



University Transportation Research Center

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# **Economic Competitiveness: Performance Measures for Transportation**

*Review of Literature and Best Practices*

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Transportation, Albany, NY

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**Project # C-06-28: Economic Competitiveness**  
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*Task 2 Report: Review of Literature and Best Practices*

## **Problem Statement:**

The New York State Department of Transportation (NYSDOT) is developing a comprehensive set of measures that link investments in transportation to the general economic performance of the New York State Economy. The agency would like to understand in particular how NYSDOT investments singularly or in concert with investments by State and Local governments and Public Agencies/Authorities could improve economic competitiveness.

With an economic history well over 300 years, New York has developed a multi layered and multi modal transportation system that includes rail, air, canal, road and maritime shipping. As in the rest of the U.S., transport systems have been designed to link, impact and even stimulate economic activities. New York State, one of the older industrialized States must continue to evaluate the scope and impact of their infrastructure investments and estimate the quantitative impacts of those investments.

Is there a clear one to one relationship between dollars spent on transportation investments (e.g., new lanes of highways, airport access roads, rail improvements) and economic returns to the State? Economists, engineers and public policy analysts have searched for this seemingly simple relationship, but there is no consensus on what should be measured, how broad impacts should be taken, what are defined as costs, and what returns can be shown to be uniquely due to the transport investment. And this latter issue is the key to this and other studies of transport impacts. Transport investments change regional and local accessibility – seemingly creating increased demand for economic activity. But other, concurrent economic and policy strategies must be in place. Why does Buffalo, with such excellent transport investments across all modes continue to lose population, while Orange County – needing significant highway improvements, more commuter rail and bus – grow so quickly.

While it is widely posited that investments in transportation infrastructure contribute to economic growth and performance, the measurement and the magnitude of the impact of a given component of the transportation system on regional economic performance is difficult to establish. Wide scale projects that impact many users by providing increased mobility, access to port and trade facilities or perhaps provide an increase in tourist traffic are difficult to value through a single performance measure. The true economic value of a transportation system may not be best captured by measurement of individual parts, but in fact may be best measured by the overall network quality. How the quality of the network impacts economic outcomes is based on the interaction of a given transportation

network, government policy, the legal framework and other economic fundamentals that are inherent in a given region.

To what degree the legacy of the transportation systems that were mostly developed prior to 1960 serves the current mobility needs of the economy, requires an extensive study. New York State has components of the system that are significantly under-utilized as well as regions with extremely high levels of congestion. How and why these systems were deployed provides us with some guidance as to how we should plan for future expansion and contraction of the transportation system.

### ***METHODS OF STUDY- APPROACHES AND SOURCES***

To establish the national and international best practices in terms of establishing the economic value of transportation network, the authors conducted two basic forms of research. Our first method was to review the existing literature concerning the relationship of transportation on economic development. Our second method was to conduct a survey of the State Departments of Transportation across the United States to request information on their use of economic performance metrics and reporting standards regarding the economic benefits of transportation investments.

## **Literature Review**

### ***MAJOR FINDINGS – LITERATURE REVIEW***

- Transportation infrastructure investment has a direct impact on economic activity due to direct job creation of a project and the following macroeconomic impact of regional multipliers
- Transportation has the potential to alter the accessibility of a region and create opportunity for economic activity – if the regional conditions are favorable for firms to locate into the region. This effect is key to the long term economic value of a project.
- Transportation infrastructure may be a necessary condition for economic growth, however it is not a sufficient condition. Local and State factors such as taxes, labor laws, social amenities may outweigh or offset the improvement in transportation infrastructure
- Transportation infrastructure and mobility may be key components of business location decisions.
- Failing to invest by the public sector in transportation may result in a decline in private sector investment in physical capital and a corresponding decrease in economic activity.
- New York State needs to evaluate regional transportation investments in light of the underlying fundamental of each regional economy. It is highly unlikely that

transportation alone can reverse economic recessions in a given region. However, in areas that have good fundamentals, investments in transportation may be critical for future regional success.

Many studies have explored the relationship between economic activity and regional migration patterns. Economic activity can be examined based on business location decisions – that is that the supply of jobs in a region is one of the key elements for economic growth. Funding of capital infrastructure programs to provide the basic infrastructure that promotes the economic competitiveness of a region has been the basis for many economic development programs. Provision of maritime, airport and highway facilities have been high on the priority schedule of the World Bank for a generation.

A good overview of current research regarding the impact of infrastructure investment on economic performance is available from the OECD's report "Transportation and Economic Development" (2002) and the Eno Transportation Foundation's "Economic Returns from Transportation Investment" (1996). In both cases, the reports conclude that transportation investments can have broad benefits to regional economies, however, these investments must be made at the correct time and in the correct locations. They also conclude that measuring the impact of a given project is difficult to assess.

This review will illustrate that the research community has not converged on a single measure or set of metrics to describe economic impacts of transport investments; Nor did it agree on the empirical magnitude and range of these effects. We provide a review of key academic papers and regional economic development programs on measures of performance and outcomes that are most appropriate to understand the contribution of the transportation sector to the economy. We will place a particular focus on cases and studies that address particular New York State Regions or the surrounding Mid-Atlantic States.

Investing in a particular infrastructure represents a significant commitment of public resources that could be used for other competing uses in transportation or other areas. Each of these alternative uses offer different benefits to their users and correspondingly alters the amenities set of a particular region. Research by Gabriel et al (2003) showed that quality of life in a region improved if government spending was targeted toward public welfare and highway projects.

On the supply side has been the discussion of why people relocate into a region and how jobs follow the migration of people. Treyz et al (1993) argues that migration is driven from the differential derived between the economic and social amenities in a specified region and the rest of the United States. Factors such as employment opportunities, relative wages, real wage rate and local amenity mix versus national amenity mix help predict migration patterns. New York State with a wide range in the level of social amenities that are provided depending on the county, offers the ability to attract workers who seek amenity rich areas.

Voicu and Lahr (1998) create indices to measure the cost of doing business for many metropolitan regions in the United States. These indices provide firms with comparable metrics of the cost structure in a given region, so they are then able to accurately make decision regarding firm expansion or relocation. Voicu and Lahr argue that these indices can also be used as a leading indicator of regional economic growth. They further found little evidence that additional spending on public services by state and local government has a significant impact on economic development.

Lahiri and Yao (2006) develop a leading economic indicator for the US economy based on transportation sector data. As the United States economy has shifted from manufactured goods to service goods, The Bureau of Economic Analysis has had a general problem with counting service sector output as opposed to physical goods. This causes our estimates of business cycle turning points to be less accurate and this is very important for predicting recessions. Lahiri and Yao developed the Transportation Services Index to provide the BEA and the National Bureau of Economic Research with better measures of service sector performance. The Transportation Sector Index is being maintained by the Bureau of Transportation Statistics of the US Department of Transportation. The data series is currently considered preliminary in nature.

Kim (2006) in his dissertation on the effects of infrastructure on economic growth explores the impact of highway infrastructure on regional labor markets. Kim tests models both on a state (51 states) as well as for 81 Metropolitan Statistical Area (MSA). By studying the impact of changes in both highway demand as well as highway supply, the author is able to estimate over a 19 year period (1982-2000) the elasticity of net in-migration of labor to a given region with respect to highway supply or demand. He found an elasticity of between +0.129 to +0.454 for highway supply (as measured by per capital lane miles) and an elasticity of -1.511 to -0.015 for the demand for highways (as measured by vehicle miles traveled per lane mile) as compared to state economic performance. Both exhibit the expected sign for the elasticity. Additions to the supply of highways cause a positive impact on state economic performance and additional congestion causes a net reduction in the state economic performance. Kim also examines the location specific amenities including and excluding highway services. Interestingly, Kim defines New York State to be an amenity poor state if we do not consider transportation resource and an amenity rich state if we include transportation services. Therefore, in Kim's ranking, transportation serves as a key differentiator in terms of social amenities.

Eberts (1990) provides a distinction in terms of the types of public infrastructure that is provided by the government. First, economic overhead capital (EOC) and secondly, social overhead capital (SOC). While both of provide benefit to the communities that receive these investments, SOC is focused on improving human capital through investments in things such as health, education and protection services (fire and police) EOC is focused on improving the productivity of capital or promoting the movement of goods. What investments are supported by the government has a significant impact on the long term well being of a regional economy.

Eberts elaborates on the model by Hansen (1965) that placed regional economies into 3 categories: congested, intermediate or lagging in terms of economic intensity. Congested regions have significant regional activity and additional activity will contribute to creating further congestion on the generally intensively used transportation network. Further pressure to intensify activity in a congested region will be met with pressure from the regional traffic and environmental impacts.

Intermediate regions have economies that already show some characteristics that indicate that they are prepared for further economic activity. These characteristics include a well educated workforce, abundant raw materials and inexpensive power supplies. All of these factors contribute to the regions ability to grow successfully.

Finally, lagging economies exhibit significant barriers to growth that are not easily overcome by minor investments in infrastructure or social capital. These regional are typically characterized by low standards of living, small scale agriculture or declining/stagnant industries.

Eberts quotes both Looney and Frederiksen (1981) and Costa et al (1987) that reported investments in infrastructure can make very significant impacts on regional performance – if the region is an intermediate region. Regions that are lagging regions do not benefit from the capital investments, as the investments are rarely significant enough to overcome the other regional barriers to growth.

From a New York State perspective, the evaluation of a region in terms of economic vitality may be critical to understanding in what regions transportation infrastructure will have the greatest economic impact. Regions that are lagging in nature may be best served by providing SOC and investing EOC into the intermediate regions of the economy. This may indeed describe the Buffalo-Orange County dichotomy noted earlier.

Hicks (2006) examines the impact of highway investment on business location decisions for Wal-Mart Corporation. Hicks level of study is at the county level for the state of Indiana. Hicks finds that local tax costs as well as highway infrastructure have no proven impact on retail agglomeration. However, when he sub-sets the data to consider counties that have no MSA's (rural counties) he finds a modest impact of local taxes and highway services on retail agglomeration.

Erenburg (1994) studies the impact of investments in public capital and its impact on investments in private capital. Many studies have examined the impact of investment in private capital and the impacts that capital stock investment yields in terms of productivity growth. Erenburg examines whether increased investment in public capital competes for the same capital pool that exists in the economy, and so “crowds out” private capital investment. As an alternative, investments in public capital could create a “crowding in” effect, where additions to the public capital stock creates additional investment in private capital, as there is enhanced productivity of private capital. Her results indicate that additions to public capital increase the net investments in private



capital and that the long run impact of reduced public spending on infrastructure is a reduction in private sector investment in equipment and plants. In addition, these lower levels of private capital undermine both the growth rates of Gross Domestic Product (GDP) as well as real wage rates.

In all of our work on economic performance, we continued to return to the literature on economic multipliers. This theory, borrowed from macroeconomics, provides us with a basis for assessing the impact of infrastructure (or other expenditures) on the regional economy. Papers by Miller (2006), The Bureau of Economic Analysis (1997) and Rosenthal & Strange (2005) provide a basic review of how macro multiplier analysis can provide us with a good estimate of the impact of any particular economic program.

From the point of view of the regional economy, any investment in transportation infrastructure has two economic benefits – first a direct benefit caused by the investment multiplier effect from constructing the project. And secondly, the long term impact of the project on regional competitiveness. By providing improved transportation flows (accessibility), regional business should face lower costs.

The macro impact of the project construction links back to the payments out of the project contract. These factor payments to workers, suppliers, managers and others provide direct stimulation to the economy. Typically, we expect the investment multiplier to be on the local economy to be about three times the size of the investment.

For example, in Boston, The “Big Dig” provided about 14.6 Billion in direct costs due to the construction of the project. These costs are paid to workers and others and are then re-spent in the community, causing positive economic activity. We might assume a factor of around three in terms of a multiplier effect. So, the “Big Dig” would typically have been expected to provide around 45 Billion in total regional economic activity. These impacts are not realized without other costs – such as environmental and traffic delays caused by the construction. In addition, without further analysis, we can not be sure that this investment has the highest economic benefit for the region as compared to other projects that would provide the same macroeconomic multiplier effect – say a renovation of the airport or container port.

The secondary impact is harder to quantify, as it is a derived impact of improved transportation services. This may best be reflected in lower economic costs and these costs saving flowing through to increased employment and wages. Quantification of these impacts are delicate and time consuming, however, they can be estimated.

Banister and Berechman (2000) using a microeconomic three sector model (production, household and transportation) illustrated that successive additions to highway network capacity exhibited diminishing impacts on employment level after an initial period of improvement. Their findings indicated that if a region has a well developed transportation network, additional investments in infrastructure do not tend increase employment.

Banister and Berechman (2001)

In this paper the authors discuss the many pitfalls in attempts to derive economic development benefits from a transportation investment. It examines issues of double-counting of benefits, presence (or absence) of positive externalities in various markets, and impact of socio-economic attributes on the measured economic development impacts.

Berechman and Paaswell (2001)

This paper asks the question how improved accessibility, from a transportation investment, will affect the propensity of potential employees to enter the labor market. It shows that in low-income areas (the South Bronx) improved accessibility will positively affect market participation rates, but the impact is rather modest. Other factors, such as level of education and number of young children per household, have a more decisive effect. In addition, these impacts vary by occupation and industry types.

Ozmen-Ertekin, Ozbay and Berechman (2003) examined the impact of accessibility index to employment growth and income growth. The authors found that counties in the New York Metropolitan region had higher levels of job and income growth if the county exhibited higher levels of accessibility (which is linked in part to transportation system performance). The authors are careful to highlight that these results are at an aggregate level for the transport system as a whole and that they may not generalize to particular transportation projects.

Berechman, Ozmen-Ertekin and Ozbay (2006) modeled the impact of transportation capital investments at the state, county and municipal levels. They found a significant impact of private and public capital on output at the state and county, however, this impact became insignificant at the municipal level. The authors theorize that the impact diminishes as the scale of study decreases due to significant spillover effects of investments in surrounding regions. The authors test and confirm the results of Hansen (1965) that the impact of highway capital is greatest in economies that are classified as intermediate in terms of their economic intensity.

Ozmen-Ertekin, Ozbay and Berechman (2007) studied the impact of highway investment on economic development. Using data at the county level for New York and New Jersey, the authors found that investments in highways impacted output with a significant time lag and that there was a strong level of correlation between current output and output in prior periods.

Weisbrod, et al, (2001) studied the impacts of congestion on regional development patterns and economic activity. They found that the impact of congestion on business activity varied across a given region depending upon the type of business and location relative to the central business district. They developed two case studies in Philadelphia and Chicago.

Their models indicated that businesses that needed a broad range of worker skills or were heavily dependent on truck shipments were most negatively impacted by congestion. Correspondingly, firms that had low skill requirements in terms of labor or firms that used non-specialized inputs were hurt less by congestion. Weisbrod et al found that congestion can actually mitigate some of the benefits of agglomeration that occur in urban areas. By reducing the access to specialized labor and inputs due to congestion delays and commuting times, the regional economy has lower productivity.

Firms located in the central business district tend to specialize in service-oriented activities and have relatively less need for outgoing truck deliveries – so congestion reductions in the CBD tended to benefit firms located in the CBD. In contrast, congestion reductions in older industrial areas created more general impacts on the whole region. Firms located in these areas tend to serve the whole region with heavy outgoing shipments of goods, so reductions in congestion in these regions benefited the whole regional economy.

Eberts et al (2006) presents an attempt to develop a full set of regional competitiveness indicators for the Northeast Ohio economy. Ebert et al. develop a conceptual set of performance themes that will indicate the attractiveness of a given community to business and economic activity.

The initial themes were:

- 1) Economic Growth and Employment
- 2) Education and Workforce
- 3) Quality of Life and Place
- 4) Equity and Fairness
- 5) Cooperation and Governance

From this the team identified 40 economic and social variables that they felt represented the initial themes. Key to inclusion on this list is the regular reporting of these variables by reputable agencies with a minimal of lag in reporting. They then use the statistical technique called factor analysis to condense initial metrics into 8 core performance factors. Using the technique called factor loading analysis and specifically the varimax rotation method, the authors are able to identify the relationship between the relationship between the variables and the performance factors.

The performance factors identified were:

- 1) Skilled Workforce “skilled workers”
- 2) Urban Assimilation “minority business and home ownership”
- 3) Racial Inclusion “diversity of city”
- 4) Legacy of Place “old city and infrastructure”
- 5) Income Equality “fairness of income distribution”
- 6) Locational Amenities “nice place and climate”
- 7) Business Dynamics “high activity in small businesses”
- 8) Urban/Metro Structure “core city poverty, government fragmentation”

Researchers that study the impact of transportation on economic development are far from reaching a consensus with regards to the impact of a given investment in transportation on economic development.

A useful review of the literature is contained in the 2002 report from the European Conference of Ministers of Transport. The conclusions they draw in the summary of the conference offer us guidance as to the impact of transportation infrastructure on economic development and sums up the argument very succinctly:

“Although the issue was debated at some length, the overriding opinion of the experts at the Round Table was nonetheless to the effect that improvements in transport systems did not induce specific effects capable of systematically increasing the production of a region.”

## **Survey Results: State Departments of Transportation**

The University Transportation Research Center conducted a survey of State Departments of Transportation (see Appendix 1) to establish their current utilization of economic performance measures. The UTRC staff contacted 45 state DOTs and submitted an electronic survey for their staff to complete. We received responses from 17 State DOTs. This represents a 38% response rate which is very good given that it was conducted as an email survey with a relatively short response time in Fall 2007.

### ***KEY RESPONSES***

- 47% of the responding State DOT's indicated that they did not measure the contribution of the transportation system to economic development
- How the transportation system interacts with other components of the economic system to produce growth is still being studied.
- It appears from the responses that the State DOTs provided to our survey, that states still in general are focusing on mobility measures to gauge the impact of transportation improvements on the economy.
- Some DOTs use measures of congestion or service levels, while others measure the availability of a given quality of road to certain cities or towns (county seats).
- Some focus on freight movements or truck miles as their measure of success.
- A number of states reported measures of traffic flow or volume of trucking as their measures of economic performance, while still others used quality of rail service in terms of load capacity.
- Finally, some states focus on the pure jobs created by a given construction project or the construction of lane miles in their particular state.
- Clearly, no consensus measures or methods have as of yet emerged from the State DOT's.

The State DOT respondents were both candid in their responses and in most cases provided detailed reviews of their states use of economic performance metrics. A great many expressed interest in the final results as they are also interested in measuring the economic performance of their transportation sector.

In eight out of the seventeen responses (47 percent), the State DOT indicated that their agency does not measure the contribution of the transportation system to economic development. The additional nine respondents indicated some form of economic performance measurement and a corresponding metric, however, in some cases, these performance metrics seem to be almost unrelated to any transportation specific impacts.

How the transportation system interacts with other components of the economic system to produce growth is still being studied. It appears from the responses that the State DOTs provided to our survey, that states still in general are focusing on mobility measures to gauge the impact of transportation improvements on the economy. Some DOTs use measures of congestion or service levels, while others measure the availability of a given quality of road to certain cities or towns (county seats). Some focus on freight movements or truck miles as their measure of success.

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Macroeconomic variables, such as unemployment rate or population growth depend on many factors other than transportation, so the authors doubt their ability to accurately measure how the transportation system contributes in a unique way to the economy. The authors do not suggest transferring these broad measures of the economy to the NYS DOT as a measure of economic success. Their direct linkage to the transportation system is weak at best and there is a wealth of other factors that contribute to changes in these broad metrics

A number of states report a tracking metric of jobs created as a direct response to investments in transportation construction projects or an actual dollar amount expended on construction projects. While this may be of some interest to local or state governments, this kind of measure provides us with very little help in measuring the growth impacts of transportation. In fact this kind of measure could be directly applied to any state or local agency or project and would provide the same level of project justification as any transportation project.

Metrics used by Wisconsin include measures that might be transferable to New York State. In particular, a measure of how the transportation project accommodates business along high growth sectors along a highway as well as productivity along a highway may be of use to the New York State DOT.

Ohio utilizes measures of non-retail job creation and retention of existing jobs as well as measures of economic distress and cost effectiveness of a given project. In particular, the cost effectiveness may be of use to New York State. By measuring the ratio of the cost of a project to the state government divided by the number of jobs created, the state gets a good measure of the impact of a program on local job creation.

Based on a review of the surveys, we feel that the metrics proposed by most state governments, while interesting, do not represent the kind of performance metric requested by the New York State Department of Transportation.

## **Findings:**

### ***CROSS CUTTING FINDINGS***

- 1) Transportation infrastructure investment has a direct impact on economic activity due to direct job creation of a project and the following macroeconomic impact of regional multipliers
- 2) Transportation has the potential to alter the accessibility of a region and create opportunity for economic activity – if the regional conditions are favorable for firms to locate into the region. This effect is key to the long term economic value of a project.
- 3) Transportation infrastructure may be a necessary condition for economic growth, however it is not a sufficient condition. Local and State factors such as taxes, labor laws, social amenities may outweigh or offset the improvement in transportation infrastructure
- 4) Transportation infrastructure and mobility may be key components of business location decisions.
- 5) Failing to invest by the public sector in transportation may result in a decline in private sector investment in physical capital and a corresponding decrease in economic activity.
- New York State needs to evaluate regional transportation investments in light of the underlying fundamental of each regional economy. It is highly unlikely that transportation alone can reverse economic recessions in a given region. However, in areas that have good fundamentals, investments in transportation may be critical for future regional success.

Taken as a whole, the literature does not provide us with clear direction in terms of a single variable that could used to provide the impact of the total transportation system on economic performance that would be applicable to New York State. Given the wide geographic area that needs to be served by a single metric, it is highly unlikely that a broad system wide variable will be sufficient to estimate system performance.

In addition, the varying levels of economic development as well as land use intensity in New York State create an economy that is clearly segmented in terms of economic performance and development. The trajectories that the regional economies of New York State have established over the last 50 years are largely divergent in terms of economic performance, with the upstate region of the state retaining a traditional manufacturing type economy and the downstate economy becoming more focused on international trade and finance. The long and intense decline in economic activity that has occurred in the North and West of the state has its roots in the structural change that has occurred in the United States economy. Whether it is possible to create conditions that will revive the upstate economy in any significant way in the short run is debatable at best. Clearly, transportation system improvements alone are not likely to create the kinds of conditions that are necessary for a protracted economic Renaissance.

Analysis of the survey results from the State Departments of Transportation again does not provide us with a set of consistently used measures of economic impacts. The variation in metrics is probably a strong statement that the pathway of causality is still not established to the satisfaction of all of the policy leaders in the United States or in other Developed Countries.

## **Recommendations**

Based upon direct conversations with business owners as well as consultants at the NYS Small Business Administration, we found that many business owners believe that traffic and congestion represented significant threats to the regional economies of New York State. In general, many owners spoke of the challenges that they face in terms of goods movement. Slow moving traffic and unreliable road systems can and do cause impacts on business activity such as service calls and delivery of goods. New York was generally seen as not a particularly easy place to develop a business, yet many firms reported that they were moving forward with expansion plans in spite of the economic conditions. Market access and size were key factors in their expansion decisions. In the Upstate region, significant delays at international border crossings decrease the value of New York's proximity to Canadian markets. The long delayed reconstruction of the Peace Bridge was cited by regional political leaders as an impediment to future economic growth.

On an anecdotal basis, we found many stories about the impact of congestion on business activity. Two brief case studies provide us with some insight into the general conditions that business owners face on a day-to-day basis:

First, the owner of a heating oil distributor in New York City reported to the authors that his deliveries per day have dropped from 40 per truck in 1980's to 25 per truck in 2008. This productivity drop was completely caused by traffic and road conditions. Since less product is moved in a standard day, this impact clearly results in lower profits and firm performance. In addition, this lower productivity may result in lower investment, as potential profits are lost to the congestion costs.

A second example, John Henry, Senior Vice President and CFO for Duane Reade Corporations, stated at a recent transportation conference that his firm's delivery trucks travel 450,000 miles a year on the New York Metropolitan Regions roads moving products to their stores. The average trip from their warehouse to their stores is 14 miles and it takes them on average 4.5 hours in travel time for each trip. Obviously, this represents a significant impact on their worker productivity, as the average worker could only complete one trip in an 8 hour shift. Improving travel speeds above 3.1 miles per hour would allow a driver to complete additional productive work for the firm. The authors believe that there is significant value to more fully understanding the relationships between transportation infrastructure and economic activity.

Perhaps the most significant opportunity is to develop strong regional economic metrics based on the commuting or activity shed for a given city or county that can then be weighted into a state-wide metric that would reflect the relative importance of the county to the performance of the whole state. One could then weight together these metrics to develop a composite picture of the economy of the whole state. We encourage the New York State Department of Transportation to pursue that goal.



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