Selected Indirect Benefits of State Investment in Public Transportation

DETAILS

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AUTHORS

Porter, Christopher; Lee, Jonathan; Dennerlein, Taylor; and Paula Dowell

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Responsible Senior Program Officer: Gwen Chisholm-Smith

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SELECTED INDIRECT BENEFITS OF STATE INVESTMENT IN PUBLIC TRANSPORTATION

This digest presents the results of NCHRP Project 20-65, Task 52. It was prepared by Christopher Porter, Jonathan Lee, Taylor Dennerlein, and Paula Dowell of Cambridge Systematics, Inc. The research was conducted by Cambridge Systematics, Inc.

SUMMARY

The economic impact of transportation investments, including transit projects and services, has been of great interest in recent years. Studies have typically focused on three aspects of economic impacts: job creation through capital and operating spending; effects on local development patterns; and direct benefits to riders (e.g., time and cost savings) and resulting impacts on business costs and productivity. An additional, indirect impact that has seen less consideration in transit program and project planning is the potential cost savings to other government programs that result from the benefits provided by transit. These indirect benefits can result from improved access to jobs, health care, and education, which can reduce the demand for government services.

This research broadens the range of transit-related economic benefits that may be considered by providing information on the state of knowledge regarding these indirect benefits as well as tools available to estimate these benefits. The research also proposes a framework for how they might be incorporated into program and project evaluation. The research began with a literature review. The review determined that the relationships between transit access and indirect cost savings have been quantified to varying degrees, with some documented more reliably than others. Findings include:

- Transportation is a critical factor for employment. The literature found a connection between transit and job access, where job participation increased for low-wage workers following the start of new transit services.
- Transit can improve access to educational opportunities, indirectly supporting increased employment. Literature has found that more and better education leads to lower unemployment, better chances of reemployment, and higher wages.
- Increased employment reduces demand for other government services such as unemployment transitional assistance. Limited available research found that individuals' lifetime earnings and wage growth trajectories were potentially affected by transit and other job access transportation programs.
- Improved access to preventive health care can provide cost savings in health care services by avoiding the need for costlier emergency care visits as well as costs associated with home health care visits.

For example, a study in Michigan found social benefits of $1.24 per public transit

CONTENTS

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trip, for all trips. Public transit in Wisconsin is estimated to provide a benefit of about $1.55 per work-related trip, $4.03 per educational trip, and $5.66 per health care-related trip. Studies of transit services specifically designed to provide job access have consistently found benefit/cost ratios greater than 1.0. The benefits of a particular transit service, however, can vary widely depending on the type of service, geographic context, and populations served. Benefits expressed in terms of cost per trip may be more generalizable than studies reporting an overall benefit/cost ratio or cost savings, which may vary greatly depending upon service utilization and rider characteristics.

A framework for evaluating the indirect benefits was created that includes three analysis tiers:

1. **Transit Program Development and Resource Allocation**—At this level, estimates of indirect benefits may be based on sketch-level data and analysis of potential populations served.
2. **Project Development**—At this level, evaluation of more detailed project area data can help influence route selection, frequency, or other characteristics of the proposed transit services.
3. **Monitoring and Performance Evaluation**—Ongoing evaluation can measure the effectiveness of the service, assist in evaluating future service needs, and provide insight into service changes to maintain long-term indirect benefits.

Data that must be considered at each level include

- The number of new riders using the service;
- The percent of these riders that previously participated in social assistance programs;
- Trip purposes of riders; and
- The percent of these riders that will reduce use of other social benefits due to improved transit access to jobs, education, and/or health services.

These factors may be estimated from ridership forecasts, analysis of the socioeconomic characteristics of target populations, evidence from surveys conducted of the target populations, and/or survey data from populations using similar services elsewhere.

Guidance is also provided on how the indirect benefits described here relate to the benefits quantified in traditional economic impact analysis and benefit/cost analysis. These benefits are not additive; rather, the indirect benefits analysis should be seen as another data point to inform decisionmaking.

Implementation of these methods in an analysis tool could assist agencies in documenting a more complete range of benefits when evaluating future transit investments. Two tools were identified, developed for the Michigan and Wisconsin DOTs, to evaluate indirect benefits along with other economic benefits of transit. However, these tools are not publicly available and their use by other agencies would require customization for local data sources and other modifications. A new tool could also be developed that would include "default" data from existing studies along with options for user-input local data. The framework described in this report could potentially serve as the basis for such a tool.

SECTION 1 OVERVIEW

STUDY PURPOSE

The objective of NCHRP Project 20-65, Task 52 is to expand the accounting of benefits arising from transit to more adequately reflect the full range of benefits, including those that could help offset the cost of transit investments and operations. Specifically, this research identifies and documents potential indirect government benefits arising from transit investments and services to help states better make the case for strategic investment. In addition, the research addresses methods and tools for quantifying these benefits and provides a conceptual framework for including these benefits along with other economic impact and benefit/cost analysis for transit.

DEFINITION OF INDIRECT BENEFITS

The indirect benefits addressed in this study include the potential cost savings to other government programs that result from the benefits provided by transit. These indirect benefits can result from improved access to jobs, health care, and education, which can reduce the demand for government services.

Figure 1 shows these indirect benefits in context with other economic and non-economic benefits of transit investments and services. These other benefits include the following:

- **Box A** in Figure 1 represents traditional economic impact analysis, including effects on jobs, business productivity, personal income,

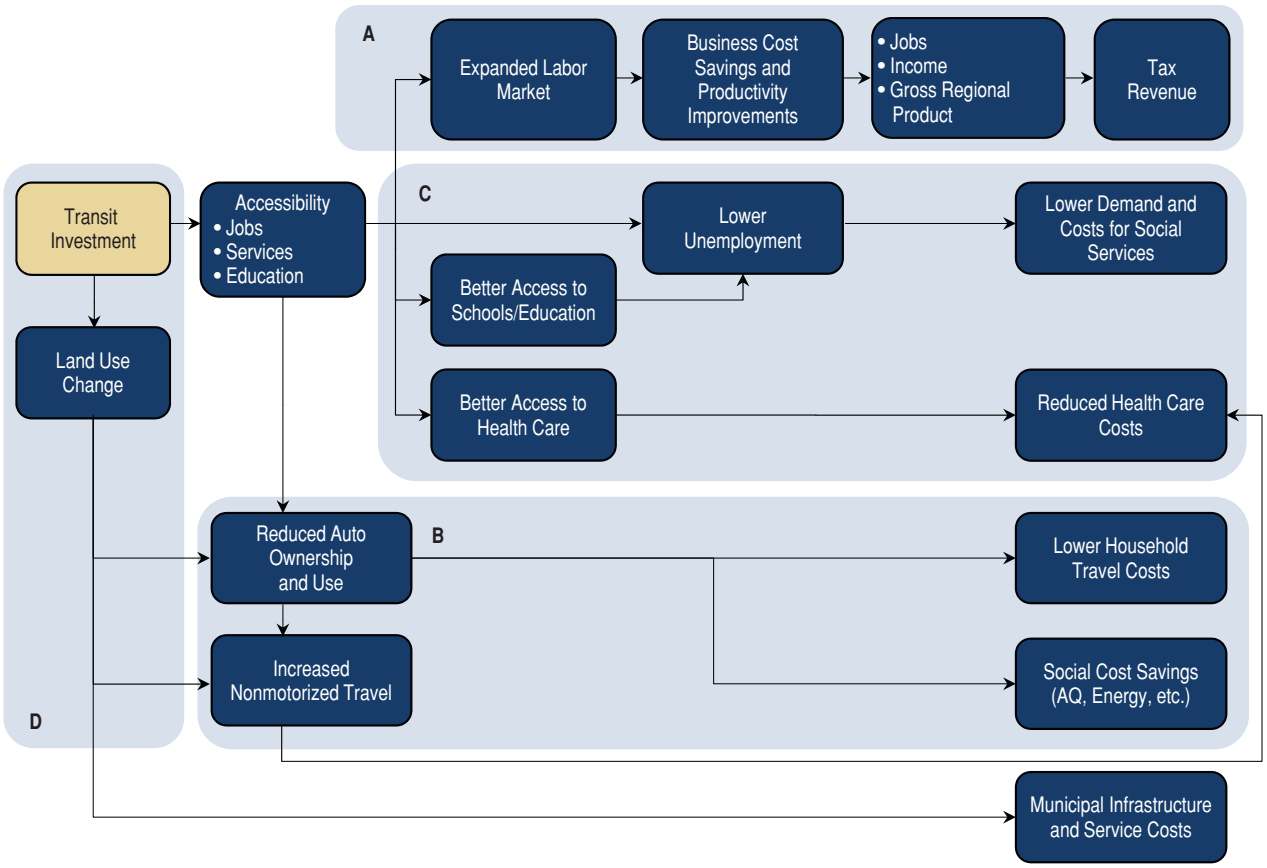

Figure 1 Direct and indirect benefits of public transit investments.

and overall economic product, as well as resulting tax revenue effects. These impacts can result both from direct spending on transit capital and operations and on benefits of transit services, including reduced travel time and costs and greater accessibility.

- **Box B** represents other social cost savings, which may result from savings in vehicle ownership and operating costs, as well as social benefits such as reduced air pollution. These benefits are often included in a cost-benefit analysis.
- **Box D** represents additional, secondary benefits that may result from land use change (e.g., more compact development patterns) facilitated by transit.

The focus of this research is on **indirect cost savings resulting from improved access to jobs and services by transit users**—the linkages shown in **Box C** of Figure 1. Figure 1 illustrates the linkages leading from transit investment and services to outcomes in terms of government cost savings and other benefits and impacts. Improved transit access is hypothesized to lead directly to reduced unemployment (through access to jobs), as well as to increased educational opportunities, which can reduce unemployment in the long run. Reduced unemployment can lead to lower costs for public assistance programs. In addition, improved access to health care provided by transit can reduce public as well as private sector costs for health care services.

STUDY APPROACH

The first element of this research was a literature review. Academic studies were reviewed along with research conducted by state transportation agencies and in support of federal programs. Key researchers in the field were contacted to ensure that the review was comprehensive. The findings of the literature review are described in Section 2, and an annotated bibliography is provided in the appendix.

Following the literature review, a critical synthesis of the findings was conducted. This is presented in Section 3, which identifies factors that are

well understood and those that are not well understood. Section 3 also identifies how generalizable the literature results are and how the indirect benefits may vary from situation to situation. Finally, Section 3 reviews existing tools for estimating indirect benefits and whether they might be adapted for broader use.

Finally, a framework for evaluating indirect benefits was developed. This framework identifies three evaluation levels: program, project, and ongoing monitoring/evaluation. Data needs and potential data sources for evaluation are identified, and potential overlap between indirect benefits and other economic analyses is discussed. Section 4 describes this framework.

SECTION 2 LITERATURE FINDINGS

Findings from the literature are discussed for each of the key linkages shown in Figure 1. Following that, existing tools for assessing indirect benefits are reviewed.

EFFECTS OF TRANSIT ON SOCIAL SERVICE COSTS AND INTERMEDIATE FACTORS

Overall Effect of Transit on Social Service Costs

A number of studies have estimated the benefits of transit to overall public sector cost savings, considering the various linkages shown in Figure 1. Most studies focus on employment-related effects, but a few consider education and health care outcomes. Benefits are expressed in one of three ways: (1) a benefit/cost ratio (monetized benefits divided by costs of providing the transit service in present value); (2) a cost or cost savings per trip; or (3) a total monetary cost savings. Cost savings per trip are most likely to be generalizable since they do not depend on service utilization, which may vary widely.

Benefit/Cost Analyses Findings

- A study of Jobs Access and Reverse Commute (JARC) programs in 23 different locations found that for every dollar spent on transit, a return of $1.90, $1.50, and $3.10 to $3.50 accrues for users of transit, non-users, and society, respectively (*20*).[1]
- Using data on the same programs, a benefit/cost ratio (BCR) was calculated for multiple subsets of JARC-funded employment transportation users in 23 locations, including commuters who continue to work in the same location after using the service and those newly employed after using the service. These BCRs were estimated to be 1.9 and 2.5, respectively (*19*).
- A study estimated the BCR of special public transit programs in Clearwater, Florida, Baltimore, Maryland, and Louisville, Kentucky intended to transport clients to jobs. The BCR of these programs was estimated to be 2.87, 2.52, and 1.01, respectively (*13*).
- The introduction of a jobs access transit service in Clarksdale, Mississippi was found to reduce welfare spending by $5.89 per dollar spent on the transit service (*3*).
- A study in Florida estimates that the return on investment to the State is $11.08 for each dollar invested in transportation disadvantaged programs for medical trips, $5.71 for each dollar invested for employment trips, and $5.85 per each dollar invested for educational trips. The overall return on investment for all transportation disadvantaged programs, including nutrition and life-sustaining trips, is estimated to be $8.35 per dollar invested (*22*).

Findings on Per-Trip Benefits

- Public transit in Wisconsin is estimated to provide a benefit of about $1.55 per work-related trip; $4.03 per educational trip considering forgone educational trips; and $5.66 of benefit per health care-related trip in terms of home health care costs. These home visits may be partially paid for by the government (*11*).
- A study in Michigan found the social benefits (economic value of forgone work or medical trips, homecare cost savings and welfare cost savings) to be $1.24 per trip, for all trips (*10*).

Findings on Total Cost Savings

- For non-users of JARC-funded transit, an average transfer payment (welfare and unemployment benefits used alternatively) of $5,000 per person was estimated for the 23 locations studied (*19*).

[1]Numbers in parentheses refer to citation in literature review (see Appendix).

- A study of the fixed-route bus system in Indiana found that public costs declined or deferred due to the presence of transit was over $16.3 million per year. The impact of lost employment to workers without vehicles was estimated to be between $137 and $224 million (*6*).

Effect of Transit on Access to Jobs, Services, and Education

Some studies have shown that transit increases access to jobs. Others have estimated how many trips would be foregone if the transit service did not exist. These studies generally find that public transit serves an important role in providing access to jobs, services, and educational facilities for those who cannot or do not drive for various reasons. The findings are as follows:

- Studies in Michigan and Wisconsin found that between 34% and 48% of all transit trips are taken for work purposes, respectively. In the absence of transit, 19% to 25% of these work-related trips would be forgone (*10*, *11*).
- The percent of trips taken for work was higher (82%) for "last mile" shuttles in New Jersey. If the service did not exist, 11% of work shuttle trips would be forgone (*9*).
- Expanding transit in Minneapolis increased the number of low-wage transit accessible jobs for low-wage workers by as much as 18,000 (*7*).
- Transit expansions in Montreal increased overall access to jobs by an estimated 15% (*12*).
- Education-related trips in Wisconsin and Michigan are about 23% and 26% of all transit trips, respectively. In the absence of transit, 13% to 23% of these trips would be forgone (*10*, *11*).

Effect of Access to Transit and Jobs on Unemployment and Wages

A number of studies examined the effects of transit on unemployment, but did not monetize these outcomes. Access to public transit and jobs via public transit can be important in terms of gaining employment and higher wages. This is especially true for those without access to an automobile. The majority of studies analyzed found that public transit did play some role in individuals obtaining and keeping employment. However, not all studies agreed on which variables were significant. No studies that examined the effect of transit access on wages were found. The findings are as follows:

- Variables such as living within walking distance of a transit stop, the number of stops within walking distance, transit service frequency, and job accessibility by transit have positive effects on the probability or odds of finding employment. Studies include Aid to Families with Dependent Children (AFDC) recipients in Alameda County, California; residents of Portland, Oregon and Atlanta, Georgia; welfare recipients in Milwaukee, Wisconsin; and residents of Houston, Texas (*8*, *16*, *18*, *21*).
- A study in Broward County, Florida found that for every 1,000-point increase in the transit accessibility to jobs index, the average length of time a welfare recipient stays in the Temporary Assistance for Needy Families (TANF) program decreased by 0.129 months (*1*).
- A study in Wisconsin found that in the absence of transit, a 12% increase in the public assistance case load was estimated (*11*).
- A few studies showed no statistical significance for various transit variables, but did show significance in other variables. For example, the number of children in the household, age, and years on assistance were found to be negative factors when predicting employment outcomes. These studies conclude that public transit may still be important, but other variables such as childcare, may be of greater importance. Data for these studies were from Atlanta, Baltimore, Dallas, Denver, and Portland (*16*, *17*).
- Variables pertaining to car ownership had a positive and significant effect on finding employment in Atlanta and Portland; in one study in Alameda County, the variables had the same effect on leaving public assistance (*8*, *16*).

Effect of Access to Schools/Education on Unemployment and Wages

Similarly to access to jobs, access to schools and education is linked to lower unemployment and higher wages. The literature agrees that more and better education leads to lower unemployment, better reemployment, and higher wages. The findings are as follows:

- Nationally, unemployment for persons with a Bachelor's degree is 5%. For persons with

only a high school diploma, the unemployment jumps to 23%. Unemployment is highest for high school dropouts at 32%. The unemployment rate for those with a graduate degree is the lowest at 3% (*5*).

- A study of metro areas and employment rates showed lower unemployment rates for workers with a Bachelor's degree than workers with a high school diploma or less. Metro areas with larger education gaps (average number of years of education required by employers minus average number of years of education of the population) had higher unemployment rates than did other areas (*15*).
- Controlling for other factors, the probability of re-employment with 9 years of schooling was 0.52, while the probability increased to around 0.70 with 18 years of schooling. The greatest increase in probability was from 11 to 13 years (graduating from high school) and 15 to 16 years (obtaining a Bachelor's degree) (*14*).
- In terms of wages, the average earnings for a Bachelor's degree holder are about $48,000, while the average earnings for a graduate degree holder are $62,000 (*5*).
- A meta-analysis found positive relationships in all studies analyzed between an increase in schooling and an increase in earnings (*4*).

Effect of Lower Unemployment and Higher Wages on Demand and Cost for Social Services

As previously stated, access to employment via public transit can lead to lower unemployment and other related benefits. These benefits lead to monetary benefits, particularly in lower demand and cost for social services. Some studies, in the process of estimating the benefits of transit services, have used information to monetize these benefits such as the cost per TANF case eliminated. The findings are as follows:

- A study of transit users in Wisconsin estimated that the absence of transit would lead to an increase in public assistance of about 13,800 cases, or $74 million in public assistance. This implies a savings of about $5,362 in public assistance per case due to the presence of public transit (*11*).
- A study of special public transit programs in Clearwater, Florida, Baltimore, Maryland, and Louisville, Kentucky used an estimated $6,000 per client per year in reduced public assistance for the benefit/cost analysis. The source of this estimate was not documented (*13*).

Effect of Access to Transit on Health Care Access and Utilization

Three studies looked specifically at the impacts of transit on health care utilization. Without physical access to health care, whether by car or transit, non-emergency health care visits and regular check ups may be utilized less frequently then needed. The findings of the studies are as follows:

- Health care-related transit trips in Michigan and Wisconsin are approximately 8% to 11% of all transit trips, respectively. In the absence of transit, 24% of health care-related trips would be forgone (*10*, *11*).
- Some forgone trips may lead to forgone medical treatment. In a study of rural North Carolinians, those who had a driver's license had 2.29 times more health care visits for chronic conditions and 1.92 times more visits for regular checkups compared with those who did not. Those who used public transit averaged four more chronic health care visits than those who did not use transit (*2*).

Effect of Health Care Utilization on Health Care Costs

Health care utilization can reduce health care costs in different ways. More regular visits can replace sporadic, more expensive emergency visits. Forgone visits can also lead to home health care, which is also more expensive. Health care utilization not only benefits the individual, but also can benefit the government in terms of reduced Medicaid payments. Additionally, two studies in Michigan and Wisconsin estimated the social benefits per trip of health care access, as reported in the overall findings section above.

EXISTING ANALYSIS TOOLS

Analysis tools were used in two of the studies reviewed to assess the benefits of transit. HDR Decision Economics created a Microsoft Excel-based model for the Michigan DOT to calculate the difference between transportation costs in the presence

and absence of transit. Data for the model were obtained from on-board passenger surveys from seven representative transit agencies across Michigan, as well as transit data at the agency level. The HDR model inputs include ridership by trip purpose, percent of trips diverted to other modes or forgone in absence of service, and relevant transit data such as fare revenue and total expenses. Outputs include out-of-pocket cost savings and impacts, affordable mobility benefits, cross-sector benefits (access to entertainment, retail, education, health care, and social services), and impacts of transit operations (*10*).

For the Wisconsin DOT, HLB Decision Economics (now HDR) created a model to calculate the corresponding savings of the public transportation impact on different sectors in Wisconsin. An on-board user survey was conducted to collect data from transit users. Supplemental data were obtained from both state and national sources. Inputs include trips by purpose, percent of trips forgone in absence of transit, general cost of each mode, and incremental cost of home health care or public assistance case. Outputs include out of pocket savings and cross-sector benefits due to transit. Key assumptions include ridership estimates, and the percent of forgone trips leading to home health care visits or unemployment (*11*).

In both studies, the estimated out of pocket savings were then used as an input to the IMPLAN economic impact model. This input/output model calculates the direct, indirect, and induced economic benefits based on changes in spending in different sectors.

SECTION 3 STATE OF KNOWLEDGE AND ANALYSIS TOOLS

The overall objective of this research is to expand the accounting of benefits arising from transit to better reflect the full range of benefits, specifically the indirect benefits that may help offset the cost of transit investment or operation. These potential indirect benefits complement traditional benefit/cost and economic impact analysis to help states and transit agencies make the business case for strategic transit investment. The literature review found areas where transit can provide savings in other government programs. The literature suggests transit access can have the following indirect benefits:

- Improved labor force participation and incomes;
- Reduced transfer payments or social assistance; and
- Increased health and education-related trips, supporting long-term reductions in health care and unemployment-related costs.

This section assesses the evidence found in the literature review on program cost savings related to transit investment, addressing the following questions:

- Which relationships are well understood and documented? Which relationships are not well understood?
- Can findings from existing literature be generalized from the cases studied to other situations?
- Could existing tools be used more widely, and what inputs would be needed for their application? What enhancements or new tools might be needed?

SUMMARY OF INDIRECT TRANSIT INVESTMENT RELATIONSHIPS

The literature review focused on the impacts of transit on education, healthcare, social costs, and unemployment. Each article was evaluated for any measureable qualitative and quantitative effects on program performance and public spending impacts and was categorized. Based on the literature review, the well understood relationships include the effects of

- Transit on access to jobs, services, and education;
- Access to transit and jobs on unemployment;
- Access to schools/education on unemployment and wages; and
- Access to transit on health care access and utilization.

The relationships that are not well understood or hard to quantify include the effects of

- Transit on social service costs,
- Access to transit and jobs on wages,
- Lower unemployment on demand and cost for social services, and
- Health care utilization on health care costs.

Which relationships are well understood?

Effect of Transit on Access to Jobs, Services, and Education

Four studies identified in the literature review examined transit access to jobs, services, and education.

The scope of these studies was to review the impacts of transit and job access on low-wage earners and the effectiveness of transit programs focused on job access. Access to jobs was the most studied, while access to education was only considered in two studies. The literature agrees that more and better education leads to lower unemployment, better chances of reemployment, and higher wages. The link between jobs and transit was established using percent of transit trips by purpose and trips forgone in the absence of transit (from surveys) as well as the increase in jobs accessible by transit (from census, employment, and transportation network data). These studies identified areas where commuters are transit dependent using employment and transit data. One of the studies went a step further to measure the social equity by neighborhood as a result of existing transit provisions for total and low-skilled jobs in socially disadvantaged areas.[2] Often studies supplemented the employment and transit data with surveys specific to the project.

The studies demonstrated the connection between transit and job access, especially for low-wage workers, as in the case of the Hiawatha light rail where job participation was increased due to the new transit service. Additionally, surveys determined that certain JARC-funded programs had users who would not make the trip to work if the service did not exist. JARC-funded transit programs differ from traditional transit services by providing low-income and welfare recipients with transit access to employment centers that have either limited, no, or only peak-time transit service. These JARC-related studies confirmed that a spatial mismatch existed between the labor force, skills, and location of jobs in certain neighborhoods. These studies provided strong evidence of a link between transit access and jobs, especially for low-income earners (*7, 9, 10, 12*).

Effect of Access to Transit and Jobs on Unemployment

The effect of transit access on unemployment is also well documented. Seven different studies examined this link from a welfare-to-work and a transportation-for-needy-families perspective. Findings were presented as variables that had a statistical effect on employment, unemployment, leaving public assistance, length of stay on public assistance, and increase in public assistance case load in the absence of transit.

From these analyses, variables that were significant in determining the link between employment and public transit included the distance to transit stops, commute time, headway and frequency, and vehicles owned. These studies relied on statistical analysis, and often the results are specific to the locality or region. All of the studies found transportation as a critical factor for employment, whether these transportation options were transit or automobile. However, not all studies agreed on which variables were significant. Transit was a significant factor across all studies, with the exception of one study that did not produce results that were consistently significant across multiple regions. The results provide evidence of a link between transit, jobs, unemployment levels, and length of unemployment (*1, 8, 11, 16–18, 21*).

Effect of Access to Schools/Education on Unemployment and Wages

The effect of education on unemployment and wages is documented in four different studies included in the literature review. Studies examined not only lower unemployment and higher wages, but also re-employment. The gap between education and skills required for jobs was a significant factor in regional unemployment. The literature established the methods for determining where education gaps exist and current conditions. Other factors contributing to the education gap and unemployment are the regional industry composition, demographics, housing markets, and access to credit. The qualitative evidence supports spending on transit and education programs to benefit the labor force and reduce unemployment. The literature also found metropolitan regions with higher educational attainment had lower unemployment, whereas metropolitan areas with larger education gaps had higher unemployment rates. Supporting literature found in Michigan and Wisconsin that in the absence of transit, a significant portion of education trips would be foregone, resulting in lower educational attainment. However, it is difficult to quantify this link without applying statistical methods to determine the impact of better access to schools on unemployment, net of other factors. The qualitative nature of the relationship

[2]Manaugh, K. and A. M. El-Geneidy. "Who Benefits from New Transportation Infrastructure? Using Accessibility Measure to Evaluate Social Equity in Transit Provision." *Accessibility and Transport Planning: Challenges for Europe and North America.* Edward Elgar, London, UK, 2011.

between access to education on unemployment and wages provides mixed supporting evidence as to the magnitude of the impact (*4, 5, 14, 15, 7, 9–12*).

Effect of Access to Transit on Health Care Access and Utilization

The benefits of transit access in increasing health care utilization are well documented. Two studies (*10* and *11*), which were focused on transportation costs in the presence versus absence of transit, estimated the economic value of foregone medical trips. Two other studies (*2* and *24*) focused on ways to quantify health care access by residents of rural areas. Three of the four studies examined this relationship, all three in terms of health care trips or visits forgone in the absence of transit or taken in the presence of transit. Distance and availability of transit were significant factors in more rural regions. There can be significant cost savings if transportation services are available for preventive health care visits, avoiding costlier emergency care visits for conditions associated with a missed appointment. The reduction in home health care and emergency care visits benefits the public by reducing Medicare and Medicaid payments. Studies presented methods for evaluating regional access to health care and recommended transportation services for non-emergency medical appointments through Medicaid. The available data and statistical analyses provide evidence of a link between transit and health care access and utilization (*2, 10, 11, 24*).

Which relationships are not well understood?

Overall Effect of Transit on Social Service Costs

This relationship is discussed in the literature, but not well understood. Better or improved access through transit can lead to lower unemployment rates, higher wages, and better access to health care. The research suggests these benefits can result in a reduction in Medicaid and other social assistance program costs due to fewer participants and reduced periods on social assistance. One study focused on the impact of rail transit on social costs, but the majority of studies focused on bus transit, more specifically JARC-funded bus services. Other forms of transit, including demand response, light rail, and commuter rail are likely to have downward effects on social service costs. Few studies have measured their impacts, however, and results vary widely depending upon the types of social services studied, transit services available, service utilization, and demographic conditions and educational attainment in the areas served. While a general relationship between transit and social costs is established, the literature acknowledges the difficulty of quantifying these benefits and the wide range of results from various studies (*3, 6, 10, 11, 13, 19, 20*).

Effect of Access to Transit and Jobs on Wages

While studies estimating the effect of access to transit and jobs on unemployment were available, the literature examining this effect on wages was not as prevalent. The available research found that individuals' lifetime earnings and wage growth trajectories were potentially affected by transit and other job access transportation programs, relative to similar groups without access to transit. The limited research available suggests a link between transit and wages but is inconclusive and difficult to generalize (*19–21*).

Effect of Lower Unemployment on Demand and Cost for Social Services

Of the studies in this review, only two estimated the effect of lower unemployment on the demand and cost for social services. The methods behind the analyses were not strongly documented, adding some uncertainty as to whether the results are accurate or repeatable. While the relationship seems intuitive, more research is needed to determine which social services are impacted most, and appropriate methods to estimate the cost savings. The wide range of social services available at the state level also presents issues in estimating and comparing the potential cost savings across regions. Further research on the effect of underemployment and social services may also be important in understanding the relationship and elasticities between employment and the demand for social services (*11, 13*).

Effect of Health Care Utilization on Health Care Costs

While the majority of studies touted health care utilization as a way to lower health care costs, many did not quantify the cost savings associated with higher health care utilization. Additionally, those that did quantify this relationship did not provide a detailed methodology on how the estimates were

derived. A regional-level analysis may determine a potential cost savings per visit or per patient with further research. Regional and statistical analyses may be the only feasible analytic route as different hospital and health care systems have varying fees for service, and assisted health care programs vary by state. Data and research available constrain the level of analysis and, therefore, the relationship is inconclusive.

The relationships discussed in this section are often considerations in policy decisions and require further research to quantitatively examine. Some of these relationships may be evaluated in certain situations, may not be repeatable across geographies, or have technical constraints. The generalizability of the well understood relationships is addressed in the following section.

GENERALIZATION AND APPLICABILITY OF BENEFITS

Can findings from existing literature be generalized from the cases studied to other situations?

While not all cities and transit systems are the same, some findings from existing literature may be generalized from the cases studied to similar programs or regions. The findings that are well understood may be generalizable, while those that are not well understood are not.

Access to jobs, services, and education via transit may be generalizable. These findings include bus and light rail transit for fixed-route or services focused on smaller specific groups such as demand-response or JARC-funded shuttles. The findings from the different studies were also in agreement, particularly in terms of percent of transit trips by purpose and percent of trips forgone in the absence of transit. Although two of the main studies were located in two Midwestern states, they disaggregated the benefits by population size and density (urban versus rural), making the findings somewhat more generalizable. However, the findings may not be applicable for larger cities or metropolitan areas. Studies demonstrated that transportation access improved chances of finding employment and also demonstrated cases of spatial mismatch where the transportation gaps existed between the labor force, employment centers, and services. Statistical analyses and surveys confirmed in different cities that fixed-route transit, including bus and light rail, increased the likelihood of finding work and reduced unemployment. Studies also found that access to, or the presence of, demand-response and other transit services providing direct links to and from transit to employment centers reduced unemployment.

The effect of education on unemployment and wages is also generalizable. The findings were estimated from either national data or from meta-analyses and represent general conditions. As expected, the connection between higher levels of education and lower unemployment were demonstrated. High school dropouts and high school graduates were shown to have lower earnings compared with those with Bachelor's degrees.

The effect of access to transit on health care access and utilization is fairly generalizable in terms of health care trips or visits forgone in the absence of transit or taken in the presence of transit. While one of the studies presented results in a different way, all three studies are in agreement that lack of transit decreases the number of health care trips or visits taken. Methods for identifying health care shortage areas are generalizable using existing regional- and national-level data.

The overall effect of transit on social service costs may not be generalizable to all situations. More than 30 locations across the United States were used in these studies—including large urban, small urban, and rural locations—with similar results. The studies primarily looked at bus transit and other services like JARC that were designed specifically to improve job access and, therefore, may not be generalizable to other types of fixed-route transit, which serve multiple travel markets and purposes. While a number of studies included multiple or different locations, the results were typically aggregated.

The effect of access to transit and jobs on unemployment may not be easily generalizable. Not all studies reviewed were in agreement on the magnitude of this effect, as well as the specific variables that were significant. Many different variables and methods were used to represent access to transit, access to jobs, and unemployment.

The generalization of methods to evaluate the indirect benefits of transit in terms of jobs, education, and health care requires available regional and national data sources to start evaluating the potential connections. Statistical or meta analyses are required to quantify the impacts based on the data collected. The limitations of these analyses must be considered as

demographic, transit service, and regional differences may affect the applicability of these methods or generalizability of results.

What factors influence cost savings?

The factors influencing cost savings due to transit investment can be broken down into three major categories: (1) the type of transit investment, (2) geographic factors, and (3) populations served. For the transit investment type, the literature focused on fixed-route (either BRT or light rail), JARC, and demand-response. Each of these systems served different populations, provided different levels of service, and had different operating costs and ways to finance operations. JARC-based transit systems generated net user benefits and reduced other transfer payments consistently in the literature, but evidence for other types of services is much more limited.

Geographically the transit service can be located in urban, suburban, or rural areas with different land use patterns (population and employment density, jobs/housing balance, etc.). Different areas have different service needs, hours of operation, and demographics. In addition, trip length and trip purpose varies greatly between urban and rural transit systems. Services like JARC and demand-response should expect to have longer average trip lengths in rural regions, increasing system costs per trip. More urban environments may have shorter trips, but greater participation increasing the volume or number of trips. The most notable examples of cost savings from the literature review include the following:

- Employment transportation services reduced the average transfer payment, welfare, and unemployment benefits by almost $5,000 per person across multiple study areas (*19*).
- The average cost savings of avoiding foregone work and medical trips in Michigan could be as much as $1.24 per trip (*10*).
- Providing fixed-route systems in Indiana declined or deferred $16 million in public costs (*6*).

The benefit metrics may also vary regionally, depending upon regional differences in productivity, incomes, demographics, and levels of public benefit. For example, average wage rates vary by a factor of approximately two across all states; services in areas with higher average wage rates would be expected to provide proportionately greater benefits in monetary terms.

These indirect cost savings must be placed in the context of the capital and operating costs of the systems, as well as other costs and benefits. The role of service productivity in influencing cost savings is critical. Total indirect cost savings from a transit investment can be thought of as a function of two factors:

1. The indirect cost savings *per trip or rider served* and
2. The productivity of the system, as measured in *total number of trips served* per unit of service provided.

The indirect benefits per trip or user may vary somewhat, depending upon the characteristics of the ridership base and alternatives available. For example, the benefits are likely to be greater for lower-income populations with limited alternatives as compared with higher-income "choice" riders. Even more importantly, however, is that the *productivity* of a transit service can vary widely from context to context. For example, a capital-intensive transit system that serves low-density areas and has low ridership will only yield a small amount of benefit compared with its costs. On the other hand, services in demand-dense areas that are highly utilized are much more likely to show net benefits greater than costs. An analysis of likely service utilization is therefore critical to identifying services that may have significant indirect benefits in relationship to their costs.

EXISTING ANALYSIS TOOLS

This section evaluates the readiness of the two tools in the literature review to be utilized more widely to estimate indirect benefits. These models were developed for Michigan DOT and Wisconsin DOT. This review reflects only findings from the literature since the models were not available for a detailed review. This section provides a summary of the applications, input requirements, and potential enhancements for these tools.

Could another transit agency use the tools that were developed for Wisconsin and Michigan?

The Michigan DOT required that the tools developed allow for independent analysis at the local,

regional, and state level. The model's design criteria focused on creating a dynamic and flexible tool through using scalable methods, using publicly available data, estimating a wide array of benefits, and accounting for uncertainty using risk analysis. The Excel-based model was developed primarily for agencies in Michigan. The model itself captures three main groups of benefits, similar to the blocks in Figure 1. These benefit categories are described in the model as the low-cost mobility effect, congestion management benefits, and economic development. The low-cost mobility effects relate best to the indirect benefits evaluated in this paper. The relevant transit benefit subcategories of low-cost mobility are income from employment, the economic value of access to services like education and health care, and budget savings for welfare and social service. This model has use limited to Michigan as the transit input data comes from the Michigan DOT's (MDOT's) Public Transportation Management System (PTMS). Additionally the underlying economic impact and other data and coefficients are specific to Michigan. This model, developed for MDOT, could be updated by MDOT or the developer to reflect the latest available Michigan data. Another option is to create a new model leveraging the existing transit evaluation methodology for direct and indirect benefits, with a more flexible framework that can be modified for use across multiple states and transit agencies.

The study for the Wisconsin DOT (WisDOT) developed the model specifically for the original research paper.[3] The tool was intended for a one-time use. The WisDOT model has a similar structure and logic as the MDOT model, and the methods developed for WisDOT may have been the precursor to the later multi-use MDOT model. The model was designed to focus on three major categories of benefits: (1) cost savings measured in consumer surplus; (2) qualitative measures of transportation access; and (3) cross-sector benefits (work and health care). The model analyzed the direct transit benefits and economic development effects using IMPLAN multipliers specific to Wisconsin. Like the MDOT model, this system required local survey data. The model's logic was supported by survey data to determine ridership by transit system and purpose, the actions transit users would take in the absence of transit, and access. The results of the surveys are from 2003, but can be a good basis for looking at how transit trips in various Wisconsin transit systems change in response to adjustments in the level of service. Some riders may respond by opting not to make work, health care, or education trips due to changes in the level of service. The results of the analysis are at the aggregate level, but provide a description of methods, data sources, survey results, and logic diagrams that could be used to develop a new model for Wisconsin or other states.

[3]See Section 2, Existing Analysis Tools or References 10 and 11 in the Appendix.

Do agencies need to collect their own local data, and if so, what?

Data needed for the MDOT model include

- Transit operations data at the agency level;
- Travel characteristics;
- Riders' response to absence of transit;
- Alternative modes of transportation; and
- Value of time, accidents, emissions, and low-cost mobility.

The majority of the data would likely come from surveys and transit agencies. Agency-level data (PTMS data for MDOT) include service area population, total passengers, vehicle miles, fare revenue, total expenses, and accidents. While the availability of the WisDOT model is uncertain as it was intended for a one-time use, it would likely require significant updates in addition to the data mentioned above for the MDOT model, along with an update to the Wisconsin surveys and potentially other data presented in the following conceptual framework section.

What key assumptions would be embodied in using the tools as is?

The majority of assumptions come from the data collected—such as ridership estimates, percent of trips diverted to other modes, and the percent of forgone trips leading to home health care visits or unemployment—not necessarily from the models themselves. Key assumptions in the models are economic assumptions inherent in the transit demand curve and consumer surplus concept. The models assume that without transit, riders will pick only one other mode of transportation, when they may have multiple options. Both models employ risk analysis to calculate the uncertainty in these assumptions, which requires various functions provided by the @RISK software, an integrated MS Excel add-on.

What are the limitations of these tools?

The MDOT tool was designed to estimate the benefits of bus transit. Estimated benefits of other types of transit may not be as accurate. Both tools rely on the differences between presence and absence of transit, but other service characteristics, such as frequency and hours of operation, may also play a role in an individual's decision to take transit. The underlying data or parameters in these models require updates, and the structures of the models are fixed. The survey data and methods are also not completely apparent as to how well they relate to current conditions and are representative of the different transit systems in Michigan and Wisconsin. A complete list of limitations may be difficult to determine without a hands-on evaluation of each of the tools. If the tools are considered as a basis for further tool development, they should be compared against the framework established in Section 4 to ensure that complete accounting of economic benefits (including indirect benefits to the public sector) but without double-counting any benefits.

SECTION 4 CONCEPTUAL FRAMEWORK FOR INCORPORATING INDIRECT BENEFITS OF TRANSIT INVESTMENTS

This section describes a high-level conceptual framework for incorporating the potential indirect benefits into a transit investment evaluation. The relationship of indirect benefits to other measures of economic benefit is first discussed. Then, an approach is proposed for considering indirect benefits in three stages of planning: (1) program development/resource allocation, (2) project development, and (3) monitoring and evaluation.

INDIRECT BENEFITS VERSUS OTHER MEASURES OF ECONOMIC BENEFIT

Figure 1 organized the impacts of transit investment into three major categories. Given the related nature of transit's economic impacts and benefits, there is a potential for overlap or double-counting.

The macroeconomic impacts related to transit investment, Box A, are captured in an economic impact analysis. These macroeconomic impacts include labor, income, and industry effects on the regional economy due to short-term construction and long-term operations. Capital and operating expenditures for the transit service provide direct impacts (although these must be balanced against the effects of raising revenue to support the service). In the long term, net economic benefits can accrue from improved access to jobs and resulting increases in business productivity and household income.

The benefits and other cost savings outlined in Box B are traditionally captured in a benefit/cost analysis. A benefit/cost analysis evaluates the long-term benefits to society, including air quality, travel costs, reduced congestion, and safety, as compared against the costs of constructing and operating the service. The benefits and costs are estimated in present-value terms, allowing comparison between different projects and transit modes.

The indirect benefits discussed in this study (Box C) are in the form of cost savings to other government programs. In and of themselves, these do not represent a net social benefit since they are simply a reduction in transfer payments. The net economic impacts may also vary, depending upon how the cost savings are redirected (e.g., to other government programs or returned to taxpayers). However, the indirect benefits may reflect net economic benefits if increased employment and health care access result in increased income generation and reduced long-term spending on health care.

Table 1 presents a conceptual framework for how the various forms of economic analysis relate. The table displays the indirect benefits measured, the areas for potential overlap, and guidelines to avoid double-counting.

As the table shows, any indirect social program cost savings should not be counted in the benefit/cost analysis for transit investments. The U.S. DOT guidelines for benefit/cost analysis explicitly state that transfer payments should not be included and, therefore, reductions in public assistance payments to individuals should not be counted.[4] Income, wages, or other transfers should also be avoided in benefit/cost analysis, but can be cited as an independent metric of the analysis.

Cost savings at the program level can potentially alter government spending at the local, state, or federal level. However, it is unclear how program cost reductions are handled within government budgets,

[4]TIGER 2013 NOFA: "Benefit/Cost Analysis Guidance" U.S. DOT, Washington, D.C., May 2013; www.dot.gov/policy-initiatives/tiger/tiger-2013-/-nofa-benefit-cost-analysis-guidance.

Table 1 Conceptual framework of indirect benefits.

Transit Investment	Indirect Impacts Measured	Alternative Analysis Type	Areas for Potential Double-counting	Proposed Method
Increases labor force participation	Reduction in unemployment and welfare payments	Economic Impact Analysis	Reduction in program costs may occur, but unclear how it will affect government spending and budgets.	Change in program spending should be documented, but should not be applied to economic impact multipliers.
		Benefit/Cost Analysis (BCA)		These are government transfer payments and should not be counted in the BCA, per U.S. DOT Guidance on BCA.
	Increase in personal income	Economic Impact Analysis	Counting transfer payments and full wage contributions.	Count net new income above previous unemployment insurance and welfare transfer payments.
		Benefit/Cost Analysis		Exclude changes in income from BCA, as these are transfer payments.
Increases health care participation	Indirect reduction in Medicare and Medicaid payments	Economic Impact Analysis	Reduction in program costs may occur, but unclear how it will affect government spending and budgets.	Change in program spending and any potential increase in productivity should be documented, but should not be applied to economic impact multipliers. Avoid adjustments in medical spending as health care outcomes and costs shifts are unclear.
		Benefit/Cost Analysis		These are government transfer payments and should not be counted in the BCA, per U.S. DOT Guidance on BCA.

and these changes to government spending may have to be analyzed after-the-fact to accurately capture the flow of funds. For example, spending for other programs may be increased, taxes may be reduced, or funds may be used to pay down debt or increase reserves. The economic impact analysis can also incorporate changes in net new income, but to avoid double-counting, the original transfer payments (unemployment insurance or welfare payments) must be subtracted from the total income impact before applying the multiplier effects.

CONSIDERING INDIRECT BENEFITS IN PROGRAM AND PROJECT EVALUATION

The review of existing literature and tools available provided guidance for developing a conceptual framework for evaluating the indirect benefits of transit investment. The framework can be combined with existing economic analysis methods for transit, including the tools developed for WisDOT and MDOT. The conceptual framework for evaluating indirect benefits should be used as a supplement to other economic analyses. The lack of reliable quantitative data on many of these indirect benefits presents a challenge for accurately estimating the indirect benefits across multiple geographies and incorporating them into a benefit/cost analysis.

The proposed conceptual framework for evaluating the indirect benefits of transit is broken down into three major tiers. This is suggested as an overarching method that will enable analysts to establish a baseline of current conditions, determine impacts, and monitor long-term performance. However, any of the three tiers can be used independently based on the agency or project needs. A discussion of data sources for this framework follows. The three tiers are

1. Program development (resource allocation at the state and regional level);
2. Project development; and
3. Monitoring and performance evaluation.

Program Development/Resource Allocation

Planners and policy analysts have numerous performance metrics and evaluation criteria available for prioritization and policy planning. The indirect benefits are another set of performance metrics or criteria that can be added to the existing analysis to determine how limited federal, state, or local funding for transit can be allocated among a large set of priority projects. At this level, the indirect benefits analysis may be primarily qualitative and sketch-level in nature. It may draw, in part, on general findings from the existing literature, as well as local data and evaluation studies. Collecting data and creating a set of existing conditions can be used to demonstrate where improved or new transit services are needed most by underserved populations to access education, health care, and job centers. The existing conditions analysis provides insight to formulate goals and strategies to improve transit access and to generate indirect benefits.

Program-level benefits for an overall program of public transportation investments can be built up from representative project or service-level assessments using local data and/or information from studies of services in similar contexts (spatial, socioeconomic, etc.) elsewhere. For example, an estimate of dollars saved per rider served can be applied to an estimate of the number of riders served across the entire program. The key to achieving reasonable program-level estimates is to consider how benefits may vary across different types of services in the program. For example, services focused specifically on jobs access may provide greater indirect economic benefits per rider than services that primarily support "choice" commuters who have other alternatives available (although these services may provide other types of economic benefits such as travel time savings and business productivity).

Other factors can lead to variation in benefits within a program of services. For example, the first investments in a region are likely to be the most productive, serving the populations and areas of greatest need. As more investment is made, returns will diminish as less productive services are introduced. On the other hand, there may be synergies achieved through linking complementary services—for example, providing access to a much broader job market than would otherwise exist. Accounting for service synergies and/or diminishing returns should provide a more accurate estimate of benefits than simply assuming that each incremental dollar of investment will yield the same benefit.

Data collection should focus on establishing existing conditions in the following key areas: transit performance, economic conditions, and demographic characteristics. Potential metrics for establishing baseline conditions may include

- **Transit data**—ridership, origin-destination patterns, number of trips (peak and off-peak), farebox revenue, and farebox recovery;

- **Economic data**—jobs, income, employment status, employment centers, and participation in social assistance programs; and
- **Demographic data**—population by age group, household income, households without vehicles, families below the poverty line, and educational attainment.

The data collected will enable agencies to evaluate baseline conditions for service areas. Supply (existing service provision) can be compared with potential demand (based on economic and demographic data) to identify areas (neighborhoods, job centers) or travel markets (origin-destination pairs) that may be underserved.

Once the baseline conditions are established, trends and needs analysis can be performed and used to assess needs for specific projects or services as well as overall funding needs. Data sources with small geographic building blocks, such as the census, can be used along with geographic information systems (GIS) analysis to target areas for new or improved services. Each agency can apply or develop its own performance metrics and goals for this sketch-level needs planning process. Public input also plays an important role in providing qualitative information that may not be evident from the data analysis.

The following literature are good resources and guides for establishing baseline conditions and needs assessment:

- Pratt Center for Community Development. *Mobility and Equity for New York's Transit-Starved Neighborhoods: The Case for Full-Featured Bus Rapid Transit*, 2013 (*23*).
- Grant, R., et al. *The Health Transportation Shortage Index: The Development and Validation of a New Tool to Identify Underserved Communities*. A Monograph from Children's Health Fund, 2012, New York: Children's Health Fund (*24*).

Project Development

Once project development is underway, assessment of indirect benefits can help influence route selection or the allocation of transit services. For example, if one of the goals of the transit investment is to improve mobility for underserved populations, a comparison of the expected indirect benefits, in addition to other analyses, can be used to determine where the investment will have the most impact by improving access to jobs, health care, or education. This can also be important in determining the transit frequency or level of service. In addition, these impacts can be compared among different fixed-route, JARC, or demand-response services to determine the most effective or cost-effective type of service.

Geographic, demographic, and economic characteristics along with public outreach can help select priority transit projects or refine potential alignments and service plans. The transit service goals for indirect benefits should coincide with results of the public outreach. The ranking and analysis of indirect benefits at the project level should be viewed as supplementary to the planning and benefit/cost analyses. Project development and planning may include the following elements:

- **Review existing conditions:**
  - ***Economic and demographic conditions***—jobs, participation in social assistance, population, household income; and
  - ***Transit constraints***—availability of transit, households without vehicles, and commuting patterns for low income.
- **Develop indirect service performance goals**, such as:
  - ***Economic goals***—reduce poverty and reduce unemployment; and
  - ***Transit goals***—improve mobility for households without vehicles.
- **Evaluate and rank:**
  - ***Prioritize***—score projects or alternatives using service performance metrics through public outreach, surveys, and data analysis.

Information on indirect benefits can help qualify the potential performance of the alternatives and assess how the project will meet the indirect service goals. Proxy measures, such as low-income or transit-dependent populations served, may assist even if indirect benefits cannot be quantified. These metrics can help planners determine which alternative will be the most effective at generating indirect benefits, in addition to other evaluation processes like a traditional benefit/cost analysis. The following literature is a good resource for transit project development:

- Manaugh, K. and A. M. El-Geneidy. "Who Benefits from New Transportation Infrastructure? Using Accessibility Measure to Evaluate Social Equity in Transit Provision." In *Accessibility and Transport Planning: Challenges for Europe and North America.* Edward Elgar, London, UK, 2011 (*12*).

Monitoring and Performance Evaluation

Following project development, performance monitoring can measure the effectiveness of the service and can provide insight into service changes to maintain long-term indirect benefits to users. For each project, the transit service goals and the performance metrics to measure the indirect benefits should be established. These indirect benefit performance metrics are evaluated independently of direct transit benefits like time savings, safety, and vehicle emissions. Monitoring requires periodic review of the transit service using published time series transit, economic, and demographic data along with surveys to establish use characteristics such as trip purpose. Trip purpose is important in determining which indirect benefits exist and the magnitude of those benefits.

For this level of detail, planners must design an on-board survey to capture trip and ridership characteristics. For adequate data collection, the on-board ridership surveys should be distributed periodically to capture the effects of time and changes in service. To generate large enough survey responses, agencies will have to carefully plan out the duration between survey distribution and ways to increase survey participation—for example, marketing and online versions of the survey. Surveys should focus on

- Origin and destination;
- Trip purpose (work, school, business travel, health care, other);
- Trip frequency;
- What riders would do in absence of transit (walk, car, or not take trip);
- Perceptions of quality (travel time, reliability, etc.) which may influence long-term use; and
- Use of government services before and after implementation of the transit service.

The following literature is a good resource for a transportation study utilizing ridership surveys:

- Thakuriah, P., J. Persky, S. Soot, and P. S. Sriraj. "Costs and Benefits of Employment Transportation for Low-Wage Workers: An Assessment of Job Access Public Transportation Services." *Evaluation and Program Planning*, Vol. 37, 2013; pp. 31–42 (*19*).

The metrics for evaluating the effectiveness of transit at providing indirect benefits are similar for fixed-route and demand-response travel. Examples of such metrics are shown in Table 2. These metrics can be compared against the cost of service and cost per trip to evaluate the cost-effectiveness of services.

Analysis Constraints

There are a number of constraints that may limit the ability of transit authorities or DOTs to perform the required analysis for the three major components of this framework. Administrative constraints include staff availability, budgets, and training. Staff must be able to produce surveys, distribute, process responses, analyze results, collect local data, and perform statistical analysis. The survey and data collection should track progress over time and space. Technical constraints are associated with survey response, with data availability, and, to some degree, with how applicable results are in one region to others.

Table 2 Potential goals and metrics for reducing social costs with transit.

Goal Area	Transit Goals	Potential Metrics
Jobs and unemployment	Increase access to jobs and reduce unemployment	Increased trips to work Reduced missed days at work Labor force participation Unemployment rate Average wages of residents Household income
Education	Increase access to education centers and enrollment	Increased trips to education centers Graduation rates Dropout rates
Health care	Improve access to and utilization of health care	Increased trips to health care facilities Missed health care appointments Emergency rooms visits for existing conditions

Suggested Data Sources

The suggested data sources below were compiled from the literature review and other sources. Data are typically constrained by one or more of the following:

- **Geographic size**—socioeconomic datasets often only exist at the county level,
- **Publication lags**—data are often published annually and tend to lag a year or two depending upon the series, and
- **Data availability**—certain datasets are private or must be purchased.

The literature acknowledged these constraints, but demonstrated that in many cases statistical, trend, and spatial analyses were possible with the available data. Table 3 provides data sources, a description of the data, and the potential uses for agencies planning to analyze a portion or all three parts of this framework.

APPROACH TO ESTIMATING INDIRECT BENEFITS

This section outlines an analysis approach to estimate the indirect cost savings of a transit project, service, or program investment, should an agency decide to support further tool development. The approach described below could apply to program development/resource allocation (using sketch-level data at a program level) as well as to project development (using more detailed, project-specific data) and to evaluation of implemented services.

Figure 2 diagrams an approach to estimating indirect benefits, identifying data that should be collected locally as well as parameters that may be taken from national studies. Some of the local data may be available from ridership forecasts or counts. The remaining data gaps can be filled preferably with surveys conducted on local populations or, alternatively, with data collected from similar services in other areas. Data requirements from ridership forecasts, surveys, and/or published sources include

- Estimated number of new riders using transit service for starting year and future year;
- Percent of new riders that participate in social assistance programs;
- Trip purpose for new riders—work, health care, education, and other;
- Number or percent of new riders that would not have made trips without new or expanded transit service for work, healthcare, or education; and
- Number of riders that will reduce use of other social benefits due to improved transit access to job and health centers.

Typically, a ridership forecast study will provide estimated ridership for the base year and future year for the no-build and build scenarios. For estimating the indirect benefits, we are mostly concerned with the number of new and existing riders in the build scenario for whom access is improved and who use some form of social assistance. Since the build scenario is already established, the forecast may require only importing or minor formatting (e.g., from daily to annual riders or interpolation for interim years). To account for potential ridership growth over time, the analysis period may need to extend 10 to 20 years into the future.

Ridership forecasts will not provide direct information about how many riders are using social assistance (although they may include the income of riders which could be used to infer social assistance usage). This information, as well as estimates of how many riders would not have made the trips to work or for health care appointments, may be obtained from survey data. Prior to operating the service, of course, the population who will use the service cannot be directly observed. Instead, survey data may come from populations using similar services in the same area, from similar services operating in other areas, or from stated-preference surveys of the target population for the service. Once this subset of riders is established, the average social program cost savings per person from the literature can be applied by trip purpose.

If the analysis is conducted at a program level, estimates of ridership, existing social service use, new access to jobs and health care, and reductions in social service use may be developed at the program level. These estimates can be built up from studies of specific services or may be developed more generally from program-level data. The program-level estimates are not likely to be as accurate as project-level estimates, but may still assist in planning. Evaluations of implemented services can help to build a base of data over time to improve program-level estimates for future investments.

Costs savings values from the literature include $1.55 for job-related trips and $5.66 for medical trips from the transit benefits analysis for WisDOT (HLB Decision Economics, 2003), or social benefits of $1.46 per trip from the analysis for MDOT (HDR

Table 3 Supplementary list of available data sources for conceptual framework.

Data Sources	Series Name	Data Type	Use	Geographic Detail
U.S. Census Bureau	American Community Survey (ACS)	Demographic, economic, social, housing, commuting, and income.	Comparison and ranking. Determining transit needs.	County, City/Town, ZIP code, Census tract
	Longitudinal Employer Household Dynamics (LEHD)	Geographic data on job flows, unemployment insurance, earnings, industry, and different demographic groups. Estimates data on workers' residential patterns.	Locating spatial mismatches. Understanding demographic and geographic needs.	County, City/Town, ZIP code, Census block and tract
Federal Transit Authority (FTA)	National Transit Database (NTD)	Transit reporting.	Local funding, service, and performance.	Transit agency
	Job Access and Reverse Commute (JARC)	Historical. Program consolidated under MAP-21.	Determining level of service and transit needs.	Transit agency
Bureau of Labor Statistics	Quarterly Census of Employment and Wages (QCEW)	Employment and wage data by industry.	Comparison and ranking. Industry growth and mix.	County
	Local Area Unemployment Statistics (LAUS)	Unemployment data.	Jobs, labor force, and unemployment rate.	County
	Occupational Employment Statistics (OES)	Occupational employment.	Industry and skills analysis.	County
U.S. Department of Health and Human Services	Health Professional Shortage Areas (HPSA)	County-level designations for health care professional-to-population ratio.	Comparison and determining health care/ transit level of service.	County
American Public Transportation Association (APTA)	Public Transportation Factbook and Statistical reports	Transit reporting.	Establishing baseline transit performance. Comparing services.	Transit agency
Local Geographic Information Systems (GIS)	Varies	Land use and geographic allocation.	Geographic analysis of social and economic characteristics. Identifying housing and transportation gaps.	Subcounty

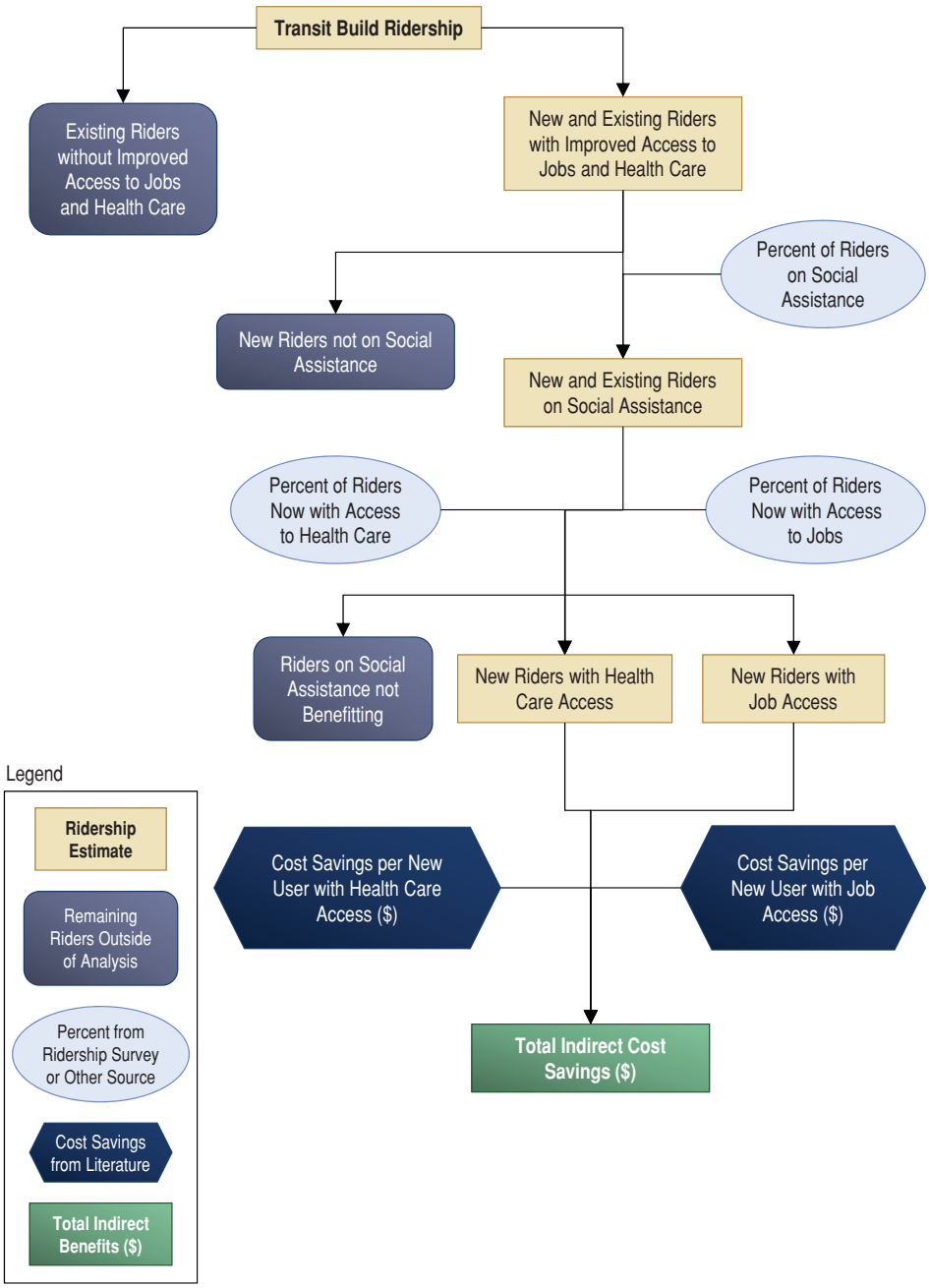

Figure 2 Flow diagram of indirect benefit calculations from ridership data.

Decision Economics, 2010). These savings parameters can be replaced with local or regional per unit estimates of cost savings, if available.

Although this analysis approach uses some of the same data as other transportation economic analysis methods, the indirect benefits analysis must be considered as a set of additional metrics rather than being additive to other economic benefits for reasons discussed above. It should also be treated as a sketch-level analysis rather than a definitive public savings. Other factors that may influence the results include

- Limitations of the available surveys and ridership forecasts,
- Shifts in the labor market or public assistance,
- Spatial mismatches between job centers (demand) and the labor skills available, and
- Health care services available locally.

All of these factors will shift and influence the actual indirect cost savings and, therefore, these results should be considered static. For more dynamic results, a project's indirect benefits should be reviewed and recalculated once revised forecasts or surveys become available. Lastly, if these results are going to be compared against other projects or against project costs, the tool should be capable of discounting the total benefits back to present value terms.[5]

SECTION 5 CONCLUSIONS

The literature review and research found transit investments provide indirect benefits and program cost savings. The methods for analyzing the indirect benefits have areas of overlap with traditional forms of economic analysis of transportation and must be presented clearly to avoid misrepresenting the magnitude of benefits or double-counting. The conceptual framework outlined in this report demonstrates three ways in which indirect benefits can be used in transit analysis: resource allocation, project development, and monitoring conditions. State DOTs and transit agencies can implement these methods and performance metrics to further make the case for future transit investments that may have additional benefits beyond traditional transit benefits.

The project development aspect of the proposed indirect benefits analysis can be integrated into the an existing tool, like MDOT's, or these methods could be integrated into a new more generalized tool offering more geographic flexibility. In the absence of a revised tool, the suggested framework will allow agencies to develop inventories of existing conditions through the resource allocation process, analyze individual projects and alternatives through project development, or monitor long-term indirect benefits in custom or one-off spreadsheet models.

[5]For discounting information, see OMB, Circular No. A-94 Revised, www.whitehouse.gov/omb/circulars_a094/.

APPENDIX: ANNOTATED BIBLIOGRAPHY

1. Influence of Transit Accessibility to Jobs on the Employability of the Welfare Recipients: The Case of Broward County, Florida

- Alam, B. M. *Influence of Transit Accessibility to Jobs on the Employability of the Welfare Recipients: The Case of Broward County, Florida.* Electronic Theses, Treatises, and Dissertations. Florida State University, 2005. diginole.lib.fsu.edu.libproxy.lib.unc.edu/etd/45/; accessed July 8, 2013.

Objective: This study assessed the impact of transit accessibility to jobs on the length of stay in the TANF program. Length of stay in the program was used as a surrogate for employability.

Methodology: An ordinary least squares (OLS) regression used individual-level data to examine the impact of transit accessibility. Transit data was obtained from Broward County 2000 Transportation Model Dataset. Individual welfare recipient data was obtained from the Florida Department of Children and Families (FDCF). Accessibility index was calculated using inputs, including total travel time between traffic analysis zone (TAZ) centroids, jobs, job density, population, population density, and proportion of TAZ located within one-quarter mile of transit.

Key Findings: Approximately half of all welfare recipients in Broward County live in a TAZ where 80% to 100% of the area is within one-quarter mile of transit. The accessibility index ranged from 0 to over 8,500, with a mean of just over 3,000. This study found that an increase in transit accessibility to jobs would lead to a decrease in the number of months on welfare. More specifically, for every 1,000 index increase in transit accessibility to jobs, the average length of time a welfare recipient stays in the TANF program decreases by 0.129 months.

Relevant Relationships:

	Transit → Access	Land Use → Access
X	Access → Unemployment, Wages	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education	Access → Health Care Utilization
	Schools/Education → Unemployment, Wages	Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

2. Access to Transportation and Health Care Utilization in a Rural Region

- Arcury, T. A., et al. "Access to Transportation and Health Care Utilization in a Rural Region." *The Journal of Rural Health*, Vol. 21, 2005; pp. 31–38.

Objective: This study analyzes the relationship between transportation and health care utilization in rural North Carolina.

Methodology: The data used was from a survey (n = 1,059) of residents of 12 rural counties in North Carolina in 1999 by the Research Triangle Institute. Log-linear and multivariate regressions assessed the relationship between health care utilization and numerous variables.

Key Findings: Survey respondents who had a driver's license visited health care centers for chronic conditions 2.29 times more often than those who did not have a license. They also had 1.92 times more regular checkup visits than those who did not. While the number of respondents who used public transportation to access health care facilities was small, they averaged four more chronic health care visits per year than those who did not use public transit.

Relevant Relationships:

	Transit → Access		Land Use → Access
	Access → Unemployment, Wages		Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education	**X**	Access → Health Care Utilization
	Schools/Education → Unemployment, Wages		Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

3. Economic Benefits of Coordinating Human Service Transportation and Transit Services

- Burkhardt, J. E., D. Koffman, G. Murray. *TCRP Report 91: Economic Benefits of Coordinating Human Service Transportation and Transit Services.* Transportation Research Board of the National Academies, Washington, DC, 2003.

Objective: This report examined the economic benefits, as well as additional benefits, that are associated public transit and coordinating services.

Methodology: Innovative and promising strategies were identified through interviews, published reports, and site visits. Of the 28 case studies chosen, 3 are of interest to this report: Clarksdale, Michigan; Portland, Oregon; and Miami-Dade County, Florida.

Key Findings: Through the JOBLINKS–funded portion of Mississippi's Delta Area Rural Transportation System (DARTS) program alone, it was estimated that the program helped 283 persons find employment. It was assumed that 90% of these clients would be unemployed in the absence of DARTS, also assuming 75% of whom would be taking welfare payments. The DARTS program saves over an estimated $1 million per year in social service benefits. This amounts to $5.89 of benefits in reduced welfare spending per dollar spent. Portland implemented the Medical Transportation Program (MTP), which worked to shift Medicaid non-emergency trips from the agency's three-county service area to transit. Using Tri-Met's operating data and pre-MTP data on the percentage of rides by mode (16.4 percentage point increase in bus passes and 10.4 percentage point decrease in taxis), the total savings from MTP was estimated at more than $1.4 million in 2000–2001. Miami-Dade Transit used a similar approach issuing bus passes to shift Medicaid clients from paratransit trips to fixed-route trips. Metropass program users (n = 4,943) were making at minimum 12 paratransit trips per month at a cost of $16 per trip. Monthly Metropasses cost an average of $31.44 per pass plus $7.20 administration fee, saving the Medicaid program over $9 million per year.

Relevant Relationships:

X	Transit → Access		Land Use → Access
X	Access → Unemployment, Wages	**X**	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education	**X**	Access → Health Care Utilization
	Schools/Education → Unemployment, Wages	**X**	Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

4. Estimating the Return to Schooling: Progress on Some Persistent Econometric Problems

- Card, D. "Estimating the Return to Schooling: Progress on Some Persistent Econometric Problems." *Econometrica*, Vol. 69, No. 5, 2001; pp. 1127–1160.

Objective: This study reviewed previous papers that examined the effect of education on earnings while comparing ordinary least squares and instrumental variable (IV) methods.

Methodology: Eleven studies were chosen through a selective review process. These studies used data from developed and developing countries. Each included different characteristics in the analysis such as family background, ability, and race.

Key Findings: The schooling coefficients for all studies included in this paper were positive, meaning an increase in schooling lead to an increase in earnings, or return. The magnitude of the coefficient varied depending on the additional variables included and the estimation method used (OLS or IV). Coefficients range from 0.028 to 0.518 for OLS models, while the range for IV models was 0.036 to 0.947.

Relevant Relationships:

	Transit → Access	Land Use → Access
	Access → Unemployment, Wages	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education	Access → Health Care Utilization
X	Schools/Education → Unemployment, Wages	Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

5. Hard Times, College Majors, Unemployment, and Earnings

- Carnevale, A. P., R. Cheah, J. Strohl. *Hard Times, College Majors, Unemployment, and Earnings.* Georgetown University Center for Education and the Workforce. Washington, DC, 2012.

Objective: This study examines the unemployment rates and median yearly earnings of different education levels in the United States.

Methodology: Data was collected from the 2009 and 2010 American Community Survey. These years were pooled to provide a greater sample size.

Key Findings: Unemployment for persons with a Bachelor's degree is 5%, while unemployment for students with new Bachelor's degrees (22 to 26 years of age) is higher at 8.9%. For persons with only a high school diploma, the unemployment jumps at 22.9%. Unemployment is highest for high school dropouts at 31.5%. The unemployment rate for those with a graduate degree is the lowest at 3%. The average earnings for a Bachelor's degree holder are about $48,000, while the average earnings for a graduate degree holder are $62,000.

Relevant Relationships:

	Transit → Access	Land Use → Access
	Access → Unemployment, Wages	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education	Access → Health Care Utilization
X	Schools/Education → Unemployment, Wages	Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

6. Fixed-Route and Demand Response Bus Systems: Financing Methods, Benefits, and Costs in Indiana

- Center for Business and Economic Research. *Fixed-Route and Demand Response Bus Systems: Financing. Methods, Benefits, and Costs in Indiana.* Prepared for Indiana Transportation Association. Ball State University, January 2013.

Objective: This study examines policy considerations related to the financing of transit and estimates the costs and benefits of fixed-route bus transit in Indiana.

Methodology: Benefits are grouped into four categories: public costs deferred or reduced due to transit; private costs reduced due to transit; private-sector benefit of the system; and federal, state, and local tax revenues linked to transit. Data sources include Indiana ridership surveys, National Transit Database, and state statistics.

Key Findings: The total annual cost of the bus system in Indiana is estimated at $145.3 million. The total annual public cost deferred due to the presence of the fixed-route bus system is estimated to be over $16.3 million. This includes additional bus service for school students, additional demand-response service, and an increase in food stamps. The income benefit to workers without vehicles was estimated to be between $137 and $224 million (assuming the workers would not be able to get to work; social service costs are not included). The income benefits to workers with vehicles (assuming that 20% stop working without transit) were estimated to be between $59 and $84 million. The study also concluded that each $1 of expenditure on public transit is associated with $1.27 of public benefits and $3 of total benefits (including all benefits, not just avoided government services).

Relevant Relationships:

	Transit → Access		Land Use → Access
X	Access → Unemployment, Wages	**X**	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education		Access → Health Care Utilization
	Schools/Education → Unemployment, Wages		Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

7. How Light-Rail Transit Improves Job Access for Low-Wage Workers

- Center for Transportation Studies. *How Light-Rail Transit Improves Job Access for Low-Wage Workers, A Transitway Impacts Research Program (TIRP) Research Brief.* University of Minnesota. 2010. www.cts.umn.edu/Publications/ResearchReports/pdfdownload.pl?id=1336. Accessed June 28, 2013.

Objective: The aim of this study was to discover whether Twin Cities transitways effectively connect low-wage workers with low-wage job opportunities. The study focuses on the Hiawatha light-rail line in Minneapolis, Minnesota, completed in 2004.

Methodology: Using data from the Longitudinal Employer-Household Dynamics (LEHD) database, U.S. Census Bureau, and Metro Transit, researchers located areas where high concentrations of transit-dependent individuals lived and determined their transit access to low-wage jobs before and after the light rail was built. Access was defined as 30 minutes of transit travel, with a maximum of one transfer and one-quarter-mile walking distance. Analysis was performed at the block group level.

Key Findings: The number of jobs accessible by transit significantly increased as a result of the light rail, including during off-peak hours. The number of transit accessible low-wage jobs increased by 14,000 in the morning peak hours in the light-rail station areas, while an additional 4,000 jobs are accessible in areas with direct light rail-bus connections. Due to the access provide by the new light-rail line, an estimated 907 low-wage workers have relocated closer to the station areas. It is also estimated that these upgrades brought more than 5,000 low-wage jobs closer to the stations.

Relevant Relationships:

X	Transit → Access	Land Use → Access
	Access → Unemployment, Wages	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education	Access → Health Care Utilization
	Schools/Education → Unemployment, Wages	Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

8. Transportation as a Stimulus of Welfare-to-Work: Private versus Public Mobility

- Cervero, R., O Sandoval, J. Landis. "Transportation as a Stimulus of Welfare-to-Work: Private versus Public Mobility." *Journal of Planning Education and Research*, Vol. 20, 2002; pp. 50–63.

Objective: This study seeks to examine the effect transportation has in helping AFDC recipients gain employment, as well the type of transportation that provides the best opportunity for employment.

Methodology: Multinomial logit estimation was used to assess the impact of variables such as job accessibility and bus service intensity on change in welfare status. Survey data from 1992–1993 and 1994–1995 on welfare recipient characteristics were obtained from Alameda County as part of the California Work Pays Demonstration Project (CWPDP). Geographic information systems (GIS) techniques were used to geocode addresses and perform analyses. It should be noted that the random sample survey consisted of only 466 (1% of total AFDC recipients) households. Of those, only 66 found employment.

Key Findings: While controlling for car ownership, being within walking distance (one-quarter mile) of a bus stop or transit station significantly increased the odds of securing employment. However, the model shows that the odds ratio of getting a job and leaving AFDC to not getting a job increased thirteen-fold when an individual obtained a car. Likewise, losing ownership of a car lowered an individual's odds of finding employment. Transit service intensity was also a positive, significant variable, but only in obtained employment—not in leaving AFDC.

Relevant Relationships:

	Transit → Access	Land Use → Access
X	Access → Unemployment, Wages	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education	Access → Health Care Utilization
	Schools/Education → Unemployment, Wages	Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

9. An Assessment of "Last Mile" Shuttles in New Jersey

- Deka, D. *An Assessment of "Last Mile" Shuttles in New Jersey.* Alan M. Voorhees Transportation Center, Rutgers, New Jersey, 2012. policy.rutgers.edu.?libproxy.lib.unc.edu/vtc/reports/REPORTS/LastMileShuttleFinalReport4-04-12.pdf. Accessed July 16, 2013.

Objective: This study assessed the 34 "Last Mile" shuttles in New Jersey, shuttles that are meant to carry passengers from transit stations to their final destination. These shuttles are funded by the JARC program.

Methodology: GIS was used, along with shuttle route information and data collected from the LEHD database and the American Community Survey (ACS). In addition to GIS techniques, an on-board survey of shuttle passengers was conducted ($n = 311$) on 18 different shuttle routes.

Key Findings: Approximately 82% of shuttle trips were taken for work purposes (17% work as origin, 66% work as destination). Of all shuttle trips, 13% would not be taken if the service did not exist. For work-related trips, 11% would not be taken.

Relevant Relationships:

X	Transit → Access	Land Use → Access
	Access → Unemployment, Wages	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education	Access → Health Care Utilization
	Schools/Education → Unemployment, Wages	Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

10. Economic and Community Benefits of Local Bus Transit Service

- HDR Decision Economics. *Economic and Community Benefits of Local Bus Transit Service. Case Study: Statewide Analysis.* Silver Spring, Maryland. Prepared for Michigan DOT, 2010.

Objective: This case study demonstrates how the economic model developed by HDR Decision Economics (HDR) can be used to estimate economic and social benefits of public transit, using data from local bus transit service in Michigan.

Methodology: The transit benefit model created by HDR is a Microsoft Excel workbook. The model was used to calculate the difference between transportation costs in the presence of transit and in the absence of transit. Inputs to the model include data from on-board passenger surveys from seven representative transit agencies across Michigan, as well as transit data at the agency level collected from the Public Transportation Management System (PTMS). Passenger surveys were collected in November 2009. The IMPLAN model was also used to calculate the benefits of transit to the Michigan economy.

Key Findings: Survey results estimate over 65% of transit trips in Michigan are for work, medical/dental, or educational purposes (34%, 8%, and 26%, respectively). If public transportation was not available, one-quarter of transit users stated they would not be able to work, seek medical assistance, or attend school/college. Without access to public transportation, the economic value of forgone work or medical trips is estimated at $67.6 million in 2008. The model also estimated cross-sector benefits of $56.6 million in regards to homecare cost savings and welfare cost savings attributable to public transit. These alone generated $1.24 of social benefits per trip. In terms of access to education, it was estimated that over 16,000 students would not be able to attend school or college in the absence of public transit. As a result of the multiplier effect, it is estimated that the presence of public transit sustained more than 9,200 jobs in 2008.

Relevant Relationships:

X	Transit → Access		Land Use → Access
X	Access → Unemployment, Wages	**X**	Unemployment, Wages → Demand and Costs for Social Services
X	Access → Schools/Education	**X**	Access → Health Care Utilization
	Schools/Education → Unemployment, Wages	**X**	Health Care Utilization → Health Care Costs

Model/Analysis Tool: Yes. The HDR model inputs include ridership by trip purpose, percent of trips diverted to other modes or forgone in absence of service, and relevant transit data such as fare revenue and total expenses. Outputs include out-of-pocket cost savings (IMPLAN model input) and impacts, affordable mobility benefits, cross-sector benefits, and impacts of transit operations in dollars per year.

11. The Socioeconomic Benefits of Transit in Wisconsin

- HLB Decision Economics Inc. *The Socioeconomic Benefits of Transit in Wisconsin.* Silver Spring, Maryland. Prepared for Wisconsin DOT, 2003.

Objective: This study examines the socioeconomic benefits of public transit in Wisconsin to develop a better understanding of the benefits for the employment, health care, educational, and retail sectors.

Methodology: HLB Decision Economics, now HDR, created a model to calculate the cross-sector and affordable mobility benefits of public transit. An on-board user survey was conducted to collect data from transit users. Supplemental data were obtained from both state and national sources. An IMPLAN model was used to calculate the direct, indirect, and induced economic benefits from out of pocket savings.

Key Findings: From the user surveys collected, 48% of transit trips were for work purposes, while 23% and 11% were for educational and medical purposes, respectively. When individuals using transit for work, education or medical purposes were asked what their choice of transportation would be in the absence of transit, 19%, 13%, and 24%, respectively, replied they would forgo the trip. Of the 1.39 million forgone health care trips, about 552,000 would result in home health care visits. The presence of transit was estimated to save $59 million in home health care costs, portions of which to be paid by individuals themselves, or by the public through increased insurance premiums or government subsidy. This averages to about $5.66 saved per health care-related trip. In terms of employment, it was estimated that the absence of transit would cause a 12% increase in the public assistance case load, or 13,800 cases. This relates to over $74 million saved in public assistance, or $1.55 per work-related trip. It was also estimated that 2.8 million educational trips would not have occurred in the absence of transit, a benefit of $4.03 per trip.

Relevant Relationships:

X	Transit → Access		Land Use → Access
X	Access → Unemployment, Wages	**X**	Unemployment, Wages → Demand and Costs for Social Services
X	Access → Schools/Education	**X**	Access → Health Care Utilization
	Schools/Education → Unemployment, Wages	**X**	Health Care Utilization → Health Care Costs

Model/Analysis Tool: Yes. Inputs include trips by purpose, percent of trips forgone in absence of transit, general cost of each mode, and incremental cost of home health care or public assistance case. Outputs include out of pocket savings and cross-sector benefits due to transit. Key assumptions include ridership estimates and the percent of forgone trips leading to home health care visits or unemployment.

12. Who Benefits from New Transportation Infrastructure? Using Accessibility Measure to Evaluate Social Equity in Transit Provision

- Manaugh, K. and A. M. El-Geneidy. "Who Benefits from New Transportation Infrastructure? Using Accessibility Measure to Evaluate Social Equity in Transit Provision." *For Accessibility and Transport Planning: Challenges for Europe and North America.* Edward Elgar, London, UK, 2011.

Objective: This study explores the potential impacts of proposed transit projects in Montreal, Canada, on access to total jobs and low-skilled jobs for the most socially disadvantaged areas.

Methodology: Accessibility was defined as the number of jobs reached on transit within 30 minutes of in-vehicle time. This was measured for both current and proposed conditions. GIS and travel-demand modeling software, provided by the Québec Ministère des Transports (MTQ), were used. Socially disadvantaged areas were determined by the top decile of areas on the socially disadvantaged index. This index contained five variables: median household income, percentage of foreign-born residents, percentage of adults with only high school degrees, percent of residents who commute by transit, and access to low-skilled jobs.

Key Findings: Proposed transit expansions would overall increase access to jobs by 15%, ranging from 3% to 160% in different neighborhoods. In regards to low-skilled jobs, access is increased overall by 9%, ranging from 2% to 50%. The Montreal-North and Saint-Michel neighborhoods increased transit access the most, as did the commuter rail and bus rapid transit systems. There was a reduction in travel time from neighborhoods to jobs centers ranging from 0% to 32%.

Relevant Relationships:

X	Transit → Access	Land Use → Access
	Access → Unemployment, Wages	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education	Access → Health Care Utilization
	Schools/Education → Unemployment, Wages	Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

13. Welfare to Work: Integration and Coordination of Transportation and Social Services

- Multisystems, et al. *TCRP Web Document 16: Welfare to Work: Integration and Coordination of Transportation and Social Services*, Transportation Research Board, National Research Council, Washington, DC, June 2000. onlinepubs.trb.org/onlinepubs/tcrp/tcrp_webdoc_16-a.pdf. Accessed on June 28, 2013.

Objective: The object of this study was to examine the role of transportation in aiding welfare to work initiatives. This included identifying innovative transportation plans and programs that assisted in the transition from welfare to work and evaluating such programs where possible.

Methodology: A literature review, focus groups, and case studies were all used by researchers to obtain the objective. A benefit/cost analysis was performed for select case studies where data were available. This analysis involved estimating the number of persons using the transportation assistance program, the annual value of that benefit per person, multiplying these two numbers, then comparing the result with an estimated total cost of the program.

Key Findings: Of the 11 case studies presented in this report, 4 were chosen for benefit/cost analysis, 3 of which included public transportation: Pinellas County WAGES Transportation program in Clearwater, Florida; AdVANtage II (Sojourner-Douglass College) in Baltimore, Maryland; and the Nia Night Owl of the Transit Authority of River City in Louisville, Kentucky. The Pinellas County WAGES program is estimated to transport an average of 359 clients monthly to employment. Program benefits are estimated to exceed costs by a benefit/cost ration (BCR) of 2.87. The AdVANtage II program is estimated to have helped 86 persons access jobs, with other 12 gaining employment directly through the program who would otherwise not have jobs. The BCR for this program is estimated to be 2.52. The Nia Night Owl service gives employment access to approximately 31 persons nightly. The BCR of this service is 1.01, meaning the benefits approximately equal the costs. For all analyses, researchers conservatively estimate $6,000 per year per client in reduced benefits from public support.

Relevant Relationships:

X	Transit → Access		Land Use → Access
X	Access → Unemployment, Wages	**X**	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education		Access → Health Care Utilization
	Schools/Education → Unemployment, Wages		Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

14. The Impact of Education on Unemployment Incidence and Re-employment Success: Evidence from the U.S. Labour Market

- Riddell, W. C., X. Song. "The Impact of Education on Unemployment Incidence and Re-employment Success: Evidence from the U.S. Labour Market." *Labour Economics*, Vol. 18, 2011; pp. 453–463.

Objective: This study examined the effects of education on the probability an individual will be jobless. It also examines how education effects the probability of being re-employed after a period of unemployment.

Methodology: An ordinary least squares method was used to examine the effects of education on re-employment, as well as an instrumental variable strategy. IV estimates were used as a comparison with OLS estimates. Longitudinal data from the 1980 to 2005 Current Population Survey (CPS), as well as the 1980 Census, was used for evaluation.

Key Findings: Controlling for other factors, the probability of re-employment with 9 years of schooling was 0.52, while the probability increased to around 0.70 with 18 years of schooling. The greatest increase in probability was from 11 to 13 years (graduating from high school) and 15 to 16 years (obtaining a Bachelor's degree). Conversely, the probability of job loss with 9 years of schooling was 0.06, while the probability with 16 to 18 years was 0.03.

Relevant Relationships:

	Transit → Access	Land Use → Access
	Access → Unemployment, Wages	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education	Access → Health Care Utilization
X	Schools/Education → Unemployment, Wages	Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

15. Education, Demand, and Unemployment in Metropolitan America

- Rothwell, J., A. Berube. *Education, Demand, and Unemployment in Metropolitan America.* Metropolitan Policy Program at Brookings, 2011. www.centralvalleybusinesstimes.com/links/0909_skills_unemployment_rothwell.pdf. Accessed July 3, 2013.

Objective: This report examines the gaps in education and industry demand in U.S. metropolitan areas and how they relate to unemployment rates.

Methodology: The education gap was calculated by dividing the years of education required for an average job by the education attained by the average working-age person. Education demand was calculated using the distribution of education for every occupation in the United States. This assumes that the education level of employees is the education level demanded by employers. Education supply was obtained from the American Community Survey.

Key Findings: Between 2005 and 2009, the years of education required by the average U.S. job rose by 0.17 years. In 2009, the average working-age adult had attained only 13.48 years of education. When accounting only for unemployed adults, the average education attained was 12.49 years. Metropolitan areas with larger education gaps had higher unemployment rates, about 1.4 percentage points, from 2005 to 2011 than did other areas. All metro areas studied had lower unemployment rates for workers with a Bachelor's degree than workers with a high school diploma or less.

Relevant Relationships:

	Transit → Access	Land Use → Access
	Access → Unemployment, Wages	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education	Access → Health Care Utilization
X	Schools/Education → Unemployment, Wages	Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

16. The Connection between Public Transit and Employment

- Sanchez, T. W. "The Connection between Public Transit and Employment." *Journal of the American Planning Association*, Vol. 65, No. 3, 1999; pp. 284–296.

Objective: This study analyzes the connection between the location of workers and the location of employment, as well as the role of accessible transportation connecting the two.

Methodology: Data used in the analysis were collected from the U.S. Census Bureau and analyzed in a GIS. A least squares regression was developed to determine a relationship between access to public transit and employment rates in Portland, Oregon, and Atlanta, Georgia.

Key Findings: Of the seven block group characteristics used as indicators of job access, five were significant in predicting employment participation in Portland, while six were significant for Atlanta. Significant variables in Portland include distance to nearest rail and bus stops, average commute time, transit service frequency at nearest stop, and vehicles owned per capita. Transit frequency was not significant in Atlanta, however relative access to service jobs and retail jobs by transit were. The strongest association (highest coefficient) for both cities was the number of vehicles owned per capita.

Relevant Relationships:

	Transit → Access	Land Use → Access
X	Access → Unemployment, Wages	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education	Access → Health Care Utilization
	Schools/Education → Unemployment, Wages	Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

17. Transit Mobility, Job Access, and Low-Income Labour Participation in U.S. Metropolitan Areas

- Sanchez, T. W., Q. Shen, Z. Peng. "Transit Mobility, Job Access, and Low-Income Labour Participation in U.S. Metropolitan Areas." *Urban Studies*, Vol. 41, No. 7, 2004; pp. 1313–1331.

Objective: The aim of this study was to determine whether access to public transit, and regional employment had effects on employment outcomes for TANF recipients in six different metropolitan areas.

Methodology: The six metropolitan areas in this study are Atlanta, Baltimore, Dallas, Denver, Milwaukee, and Portland. TANF recipients' addresses, demographic characteristics, and case status for all working-age persons, as well transit route and stop data, were obtained from each state by the appropriate government department or transit agency. An ordered multinomial logit (OML) model was used to estimate the probability that TANF cases found employment.

Key Findings: Multiple variables were considered in this analysis, including automobile ownership, access to transit, transit service frequency, and employment accessibility. Of these transit and employment variables, none were consistently statistically significant. Atlanta and Milwaukee showed significance for transit service frequency variable; however, it was a negative relationship. Atlanta also showed significance for employment accessibility; however, it was also a negative relationship—meaning that as evening service frequency and employment access increased, the probability of finding employment decreased. Researchers concluded that their results show that access to public transit and employment did not play a significant role in locating employment for TANF recipients for the six metro areas studied. Variables that were significant in the majority of models include children in the household, recipient age, number of adults in household, and years on assistance.

Relevant Relationships:

	Transit → Access	Land Use → Access
X	Access → Unemployment, Wages	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education	Access → Health Care Utilization
	Schools/Education → Unemployment, Wages	Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

18. Residential Location, Transportation, and Welfare-to-Work in the United States: A Case Study of Milwaukee

- Shen, Q., T. W. Sanchez. "Residential Location, Transportation, and Welfare-to-Work in the United States: A Case Study of Milwaukee." *Housing Policy Debate*, Vol. 16, Issue 2–4, 2005; pp. 393–431.

Objective: This study attempted to identify adjustments to residence and transportation that welfare recipients tend to make to obtain employment. It also analyzed whether these adjustments increase the probability of employment.

Methodology: A binary logit regression determined what variables were significant in employment for welfare recipients. Independent variables include sex, race, age, neighborhood demographics, transit characteristics, and job accessibility. Job accessibility was calculated separately for automobile and transit using the number of jobs available, number of job seekers living in the same neighborhood, and impedance functions for travel times. Changes in these variables between 1997 and 2000 were also considered to test welfare recipient relocation programs.

Key Findings: This study found that frequent public transit service had a positive effect on employment for welfare recipients. However, walking distance to the nearest stop was not significant. Having a vehicle in the household positively effected the probability of employment; however, when controlling for car ownership, job accessibility for car commuters had a negative effect on employment. Job accessibility for transit commuters was not found to be a significant variable. A second analysis was run for only those who were unemployed and on welfare in 1997. The most important variable to predict a change in employment status was job accessibility for transit commuters, suggesting transit is crucial for some welfare recipients to gain employment.

Relevant Relationships:

	Transit → Access	Land Use → Access
X	Access → Unemployment, Wages	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education	Access → Health Care Utilization
	Schools/Education → Unemployment, Wages	Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

19. Costs and Benefits of Employment Transportation for Low-Wage Workers: An Assessment of Job Access Public Transportation Services

- Thakuriah, P., J. Persky, S. Soot, P. S. Sriraj. "Costs and Benefits of Employment Transportation for Low-Wage Workers: An Assessment of Job Access Public Transportation Services." *Evaluation and Program Planning.* Vol. 37, 2013; pp. 31–42.

Objective: This study evaluates the costs and benefits of employment transportation (ET) services funded by JARC with regard to users of the service, non-users, and society as a whole.

Methodology: Users and program managers of 23 ET-funded services nationwide were surveyed on their transit use and cost and operations of the transit system, respectively. Secondary data was also collected from sources such as the 2002 CPS to complete a benefit/cost analysis for each group (users, non-users, society), broken down into subgroups.

Key Findings: Subgroup 3 users, or commuters who continue to work in the same area after using the service, are estimated to undergo an average increase in earnings of about $15,500 per year due to potential shifts to better paying jobs. This, coupled with potential changes travel time and out-of-pocket costs, amounts to a benefit/cost (B/C) ratio of about 1.9. Subgroup 1 users, or those who are newly employed after using transit, are estimated to have a B/C ratio of 2.5. However, when leisure time changes are captured, the B/C ratio drops dramatically to 0.6, mostly due to new transportation and child care costs. The estimated net benefits over a work life were also estimated by age cohorts. An ET user in the 20-year-old cohort has a net benefit of between $10,000 and $60,000 over their work life span when compared with a hypothetically identical person without access to the ET service. Non-users of the system also benefit. The average transfer payment diverted was estimated to be about $5,000. Transfer payments include welfare and unemployment benefits used alternatively.

Relevant Relationships:

	Transit → Access		Land Use → Access
X	Access → Unemployment, Wages	**X**	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education		Access → Health Care Utilization
	Schools/Education → Unemployment, Wages		Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

20. Economic Benefits of Employment Transportation Services

- Thakuriah, P., P. S. Sriraj, S. Soot, and J. Persky. *Economic Benefits of Employment Transportation Services.* University of Illinois at Chicago, Prepared for Federal Transit Administration and Community Transportation Association of America, 2008.

Objective: This report examines the benefits that accrue from employment transportation services implemented as a result of changes in welfare policy, namely the Personal Responsibility and Work Opportunity Reconciliation Act (PRWORA) of 1996.

Methodology: The study was based on surveys of users of JARC programs regarding travel behavior and work-related changes due to the use of these services. Users of services in 23 locations were surveyed in 2002. Studied programs were funded by the FTA, human service agencies, and other agencies.

Key Findings: Users report undergoing a variety of travel behavior and work-related changes as a result of using the services, which have an economic benefit to them. For every dollar of program cost, a return of $1.9 in net economic gains accrues to the user. The rate of return varies considerably by type of user, type of location where the service is operating, type of service, and how leisure time is valued. There is a return of about $1.5 to

non-users, due to changes in income taxes generated by the users, alternative use of taxpayer funds on welfare and other public assistance payments, as well as the external costs of nontransit modes of transportation that might have been previously used. Societal benefits range from $3.10 to $3.50 per dollar invested depending upon how leisure time is valued. The final societal benefits are estimated to be $1.65 per dollar when labor market impacts are factored in. Employment transportation programs are also likely to jumpstart a long-term wage growth trajectory, with every dollar spent potentially catalyzing about $15 in the future over the individual's work life.

Relevant Relationships:

X	Transit → Access		Land Use → Access
X	Access → Unemployment, Wages	**X**	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education		Access → Health Care Utilization
	Schools/Education → Unemployment, Wages		Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

21. Impact of Public Transit on Employment Status: Disaggregate Analysis of Houston, Texas

- Yi, C. "Impact of Public Transit on Employment Status: Disaggregate Analysis of Houston, Texas." *Transportation Research Record: Journal of the Transportation Research Board, No. 1986*, Transportation Research Board of the National Academies, Washington, DC, 2006; pp. 137–144.

Objective: This study examines the connection between good access to public transit, higher job accessibility by transit, and employment outcomes in Houston, Texas.

Methodology: This analysis used data from the 1995 Houston travel survey. Transit travel times between traffic analysis zones were obtained from the Houston-Galveston Area Council. Job accessibility was a function of employment opportunities in the destination TAZ and average transit travel time. A multinomial logit regression was used to attempt to explain employment status as a function of transit access, employment access, and car ownership, among other variables.

Key Findings: Job accessibility by transit for part-time workers is the variable with the greatest significant value, while job accessibility by transit for full-time workers is the second greatest. This means that increased accessibility by transit improves the chances of obtaining employment, particularly for part-time workers. Vehicles per household and having a license were also positive and significant variables, however it is unclear whether car ownership led to employment, or employment led to car ownership. The number of bus stations within walking distance (one-quarter mile) was also significant in increasing the probability of being employed both full-time and part-time.

Relevant Relationships:

	Transit → Access	Land Use → Access
X	Access → Unemployment, Wages	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education	Access → Health Care Utilization
	Schools/Education → Unemployment, Wages	Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

22. Florida Transportation Disadvantaged Programs: Return on Investment Study

- Cronin, J. J., J. Hagerich, J. Horton, J. Hotaling. *Florida Transportation Disadvantaged Programs: Return on Investment Study.* The Marketing Institute, Florida State University College of Business. 2008. Accessed September 9, 2013. tmi.cob.fsu.edu/roi_final_report_0308.pdf.

Objective: This study calculates the return generated by funds invested by the State of Florida on transportation disadvantaged programs.

Methodology: This analysis used five different trip categories, three of which (medical, employment, and educational) are relevant to this review. The economic benefits to the State were derived by either the economic activity generated by each trip or the costs that each type of trip enables the State to avoid. Data were collected from eight counties as a representative sample for the entire State. The cost of each program, as well as the number of trips for each purpose, was obtained from state records, as transportation providers are required to submit this information annually. Additional data were collected via literature review. This paper assumes that all of these trips would not occur if the demand-response service was unavailable.

Key Findings: This study estimates that, in terms of preventive medical trips, the payback to the State is $11.08 for each dollar invested due to preventive care resulting in avoidance of a hospital stay. The payback to the State for employment trips is estimated to be $5.71 for each dollar invested in the program. The payback to the State for educational and training trips is estimated to be $5.85 per each dollar invested in the program. The overall return on investment for all transportation disadvantaged programs, including nutrition and life-sustaining trips, is estimated to be $8.35 per dollar invested. The study stressed these values were very conservative. This is due to the use of the mean benefit produced in calculation, which produced a smaller benefit, as opposed to the weighted average. All costs are also assumed to be paid by the State of Florida. The researchers also claim to use conservative estimates, such as that 1% of medical trips prevents a 1-day hospital stay and 1 day trip to education or a training program results in 1 day of work.

These results of this study are optimistic given the rising cost of demand response transit, and the study lacked evidence of a sensitivity analysis. The ROI calculations were likely inflated as the full retail spending amounts were used instead of the retail margins, and the benefits included multiplier effects. Despite these analytic shortcomings, the study demonstrated that these links between transit and other public services exist.

Relevant Relationships:

X	Transit → Access	Land Use → Access
	Access → Unemployment, Wages	Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education	Access → Health Care Utilization
	Schools/Education → Unemployment, Wages	Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

23. Cost and Equity

- Pratt Center for Community Development. *Mobility and Equity for New York's Transit-Starved Neighborhoods: The Case for Full-Featured Bus Rapid Transit.* 2013.

Objective: Determine priority corridors for bus rapid transit (BRT) expansion using criteria to promote access and equity to the underserved New York City boroughs. Proposed service must address the change in commuting patterns for populations commuting from one borough to another with poor connections.

Methodology: Proposed new BRT corridors as they are cost-effective with reduced implementation time compared with other forms of transit. Corridors are prioritized based on potential benefits to underserved populations, potential for cartelizing development for low- and moderate-income areas, and physical feasibility of BRT. Priority projects were ranked into Primary and Secondary Tier corridors based on prioritization criteria.

Key Findings: The Study proposed eight Tier 1 and Tier 2 priority corridors for consideration. To advance BRT, the planning process must include stakeholders and must identify the benefits to businesses and residents. New BRT service can affect the land use, density, housing affordability, and economic development. Improvements can improve access to healthcare, employment, and schools for underserved populations. The planning process needs political and stakeholder support as alternatives are evaluated. The study acknowledges the cost of new service, transit authority debt, and other operational priorities. The study discusses a loose framework for planning and evaluating BRT service expansion for underserved populations.

Relevant Relationships:

X	Transit → Access	**X**	Land Use → Access
	Access → Unemployment, Wages		Unemployment, Wages → Demand and Costs for Social Services
	Access → Schools/Education		Access → Health Care Utilization
	Schools/Education → Unemployment, Wages		Health Care Utilization → Health Care Costs

Model/Analysis Tool: No.

24. The Health Transportation Shortage Index: The Development and Validation of a New Tool to Identify Underserved Communities

- Grant, R., D. Johnson, S. Borders, D. Gracy, T. Rostholder, and I. Redlener. *The Health Transportation Shortage Index: The Development and Validation of a New Tool to Identify Underserved Communities.* A Monograph from Children's Health Fund. 2012, New York: Children's Health Fund. issuu.com/childrenshealthfund/docs/chf_htsi-monograph__2_?e=6796486/1866261. Accessed December 17.

Objective: To help policymakers and planners identify health care shortage areas and prioritize improvement areas. These shortage areas have the following characteristics: in rural areas, a greater percentage of lower-income families, long travel distances to health care, and lack of public transit service.

Methodology: The Health Transportation Shortage Index (HTSI) pulled data from the U.S. Census Bureau, Department of Health and Human Services, and Regional Transit Authorities. The HTSI factors included population estimates, the type of geographic area, income, child poverty rate, public transit availability, HPSA designation, Federally Qualified Health Center (FQHC) in rural areas, and health care workforce availability.

Key Findings: Nationally, 9% of children in families with income less than $50,000 missed a health care appointment, and one-third of these children later used an emergency care for the condition associated with the missed appointment. Almost half of parents with children covered by Medicaid did not know transportation assistance was a Medicaid benefit. Hospital emergency department care was used more in zip codes with travel distance to the nearest FQHC was 10 miles or more. Data availability was an issue at the regional level, but was able to produce rankings for six communities. The study recommended improvements to Medicaid for non-emergency medical transportation services and promoted to link demand-response transportation services to fixed-route to creating feeder service and better transportation access to health care.

Relevant Relationships:

Transit → Access		Land Use → Access	
Access → Unemployment, Wages		Unemployment, Wages → Demand and Costs for Social Services	
Access → Schools/Education	**X**	Access → Health Care Utilization	
Schools/Education → Unemployment, Wages	**X**	Health Care Utilization → Health Care Costs	

Model/Analysis Tool: No.

Transportation Research Board
500 Fifth Street, NW
Washington, DC 20001

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