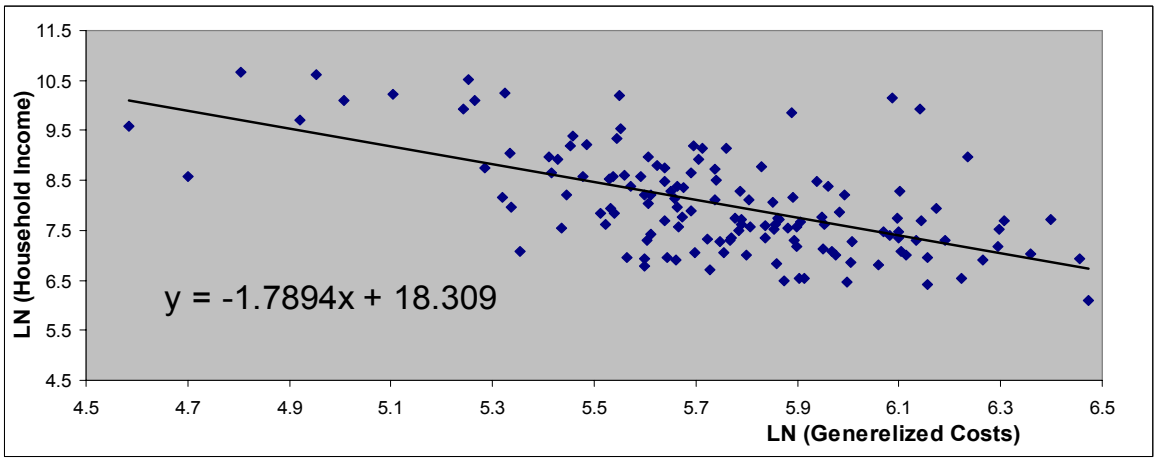
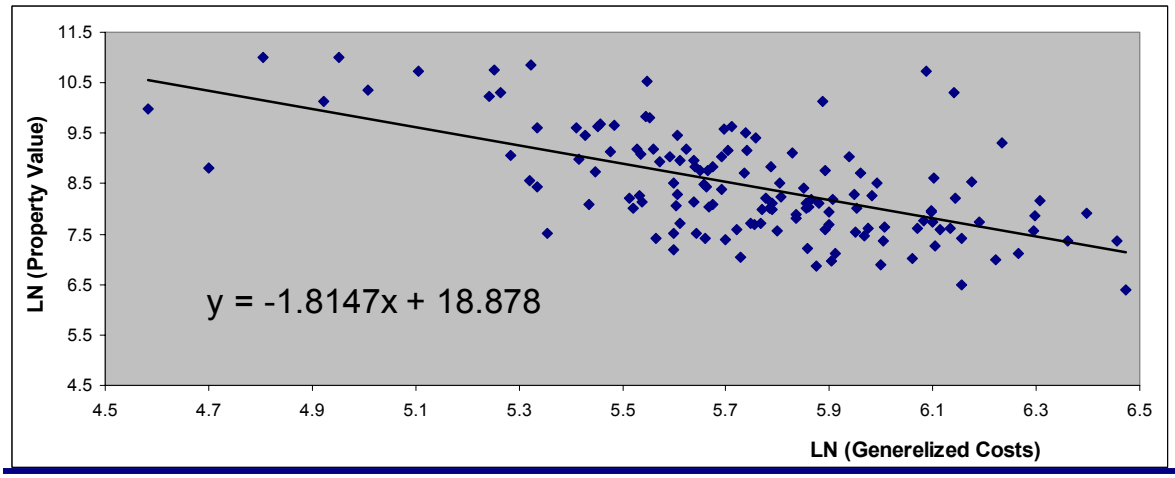


Exhibit 7.3: Property Value as a Function of Accessibility



Economic Rent coefficients (values of calibration parameters) for each of the three socio-economic indicators used in the model together with statistical measures of confidence are presented in Exhibit 7.4.

Exhibit 7.4: Economic Rent Coefficients for Employment, Household Income and Property Value

Socioeconomic variable	β_1	T - Statistics For β_1	R^2	Multiple R
Employment	-1.60	-8.38	0.34	0.58
Household Income	-1.79	-8.73	0.35	0.60
Property Value	-1.81	-8.90	0.36	0.60

It can be seen that the calibration was successful and each of the economic rent factors was shown to be significant. This proves that the economic rent profiles are well developed for the Ohio settlement patterns. Each equation has highly significant 't' values and 'R^2' values. This reflects the strength of the relationship and given the fact that there is a strong basis for the relationship shows firstly that the socioeconomic variables selected provide a reasonable representation or economic rent, and secondly that generalized cost is an effective measure of market accessibility.

Given the performance of the models the next step in developing the Economic Rent Model is to determine the change in socio-economic indicators as a result of accessibility improvement. In order to calculate elasticities we differentiate the Economic Rent function with respect to Generalized Costs (GC). As a result we obtain:

$$\Delta Emp_i = \frac{\partial Emp_i}{Emp_i} = \beta_1^E \frac{\partial GC_i}{GC_i} \qquad (13)$$

$$\Delta Inc_i = \frac{\partial Inc_i}{Inc_i} = \beta_1^I \frac{\partial GC_i}{GC_i} \qquad (14)$$

$$\Delta Pv_i = \frac{\partial PV_i}{PV_i} = \beta_1^{pv} \frac{\partial GC_i}{GC_i} \qquad (15)$$

Where:

GC_i - Weighted generalized cost of zone I;

Emp_i, - Employment of zone I;

Inc_i - Household income of zone I;

Pv_i - Property value of zone I;

β_1^E β_1^I β_1^{pv} - Calibration parameters.

It is seen that the relative change in employment (ΔEmp_i), household income (ΔInc_i) and property value (ΔPv_i) for each particular zone *i* equals the relative change in generalized cost $\frac{\partial GC_i}{GC_i}$ multiplied by elasticity $\beta^E{}_1$, $\beta^I{}_1$ or $\beta^{PV}{}_1$ respectively. The value for each β_1 is obtained from the corresponding regression equation. Absolute change in employment, household income and residential property value will be obtained from the following equations:

$$\partial Emp_i = \beta_1^E \frac{\partial GC_i}{GC_i} Emp_i \qquad (16)$$

$$\partial Inc_i = \beta_1^I \frac{\partial GC_i}{GC_i} Inc_i \qquad (17)$$

$$\partial Pv_i = \beta_1^{Pv} \frac{\partial GC_i}{GC_i} Pv_i \qquad (18)$$

Given that only owner-occupied residential property value data was available to the study[38], an adjustment was made to include other residential property and business property. In Ohio the shares of owner-occupied and other residential (renter-occupied and vacant) property constitute 65 per cent and 35 per cent respectively[39]. Business property includes commercial, industrial, agricultural and mineral property. According to Ohio Department of Taxation[40] the share of real business property in Ohio in overall taxable value of the State real property is 30 percent. In Indiana this share constitutes about 44% of real property[41].

[38] Source: Census 2000, U.S. Census Bureau, Bureau of Economic Analysis, U.S. Department of Commerce. See: American Fact Finder Database, http://factfinder.census.gov

[39] Ibid.

[40] See: http://tax.ohio.gov/divisions/tax_analysis/tax_data_series

[41] Calculated using data on shares of different property types in Indiana assessed property value. See: http://www.agecon.purdue.edu/crd/localgov/Second%20Level%20pages/topic_ptax_overview.htm

Our detailed analysis of this data available for Ohio, Indiana and other states showed that the actual value of other residential and business types of real property in Ohio Hub study area approximately equals the value of owner-occupied private real property.

In order to calculate the impact of accessibility improvement on average household income and average residential property value, we also had to determine how the improvement in accessibility influences the number of households (housing units) that are supported by any given area. To do this we use Economic Rent Model to predict the number of households (the number of housing units) that are supported by any given level of market access. The results of regression analysis are shown on Exhibits 7.5 and 7.6 and economic rent coefficients are given in Exhibit 7.7. Again it can be seen that good statistical relationships were derived with strong 't' values and correlation coefficient R^2.

Exhibit 7.5: # Households as a Function of Accessibility

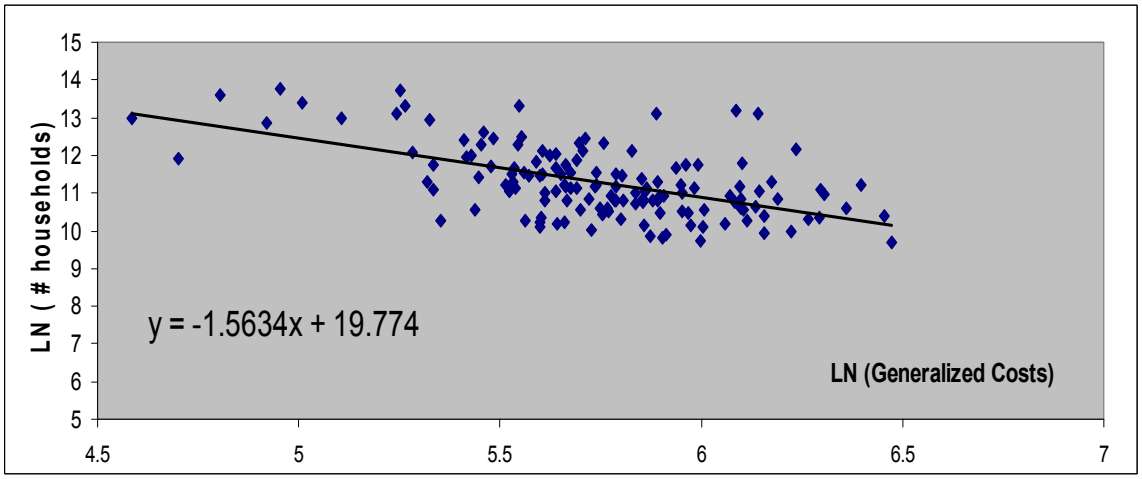


Exhibit 7.6: # Housing Units as a Function of Accessibility

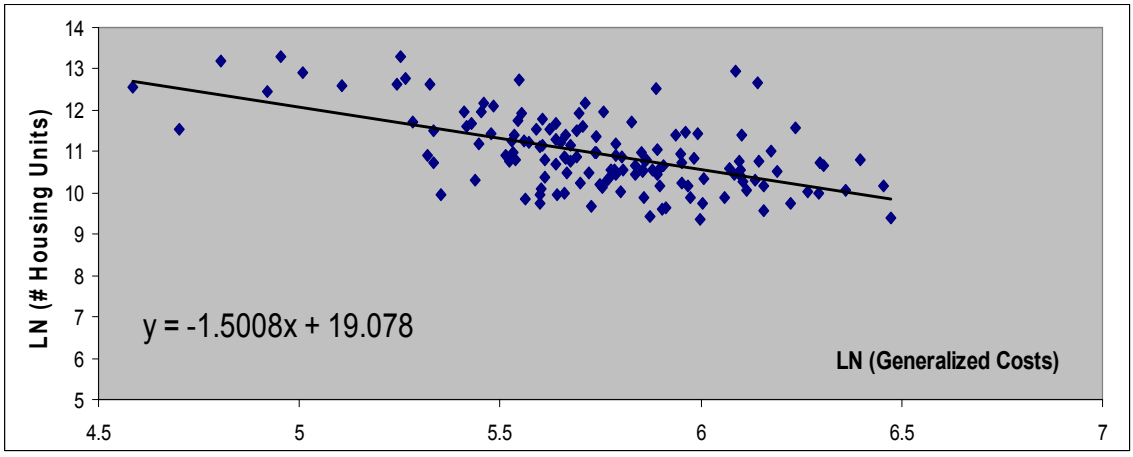


Exhibit 7.7: Economic Rent Coefficients for Households and Housing Units

Socioeconomic variable	β_1	T - Statistics For β_1	R^2	Multiple R
# Households	-1.56	-8.04	0.32	0.56
# Housing Units	-1.50	-8.13	0.32	0.57

- Change in average household income ($\partial AvInc_i$) in zone *i* is calculated as follows-

$$\partial AvInc_i = \frac{\partial Inc_i}{(Hh_i + \partial Hh_i)}) \qquad \text{where} \qquad \partial Hh_i = \beta_1^{Hh} \frac{\partial GC_i}{GC_i} Hh_i$$

- Change in average residential property value ($\partial AvPv_i$) in zone *i* was calculated as follows-

$$\partial AvPv_i = \frac{\partial Pv_i}{(Hu_i + \partial Hu_i)} \qquad \text{where:}$$

$$\partial Hu_i = \beta_1^{Hu} \frac{\partial GC_i}{GC_i} Hu_i$$

Where:

∂Hh_i / ∂Hu_i - change in the # of households/ housing units in zone *i* as a results of accessibility improvement

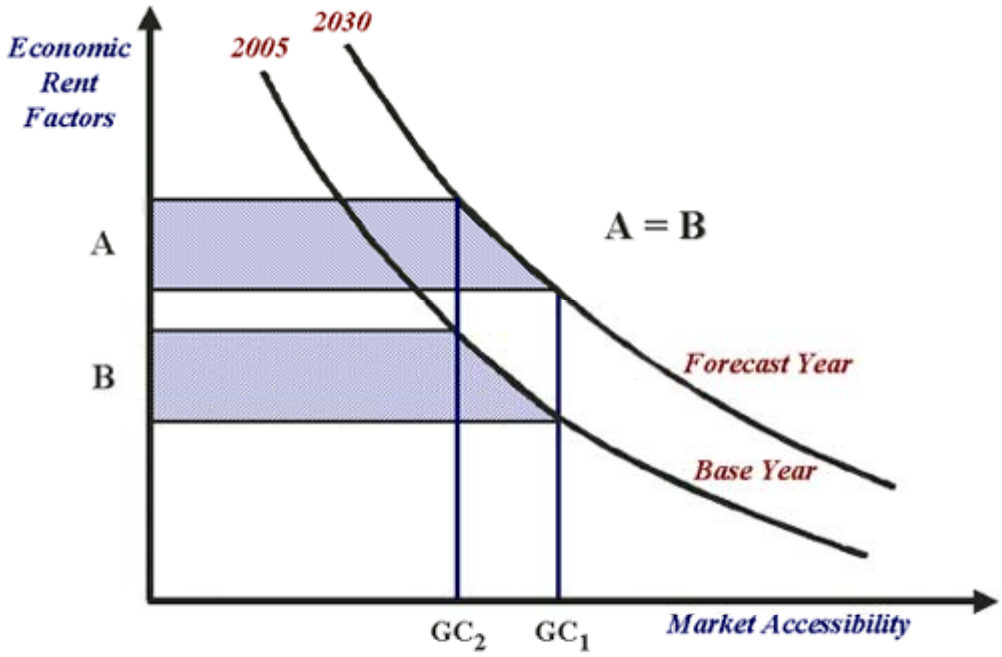
Hh_i / Hu_i - the base number of households / housing units in zone *i;*

β_1^{Hh} / β_1^{Hu} - calibration parameters for households/housing units obtained from the table in Exhibit 7.7.

The results of the analysis show that a statistically powerful Economic Rent model can be developed that reflects the responsiveness of the economy to improved transportation access. The level of economic performance relates to the strength of the economy in the Ohio Hub study region and diversity of its industry.

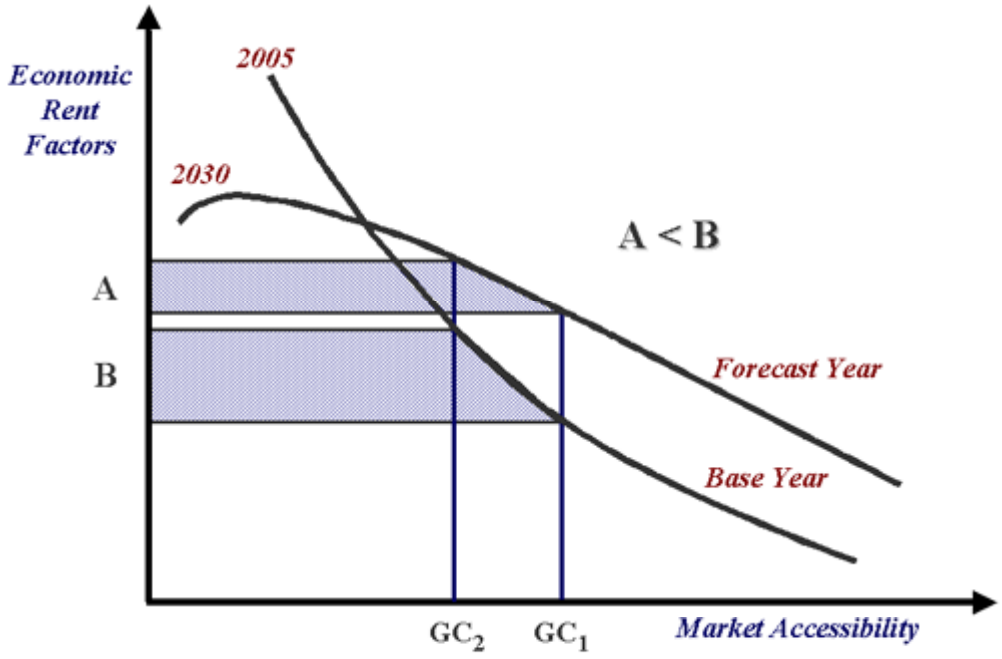
Assessment of the Impact of Economic Growth: A key assumption in the Economic Rent Analysis is the impact of economic growth on the Economic Rent Profile. Economic Growth will cause the Economic Rent Profile to grow as each component that supports the economic rent profile, land, labor and capital becomes more valuable. As the economy expands, labor wages increase, so space becomes more valuable, and assets become more expensive. This increase in factor prices results in a rise in the Economic Rent profile. If the rise in the Economic Rent profile is constant across the profile as shown in Exhibit 7.8, then the impact is that the increase in economic rent associated with an improvement in Market Accessibility (i.e. a reduction from GC_1 to GC_2) for the region is the same. As a result, in Exhibit 7.8 area A is equal to area B. This means that economic growth will not change the Economic Rent Benefits of the project. This is the assumption made in this study.

Exhibit 7.8: Impact of Economic Growth. Type 1. Constant Profile



Under most economic conditions, however, the growth in Economic Rent is not the same over the region and the profile will not grow proportionally along its entire length. For example, in Exhibit 7.9 there is a decline in the forecast year Economic Rent profile at the market center while in the more peripheral areas surrounding the market center there is economic growth, i.e. growth occurs in the suburbs, but not the market center. In this environment the forecast year benefits as measured by area A is smaller than the base year economic benefit area B. This would suggest that using the base year Economic Rent profile would overstate benefits.

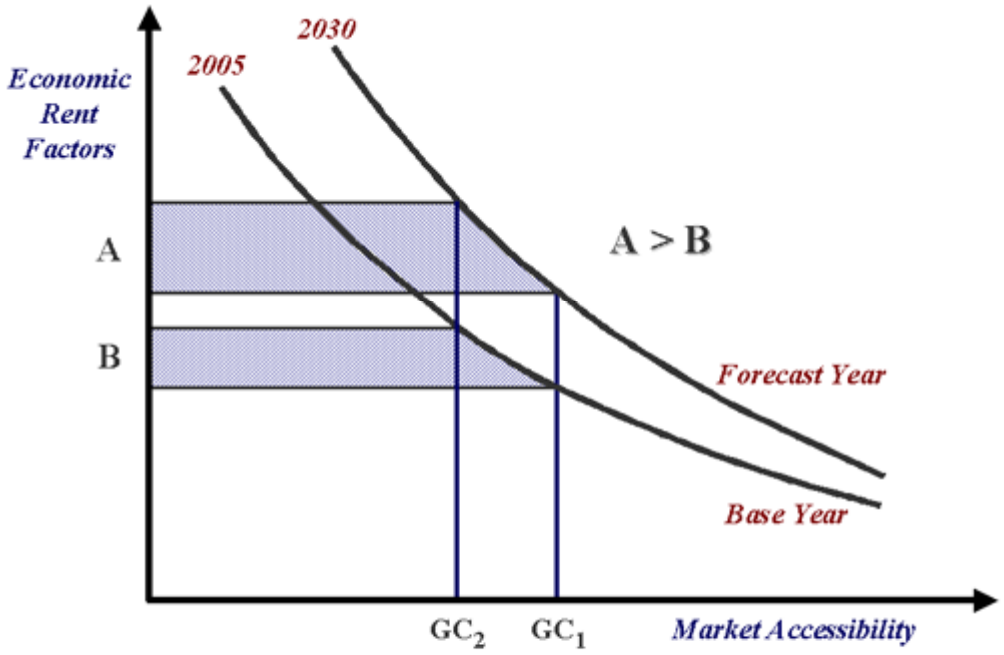
Exhibit 7.9: Impact of Economic Growth. Type 2. Decrease in Profile



This type of growth, however, does not occur in normal markets, but rather in markets that suffer economic dislocations. For example, both Detroit and Buffalo experienced this type of growth impact when their downtown businesses failed. In Buffalo the issue was the decline of metal industries, while in Detroit it was more related to social demographic pressures. In this case a forecast of Economic Benefits based on a base year assessment will be an overstatement of the benefit. Certainly if any city market areas along the Ohio corridors suffer a major dislocation such as experienced by Buffalo during the life of the project, then the forecasts prepared for the Ohio Hub corridor could be overstated.

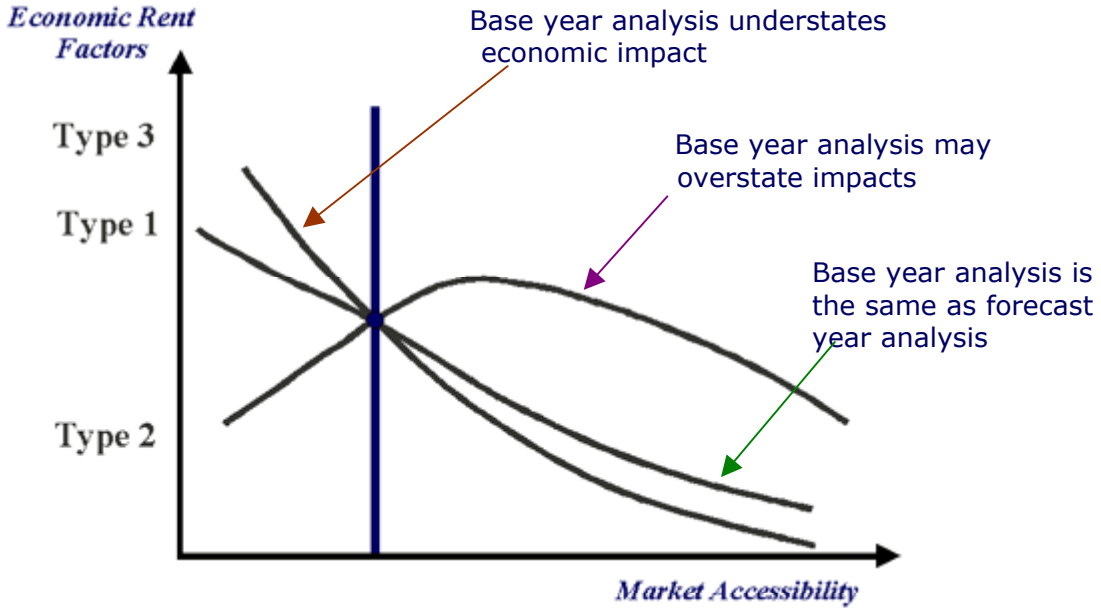
Under a normal economic growth situation in which the economy expands for a corridor, the typical impact is for growth to expand much faster at the market center than in the periphery. This reflects the fact that the market center provides the greater opportunities for growth in a normal economy and market. In this case the measurement of Economic Benefit using the base year economic profile will understate the size of the benefits to be derived from the project. Area B will be smaller than area A. (See Exhibit 7.10). Since this is the usual impact of economic growth on a market center, and as our study suggests ongoing long-term economic growth it is likely that using area B to estimate Economic Rent benefits understates the overall Economic Benefits to be derived from an Economic Rent Analysis.

Exhibit 7.10: Impact of Economic Growth. Type 3. Increase in Profile



As a result, it can be seen in Exhibit 7.11 that there are three conditions that can exist in the forecast year.

Exhibit 7.11: Types of Economic Growth



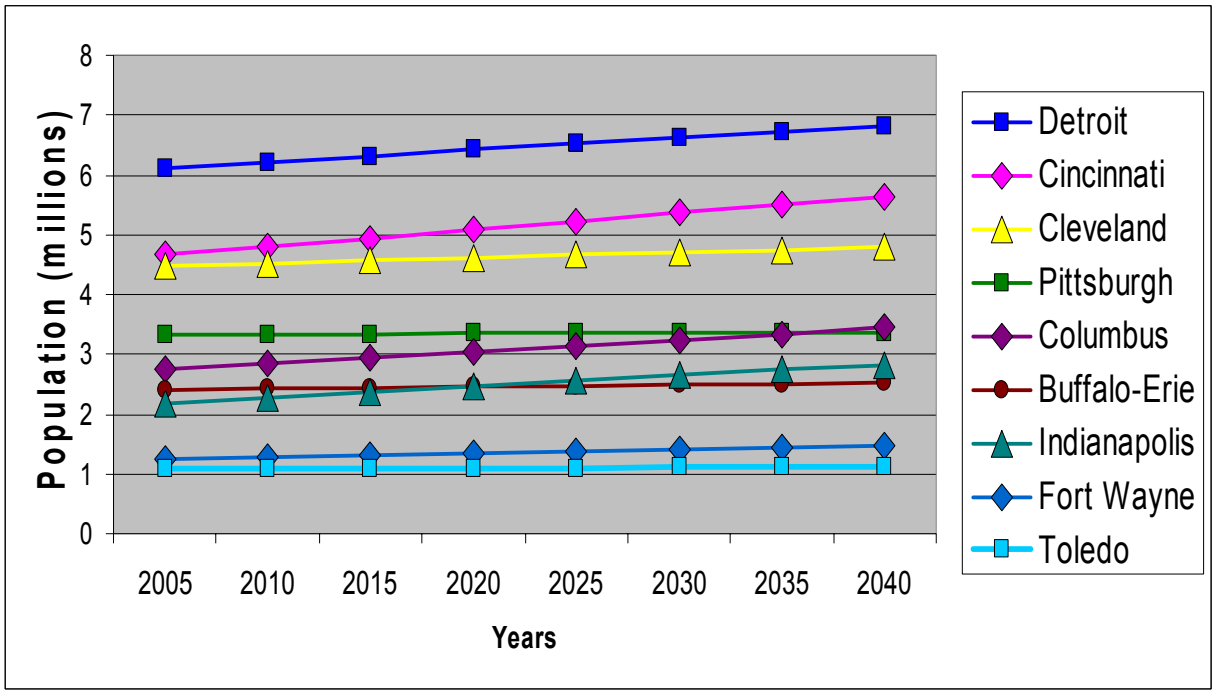
• ***Type 1*** has constant growth. This means that base and forecast year impacts along the economic rent are the same, and the base year analysis understates the benefits.

• ***Type 2*** has negative growth at the market/city center. This typically results from a dislocation to the economy due to a loss of the economic base of the region. If this occurs the economic rent results particularly in market centers would be less than those that would be achieved if a base year economic rent profile is used. Using the base year economic rent profile will overstate the benefits.

• ***Type 3*** has increased positive economic growth at the market center. As a result the future year benefits are higher than suggested by measuring the economic rent profile in the base year.

While Type 3, is the normal situation for a city or market center, various cities in northern Ohio have in the past suffered in ways similar to Buffalo and Detroit, i.e. they reflect Type 2 situations with negative economic growth in the city center. We have selected Type 1 as the basis for estimating economic benefits, which we believe is a reasonable and conservative assumption. In most towns a Type 3 environment will generate benefits greater then those estimated in this study. In one or two towns it is possible that a Type 2 conditions could prevail and lower economic benefits would be generated from the project. However, it is worth noting that such a weak performance would not be consistent with the current economic projections for Ohio's economy given by both the U.S. Department of Commerce and Woods & Poole, Inc. See Exhibits 7.12-7.14[42].

Exhibit 7.12: Population Forecast by Super Zone



[42] Forecast shown here refer to the socio-economic variable in the particular super zone and may be significantly different from the forecasts for the corresponding market centers. For example, strong income forecast for Detroit super zone does not necessary assume that the same increase would be valid for the city of Detroit.

Exhibit 7.13: Employment Forecast by Super Zone

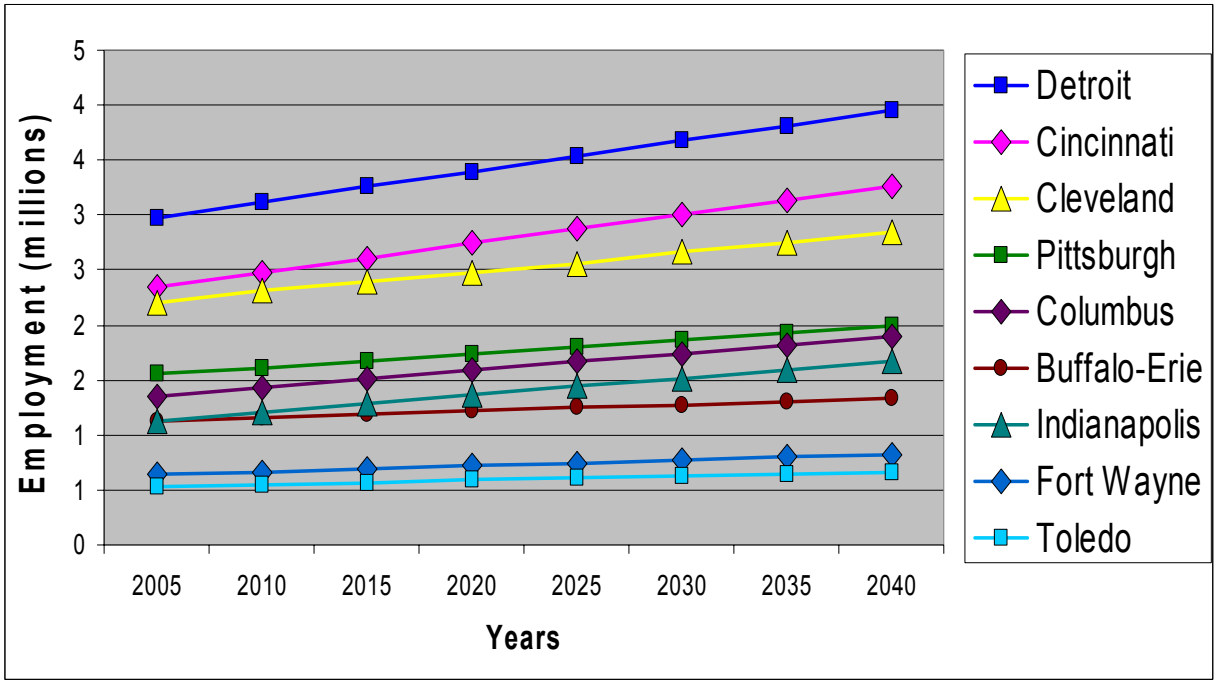
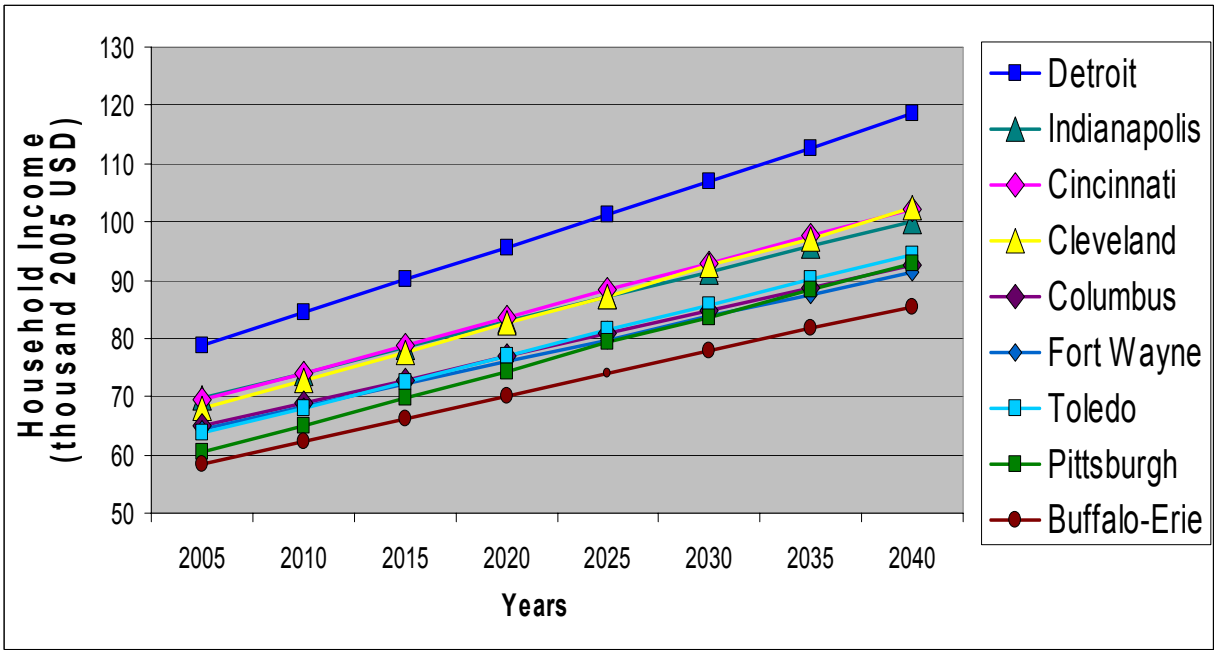


Exhibit 7.14: Average Household Income Forecast by Super Zone



Economic RENTS™ Results: For the Ohio Hub nine super zone region building Ohio Hub will create more than 16 thousand jobs; will increase development potential by more than $3 billion; urban household income is estimated to increase by over $1.0 billion. It should be noted that the increase in employment and income in study region represents a growth of 0.1 percent on current levels[43]. In the region average household income will increase by at least $90 and average housing value will increase by no less than $200. Exhibit 7.15 shows the Economic Rent results by Super Zone.

Exhibit 7.15: Economic Rent Analysis by Super Zone

"Super Zone" Center	Employment Value (# Jobs)	Household Income (Millions 2005 $)	Development Potential (Millions 2005 $)
Cleveland	3,370	225	701
Columbus	2,695	164	477
Cincinnati	3,020	200	577
Toledo	563	34	95
Pittsburgh	3,047	196	534
Buffalo	1,745	102	273
Detroit	1,034	84	246
Indianapolis	485	30	80
Fort Wayne	759	42	120
Total [44]:	**16,718**	**$1,077**	**$3,103**

Exhibit 7.15: Economic Rent Analysis by Super Zone – continued

"Super Zone" Center	Average Household Income (2005 $)	Average Residential Property Value (2005 $)
Cleveland	123	283
Columbus	149	332
Cincinnati	105	233
Toledo	80	161
Pittsburgh	138	273
Buffalo	106	213
Detroit	35	74
Indianapolis	34	69
Fort Wayne	87	169
Average:	**94**	**201**

[43] As it was estimated for the 2005 base year employment in the study region equals $13.8 million people and the total regional household income equals $951 billion. Sources: U.S. Census Bureau and Bureau of Labor Statistics databases, Woods & Poole, Inc socio-economic projections

[44] Presented here 'Total' includes benefits obtained by certain areas in Indiana, Michigan and Ohio that are connected to MWRRI and not Ohio Hub stations. Their benefits represent the incremental effect of Ohio Hub Rail Passenger System project implementation on MWRRI stations.

In terms of the time scale associated with the presented above benefits it is likely that these benefits will be achieved after the completion of the building of the entire system and within two or three years of the start of operation by the Ohio Hub. The benefits will be proportional to the development of the system routes and schedules. It should be noted that the benefits of the system will grow over time in line with growth in the economy as the analysis used the base year economic rent profile not the forecast year economic rent profile.

In a passenger rail application the highest increase in the average household income and property value is usually observed within 5-miles from the station. The further the distance from the station – the lower the expected relative benefit. Exhibit 7.16 illustrates this Economic Rent rule using the example of the three major Ohio Hub stations.

Exhibit 7.16: Expected Increase in the Average Residential Housing Value (2005$) for Selected '3-C' Stations

Station Name	5-mile Radius from the Station	Transportation Zone Average (up to 20-mile Radius)	"Super Zone" Average (up to 100-mile Radius)
Cleveland Downtown	1,313	615	283
Columbus Downtown	842	555	332
Cincinnati Downtown	1,114	478	233

To obtain state results, the overall results were disaggregated to the zone level and then state totals were estimated by summarizing the zones in each state. Exhibit 7.17 shows economic rent analysis results by state. Increase in average household income and average housing value for three states that mostly benefit from Ohio Hub implementation is shown in Exhibit 7.18.

Exhibit 7.17: Economic Rent Analysis by State/Province

State	Employment Value (# Jobs)	Household Income (Millions 2005 $)	Development Potential (Millions 2005 $)
Ohio	9,570	619	1,833
Pennsylvania	3,201	203	555
New York	1,206	74	190
Michigan	1,034	84	246
Indiana	1,252	72	202
Kentucky	215	13	39
West Virginia	160	8	23
Ontario[45]	81	4	15
Total [46]	**16,718**	**$1,077**	**$3,103**

[45] Given here is only a small portion of Ontario benefits (the benefits - obtained by St. Catherine's –Niagara Falls station). Other parts of Ontario Province were not included into Super Zone system and their benefits were not estimated in the frame of Ohio Hub Economic Rent Study.

Exhibit 7.18: Economic Rent Analysis by Selected States

State	Average Household Income (2005 $)	Average Residential Housing Value (2005 $)
Ohio	132	292
Michigan	21	43
Indiana	29	59

The states in the Ohio Hub experience different levels of community benefits. The difference depends on the proportion of Ohio Hub within a state and population size of each state. Overall, Ohio as the hub of the system will experience the largest community benefit from implementation of the project, while New York, Michigan and Pennsylvania with fewer miles and stations obtain less community benefit. Although states of Kentucky and West Virginia do not have their own stations in Ohio Hub Passenger Rail system, they are connected to Ohio Hub via feeder bus network. That is why they also benefit from the project. Even the states that are integrated into Ohio Hub system via other rail systems, such as MWRRS, might receive significant benefits from Ohio Hub project implementation. The most evident example here is the State of Indiana.

If not only Ohio Hub Passenger Rail System, but also MWRRS is implemented, certain areas will benefit from both rail corridor projects. Exhibit 7.19 summarizes economic rent results from both Ohio Hub and Midwest rail systems implementation for Ohio, Michigan and Indiana.

Exhibit 7.19: Economic Rent Analysis by Selected States
(Total for Ohio Hub and MWRRI[47])

Economic Rent Benefits	Ohio	Michigan	Indiana
Employment	13,090	8,005	5,790
Total Household Income (ml 2005$)	679	234	165
Total Property Value (ml 2005 $)	2,084	984	582
Average Household Income (2005 $)	145	61	69
Average Residential Housing Value (2005 $)	333	175	173

Although presented in Exhibits 7.15-7.17 Economic Rent results were obtained by applying RENTS™ model to Option 1 of Ohio Hub Passenger System, Economic Rent analysis was performed for all four possible options. (See Exhibit 7.20). Comparison of the overall Economic Rent results for different Ohio Hub options is given on Exhibit 7.21. It is easy to see that economic evaluation of Option 1 returned the highest results. That is why Option 1 is recommended for implementation by this Study.

[46] Presented here 'Total' includes benefits obtained by certain areas in Indiana, Michigan and Ohio that are connected to MWRRI and not Ohio Hub stations. Their benefits represent the incremental effect of Ohio Hub Rail Passenger System project implementation on MWRRI stations.

[47] The MWRRI results are obtained by applying the MWRRS Economic Rent Model. See: [20].

Exhibit 7.20: Alternative Scenarios for Economic Impact Study

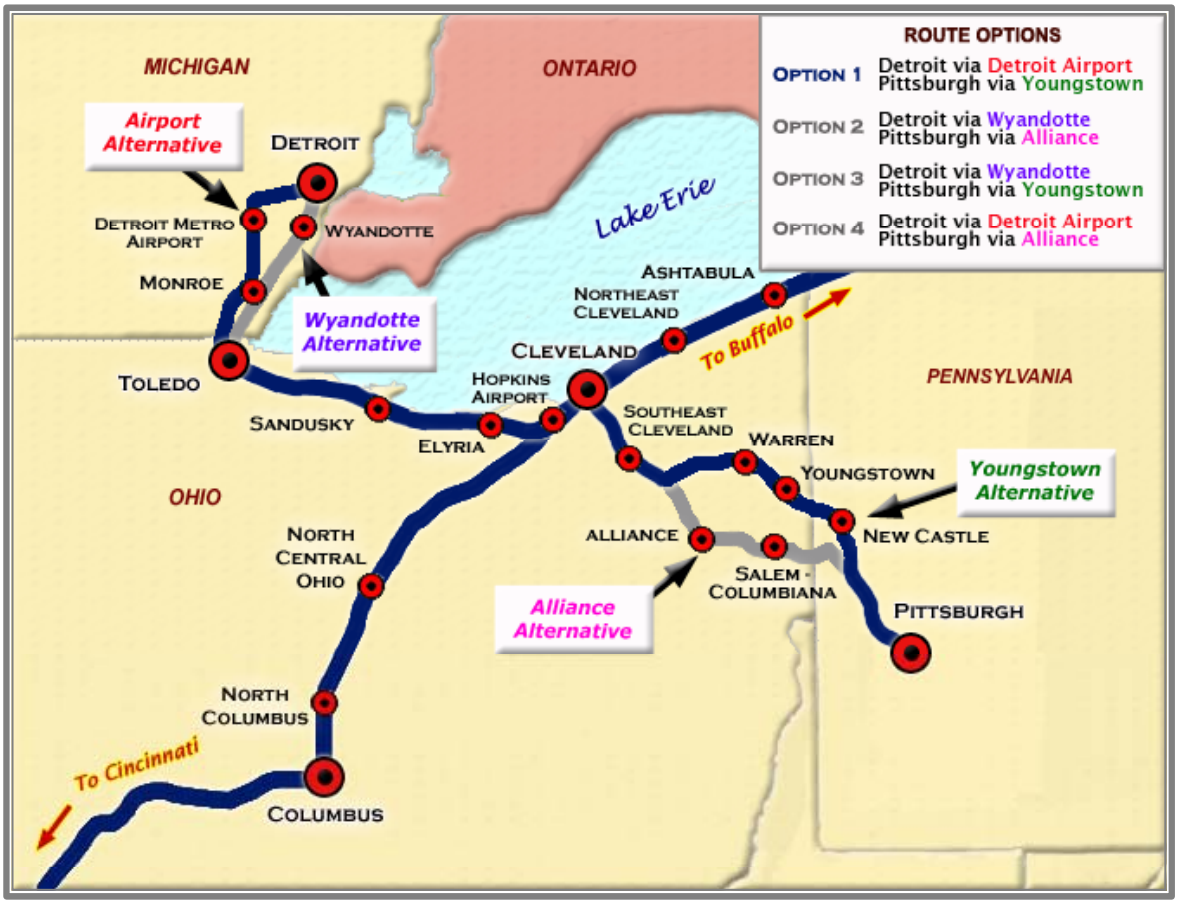


Exhibit 7.21: Ohio Hub Economic Rent Analysis for Options 1-4

Economic Rent Benefit:	Option 1	Option 2	Option 3	Option 4
Employment	16,718	15,081	16,557	16,083
Total Household Income (ml 2005$)	1,077	963	1,057	1,037
Total Property Value (ml 2005 $)	3,103	2,775	3,045	2,989
Average Household Income* (2005 $)	94	84	93	91
Average Housing Value* (2005 $)	201	180	197	194

* Calculated here 'Average' is referred to Ohio Hub super zone system (region).

Conclusion: The development of the Ohio Hub passenger rail system integrates a large number of communities, and provides wide reaching impacts. As a result, it will generate on its own a 0.1 percent growth to the region's economy. It will offer opportunities to fundamentally change the character of business in the nine 'super zone' regions. In the communities linked by the system, the project will create a new business environment that will be attractive to "New Economy" (high tech mobile industry, frequently related to computer, telecommunications, and professional services businesses). It will support existing manufacturing and service industries and will foster the growth of new small businesses across the Ohio Hub region because of the improved access between communities.

Implementation of the Ohio Hub project will encourage large businesses to distribute their operations more widely and reap the benefit of providing more efficient "back shop" operations in the highly accessible smaller communities. These communities provide a high quality of life for residents in terms of lower cost housing, good schools, friendly secure neighborhoods, and less congested highway systems.

In an environment of rising oil prices, the Ohio Hub System will offer an energy efficient and cost effective alternative to air and automobile travel that businesses and individuals will be able to use to connect with all of the cities and towns of the Midwest. Since the rail trip will be highly competitive with air and auto in travel time and provide a level of interaction with all the regions' communities, the Ohio Hub system provides a level of service that will be critical to attracting and developing "New Economy" businesses.

The development of the Ohio Hub Passenger Rail System will result in a huge economic impact in the region, providing both transport users as well as communities substantial benefits. Even building the Ohio Hub with a large share of federal dollars will generate significant economic impacts for the region.

Consumer Surplus: The traditional benefit cost methods developed by the USDOT FRA shows almost $9 billion economic impact as a result of building the system. The benefit cost ratio is a substantial (1.8) reflecting the fact that the Ohio Hub region is one of the best candidates in the U.S. for developing a regional rail system. This is due to its density of population, the distance between cities, and the availability in many corridors of low traffic freight routes.

Economic Rent: Given that the demand side benefits generated by the Ohio Hub Passenger Rail system are so large ($5-9 billion), it is not surprising that the long-term supply side benefits are also substantial. The Economic Rent analysis shows supply side benefits of –

- Almost 16,720 long-term (30 year) jobs across Ohio Hub regions, which is equivalent to more than 500 thousand person years of work over the 30 years.

- The project will raise the region's income by 0.1 percent or by over 1 billion dollars per year over the life of the project.

- The development potential assuming full advantage is taken by local communities of the development option available from the Ohio Hub project, is at least 3 billion dollars, and may be higher with effective planning and urban renewal.

Analysis of Ohio Hub impact by different states shows that the State of Ohio benefits more than other states from the project implementation. The Ohio Hub Passenger Rail project Economic Rent results for Ohio show –

- More than 9,500 long-term jobs for 30 years or about 0.2% increase in employment in the State of Ohio[48].

- An increase in the household income by almost 620 million dollars and in the average household income - by 132 dollars per year over the life of the project in the state of Ohio.

- An increase in the development potential by at least 1.8 billion dollars and in the average housing value – by 292 dollars.

The benefits obtained by the Ohio Hub system will be distributed across the five states of the Ohio Hub system[49]. The benefits are expected to be distributed in the following way –

- Ohio: 55-60 percent
- Pennsylvania: 15-20 percent
- Michigan: 5-10 percent
- New York: 5-10 percent
- Indiana: 5-10 percent

State Tax Benefit: A transfer payment of Ohio Hub system is the tax benefit generated by the extra income, sales and property value. As it can be calculated using data from Federation of Tax Administrators presented in Exhibit 7.22, both state income and sales tax increases will amount to at least 7 percent of the project life income impacts (NPV $13 billion) which equals almost 1 billion in tax benefits over the life of the project.

Exhibit 7.22: State Sales and Income Tax Rates[50]

State	State Sales Tax (%)	State Individual Income Tax (%)
Ohio	6.00	0.712-7.185
Pennsylvania	6.00	3.07
Michigan	6.00	3.90
New York	4.25	4.00–6.85
Indiana	6.00	3.40

[48] According to the Occupational Employment Statistics database from Bureau of Labor Statistics, U.S. Department of Labor in May 2005 there were 5.3 million people employed in Ohio. See: http://data.bls.gov/oes/occupation.do

[49] The States of Kentucky and West Virginia will also obtain certain benefits.

[50] See: http://www.taxadmin.org/fta/rate/tax_stru.html