The Socio-Economic Benefits of Transit in Wisconsin

Phase II: Benefit Cost Analysis

HDR | HLB Decision Economics Inc.

Final Report No. 0092-05-14

May 2006

WISCONSIN DOT

PUTTING RESEARCH TO WORK

Wisconsin Department of Transportation Research, Development & Technology Transfer

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16. Abstract
This study furthers the research begun in 2003 (The Socioeconomic Benefits of Transit in Wisconsin). There were two principal objectives of the study. First, to perform a thorough cost-benefit analysis of transit in the state, where all transit benefits and costs are assessed and compared over the life cycle of the investment (20 years in the case of transit capital investment projects). Second, to develop a comprehensive benefit-cost analysis model that decision-makers could use for quantifying transit benefits under various funding scenarios.

The study methodology followed three steps. First, update the 2002 transit benefit and cost estimates to 2004 levels to serve as baseline for the analysis. Second, quantify the relationship between funding and transit service (and ultimately ridership) in Wisconsin. Ridership is a key determinant of transit benefits. Third, assess the benefits and costs of transit over a 20-year period (2005-2024). Step 2 allowed an estimate of the number of transit trips associated with a change in transit funding. This estimate was then translated into trips by trip purpose in order to assess the annual socioeconomic benefits of transit for each year in the analysis period.

Investigators summarized the results of their cost-benefit analysis under three state funding scenarios: no annual increase in state funding over the next 20 years, a 2.5% annual increase, and a 2.5% annual decrease. Under all three scenarios transit benefits outweigh transit costs in Wisconsin: the net present value (benefits minus costs) of transit is always positive. A 2.5% annual increase in state funding would produce a net present value of $8.2 billion by 2024, for a return of $3.61 on each dollar spent on transit. A 0% change in funding would produce a net present value of $6.9 billion and a return of $3.44 per dollar invested. A 2.5% decrease in funding would produce a $6 billion net present value and a $3.32 return.

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STATE OF WISCONSIN
DEPARTMENT OF TRANSPORTATION

The Socioeconomic Benefits of Transit in Wisconsin

Phase II: Benefit Cost Analysis

Final Report

May 18, 2006

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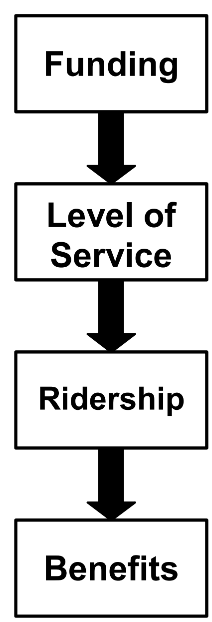
EXECUTIVE SUMMARY

Throughout the State of Wisconsin, transit provides access to employment, schools, hospitals, shopping, and recreation establishments. It is therefore critical to understand and quantify the role that transit plays in improving the quality of life and enhancing the economic growth in the state. A comprehensive assessment of socioeconomic transit benefits in 2002 revealed that a vast majority of transit users in Wisconsin do not have other means of access, and the lack of transportation will result in detriments to the quality of life and economic productivity. The study also showed that the benefits of transit trickle down to various sectors of the economy including retail, health care and education, and that their growth depends heavily on the quality of service transit provides. Table E–1 below updates the study results and shows transit benefits by trip purpose and system size in 2004. The benefits of transit to Wisconsin residents are estimated at $726 million or $7.59 per passenger trip.

Table E–1: Transit Benefits by Trip Purpose and System Size in 2004 (Millions of Dollars)

Trip Purpose	System Size			Total
	Small	Medium	Large	
Healthcare	$0.55	$3.19	$184.65	**$188.38**
Work	$0.30	$2.64	$329.77	**$332.70**
Education	$0.03	$0.22	$93.16	**$93.40**
Retail, Tourism and Recreation	$0.10	$1.89	$109.60	**$111.59**
Total	**$0.97**	**$7.93**	**$717.18**	**$726.08**

Though these results emphasize the magnitude of the benefits derived from the presence of transit, they do not provide any indication as to whether investing in transit is economically worthwhile. To answer that question a full benefit-cost analysis is necessary, where all transit benefits and costs are assessed, discounted and compared over the life cycle of the investment (twenty to thirty years in the case of transit capital investment projects).



The current study augments the scope of the 2002 study by assessing the dynamics of transit services over time. More specifically, it estimates the relationship (depicted in the adjacent flowchart) between public funding, the level of service, and subsequently transit ridership, which in turn is a key determinant of transit benefits. The study, therefore, tests various funding scenarios and assesses their corresponding rate of return to provide decision makers with a portrait of the effect (as well as its relative magnitude) of funding on transit benefits over time.

Table E–2 summarizes the results of the benefit-cost analysis for three state funding alternatives: 0 percent annual growth; +2.5 percent annual growth; and -2.5 percent annual growth. Note that these rates are in real terms (i.e., they are adjusted for inflation). Note also that the annual growth rates in local funding and federal funding are held constant across the three scenarios, so that the analysis focuses primarily on the impact of a variation in state funding on transit benefits.

Table E–2: Benefit-Cost Analysis Results, in Millions of Real Dollars (2005 – 2024)

Category	Average Annual Compound Growth Rate in Real State Funding		
	0%	+2.5%	-2.5%
Present Value of Healthcare Benefits	$2,572	$3,001	$2,280
Present Value of Employment Benefits	$4,451	$5,190	$3,949
Present Value of Education Benefits	$1,233	$1,437	$1,095
Present Value of Retail, Tourism and Recreation Benefits	$1,491	$1,737	$1,323
Present Value of Total Benefits	$9,746	$11,366	$8,648
Present Value of Operating and Maintenance Costs	$2,602	$2,886	$2,391
Present Value of Capital Costs	$233	$258	$214
Present Value of Total Costs	$2,835	$3,144	$2,605
Net Present Value	**$6,912**	**$8,221**	**$6,043**
Benefit/Cost Ratio	**3.44**	**3.61**	**3.32**
Return on Investment (Annualized)	**6.25%**	**6.51%**	**6.03%**

Note: Present values are calculated based on an expected real discount rate of 5.0 percent.

Under all three funding scenarios transit benefits outweigh transit costs (i.e., the net present value is always positive). Therefore, investing in transit in Wisconsin is economically worthwhile. The return on investment varies between 6.0 percent and 6.5 percent over the twenty-year analysis period. This is well above the opportunity cost of capital (or discount rate) of 5.0 percent used in this analysis.

The results also show that a moderate increase in real state funding (+2.5 percent annually) would have a strong effect: it would result in a net present value of $8.2 billion – an 18.9 percent increase over the 0 percent real growth scenario. In other words, every dollar invested in transit would yield a return of 3.61 dollars. On the other hand, a decrease in real state funding (-2.5 percent annually) would result in a net present value of only $6.0 billion – a 12.6 percent decrease over the 0 percent real growth scenario.

1. INTRODUCTION

In 2003, HDR|HLB Decision Economics Inc. (HDR|HLB) was engaged by the Wisconsin Department of Transportation (WisDOT) to estimate the socioeconomic benefits of transit at the state level. The study's main objective was to identify and assess the social and economic benefits of public transportation services to the main economic sectors in Wisconsin.

The study focused on the measurement of public transit benefits to the healthcare, employment, education, and retail, recreation and tourism sectors. The analysis relied on a detailed methodology developed by HDR|HLB on behalf of the Federal Transit Administration (FTA) and Transport Canada. Various sources of information and data were employed, including: a comprehensive literature search, an on-board passenger survey in six cities (Green Bay, Madison, Milwaukee, Neillsville, River Falls, and Stevens Point), data from several transit agencies, panel opinions from a group of experts, as well as reports and publications from earlier studies. The study culminated in the development of a spreadsheet model to calculate the benefits of transit and four reports presenting the results by socioeconomic sector.

HDR|HLB Decision Economics Inc. was subsequently retained by WisDOT to conduct a benefit-cost analysis of transit in Wisconsin. The study involves the development of a comprehensive benefit-cost analysis model for use by WisDOT staff to help assess the benefits of transit under various funding scenarios.

The purpose of this report is to present the methodology and the results of the benefit-cost analysis. The report consists of five chapters, including this introduction. Chapter 2 presents the methodology devised by HDR|HLB to *(i)* estimate the benefits of transit by socioeconomic sector, *(ii)* link the level of transit funding to transit ridership (and ultimately to transit benefits), and *(iii)* conduct a benefit-cost analysis of alternative public funding levels. Chapter 3 is an update on transit capital and operation costs and transit benefits in Wisconsin with the most recent available data. Chapter 4 summarizes the study findings on transit elasticities. Chapter 5 presents the results of the benefit-cost analysis.

The report also contains several appendices. Transit benefit estimates from the 2003 study are presented in Appendix 1, and transit benefits calculated over the study period are shown in Appendix 2. A primer on risk analysis is provided in Appendix 3. Appendix 4 summarizes the risk analysis results. Appendix 5 shows the macroeconomic impacts calculated with IMPLAN. An overview of the benefit-cost analysis model is available in Appendix 6. Finally, data sources and references used throughout the study are provided in Appendix 7.

2. METHODOLOGICAL FRAMEWORK

The methodology followed for this study can be divided into three major steps: update transit benefit and cost estimates, which will serve as the baseline for the analysis; quantify the relationship between funding and transit service (and ultimately ridership) in Wisconsin; assess the benefits and costs of transit over a twenty-year period (2005-2024).

This chapter starts with an overview of the methodological framework. Section 2.2 identifies the different benefit categories of transit and explains the methodology developed by HDR|HLB to estimate them. Section 2.3 discusses the relationship between transit funding and transit ridership in Wisconsin. A primer on benefit-cost analysis of transit investments is provided in Section 2.4.

2.1 Overview

Figure 1, on the following page, presents a graphical illustration of the methodological framework, identifying all of the key inputs and showing the different steps to arrive at the benefit-cost analysis results.

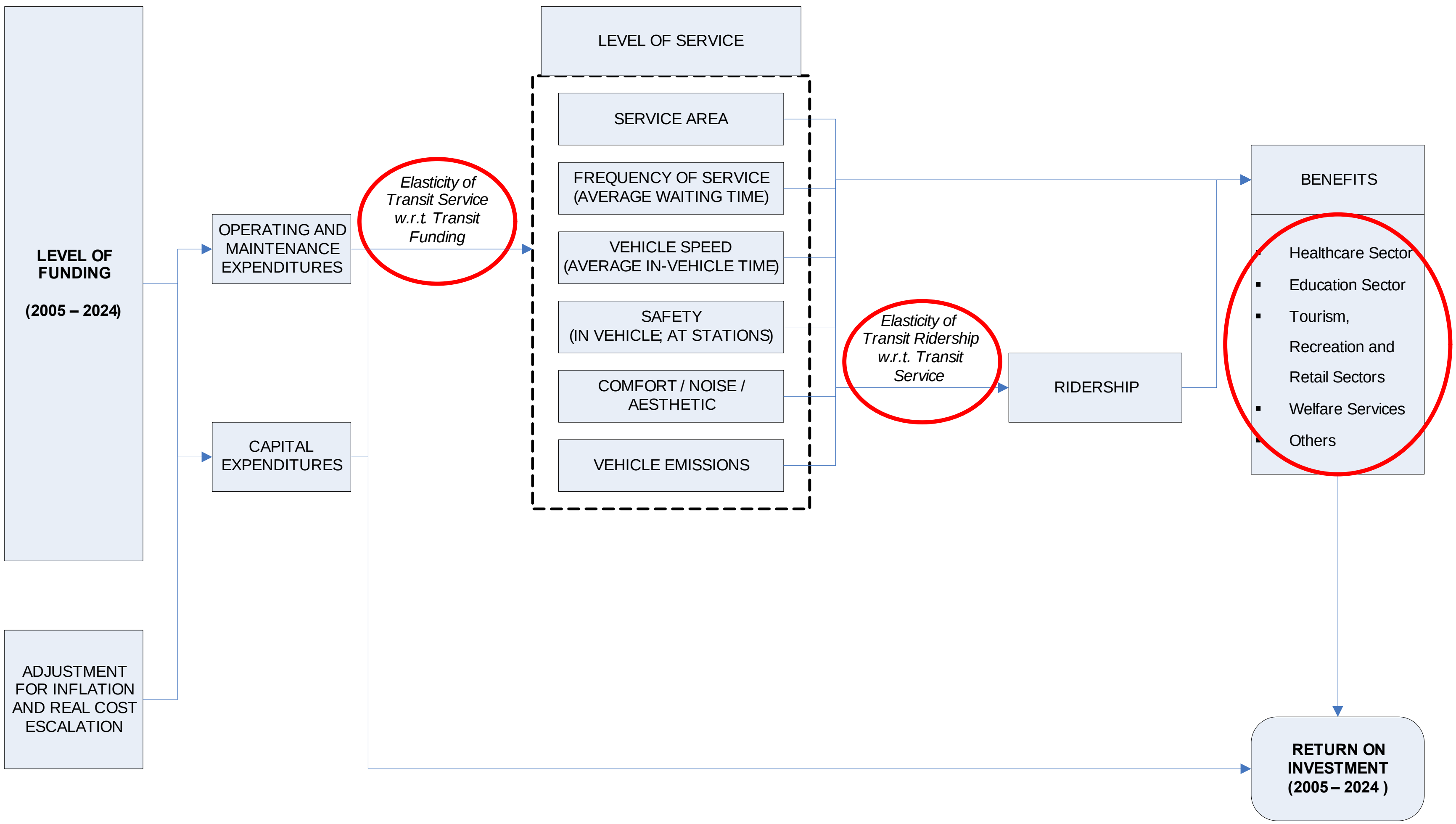
The starting point assumes a change in the level of transit funding (which covers both operating and maintenance expenditures and capital expenditures). The change in the level of transit funding is then translated into a change in the level of transit service. The level of transit service is defined by various parameters such as the frequency of service, the speed of the service, the service area, the number of routes, etc. One of the most widely used measures of transit service is the total number of vehicle miles (i.e., the number of miles a vehicle travels from the time it pulls out from the garage to go into revenue service to the time it pulls in from revenue service). The change in the level of transit service can be expressed in *elasticity* terms (i.e., the elasticity of transit service with respect to transit funding).[1] In the same way, the change in transit service is subsequently translated into a change in transit ridership via the elasticity of transit ridership with respect to transit service.

These three consecutive steps result in an estimate of the number of transit trips associated with the initial change in transit funding. This estimate must then be translated into trips by trip purpose in order to assess the annual benefits of transit in the employment, healthcare, education, and retail, recreation and tourism sectors.

This four-step process is repeated as many times as there are years in the analysis period. For transportation capital projects, a 20 to 30-year period is typically considered. Once all the benefits and costs have been estimated, the (annualized) rate of return can be calculated along with other benefit-cost metrics such as the net present value and the benefit-cost ratio. These metrics help assess the economic worthiness of public transit.

[1] See Section 2.3.2 for a discussion on the concept of elasticity.

Figure 1: Impact of Funding on Transit Ridership and Benefits



2.2 Transit Benefits

The methodology used to measure the socioeconomic benefits of transit is presented for the four following sectors: employment, healthcare, education, and retail, recreation and tourism.

2.2.1 Overview of Transit Benefits

The benefits of public transportation stem from its ability to improve people's mobility, its ameliorative effects on traffic congestion, and its positive impact on the economic development of the region.

- **Affordable Mobility/Cross-Sector Benefits** – These are the benefits from providing low-cost mobility to transit-dependent households. The benefits include income from employment made possible by transit, the economic value to access services such as healthcare, education, retail, and attractions (transit fare is typically lower than taxi fare and vehicle ownership and operating cost), and budget savings for welfare and social services due to the presence of transit.

- **Congestion Management Benefits** – Congestion management benefits are the savings in vehicle ownership and operating cost, travel time, accidents and environmental emissions due to less congestion and fewer miles traveled by personal vehicles due to the transit system. These savings in resources imply greater disposable household income for other purposes. The two principal benefits are the reduction in travel by personal vehicles, and, travel in less congested conditions by vehicles remaining on the roadway.

- **Economic Development Benefits**[2] – Proximity to transit has a positive effect on residential property values and commercial activities due to the increased availability of travel opportunities, and the ability of others to access the residence and commercial centers by transit.

HDR|HLB developed detailed methodologies for calculating each of these benefits on behalf of the Federal Transit Administration.[3] The methodologies are consistent with economic theory, and yield practical estimates of regional economic benefits without reliance on onerous data requirements.

The benefits of public transportation described above are illustrated in Figure 2 on the next page. This research effort is building on the results of the 2003 study to assess all of the transit benefits over a 20-year period.

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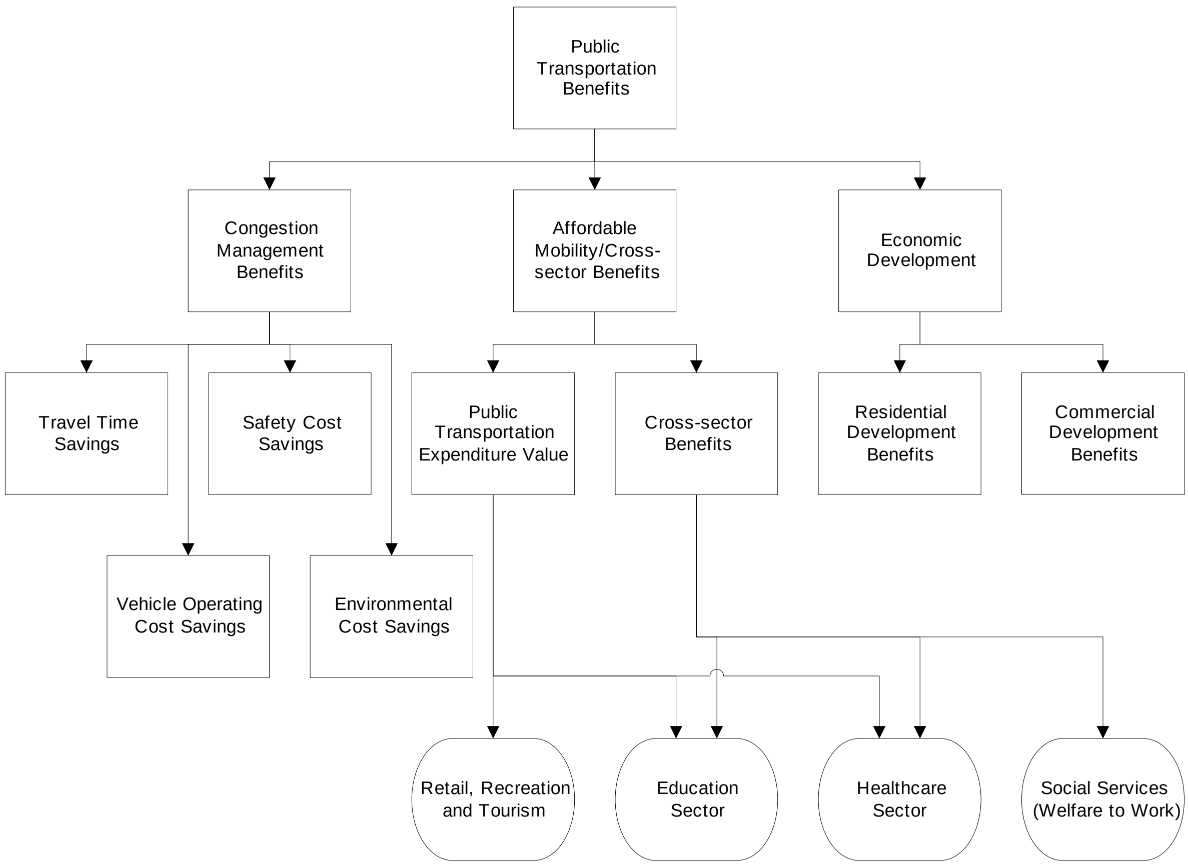
[2] This type of benefits is mainly found in corridors with rail transit systems.

[3] Hickling, Lewis, Brod, Inc., *The Benefits of Modern Transit*, prepared for the Federal Transit Administration, 1997; Hickling, Lewis, Brod, Inc., *Method for Streamlined Strategic Corridor Travel Time Management*, sponsored by the Office of Budget and Policy, Federal Transit Administration, 1999.

Figure 2: Overview of Transit Benefits



2.2.2 Estimation Process

A specific methodology is applied to each of the four socioeconomic sectors to evaluate the benefits of transit identified above. Figure 3 on page 14 gives a graphic representation of the structure and logic used within each sector to calculate the affordable mobility and cross-sector benefits.

The benefits of public transportation in each socioeconomic sector can be broken down into three components. The first component is the economic value of transit by comparison with other (more expensive) transportation modes, as measured by the consumer surplus technique.[4]

The second component is the cross-sector benefit arising in the employment and healthcare sectors. Without public transit some individuals would be unable to access work or medical facilities, and would turn to assistance programs such as welfare-to-work, or home healthcare. Although a few patients might be able to pay for their own home healthcare, a large portion of the additional healthcare costs would be borne by society as a whole. These costs would

[4] HLB Decision Economics Inc., *The Socio-Economic Benefits of Transit in Wisconsin*, Volume 1, prepared for the Wisconsin Department of Transportation, December 2003, pp. 4–5.

ultimately be passed on to consumers via higher insurance premiums. The increased demand for welfare-to-work programs would also be a burden on taxpayers.

The third component, qualitative in nature, is the value to the community of transit access to each sector. By providing access to medical facilities, recreation programs, educational institutions and work, transit holds the potential to generate social benefits that accrue not only to transit riders but to the community as a whole. The number of trips foregone in the absence of transit is an indicator of how transit is affecting the quality of life in an area.

Distribution of Ridership by System Size and Trip Purpose

The first step in the estimation process is to break down total transit ridership in Wisconsin into system size categories and trip purposes. Given that trip purpose and riders' decisions may vary by community size, transit ridership is divided into three system categories: "large" with ridership of more than 50,000; "medium" with ridership of 10,000-50,000; and "small" with ridership less than 10,000. Within each category, transit ridership is then broken down into four trip purposes: employment; education; healthcare; and retail, recreation and tourism.

Users' Decisions in the Absence of Transit

The next step in the process is to define what decisions transit users would make in the absence of transit service. Some people would switch to an alternative transportation mode (personal vehicle, taxi, etc.), while others would have no choice but to forego their trips.

For trips that would be made by other transportation modes, the generalized cost difference between transit and each alternative mode is estimated. The cost difference is then multiplied by the corresponding number of diverted trips to obtain total cost savings in a given sector.

A portion of foregone trips would result in an increase in the demand for cross-sector programs (home healthcare or welfare to work services). By multiplying the number of foregone trips by the average incremental cost associated with the service, the additional expenditure in personal, insurance, or government subsidy is determined. The additional cost required for such service is a savings that occurs when transit is available.

Risk Analysis[5]

For all statistical assumptions used in the model, probability distributions were defined to reflect the uncertainty associated with the knowledge of each variable. While point estimates could be used in the model to arrive at a single value of transit benefits, there would be no measure of confidence in the result. There is a fundamental difference between a central value of $100 million with an 80 percent confidence interval of $90 million − $110 million, and the same central value with an 80 percent confidence interval of $40 million − $160 million. The certainty of the former is much greater than the latter. Therefore, in addition to mean expected values, probability distributions were generated to express the level of certainty in the resulting benefit values.

Economic Impact Model

In addition to the direct effect of out-of-pocket savings to transit riders avoiding more costly transportation modes, multiplier effects (i.e., indirect and induced effects) can be estimated.

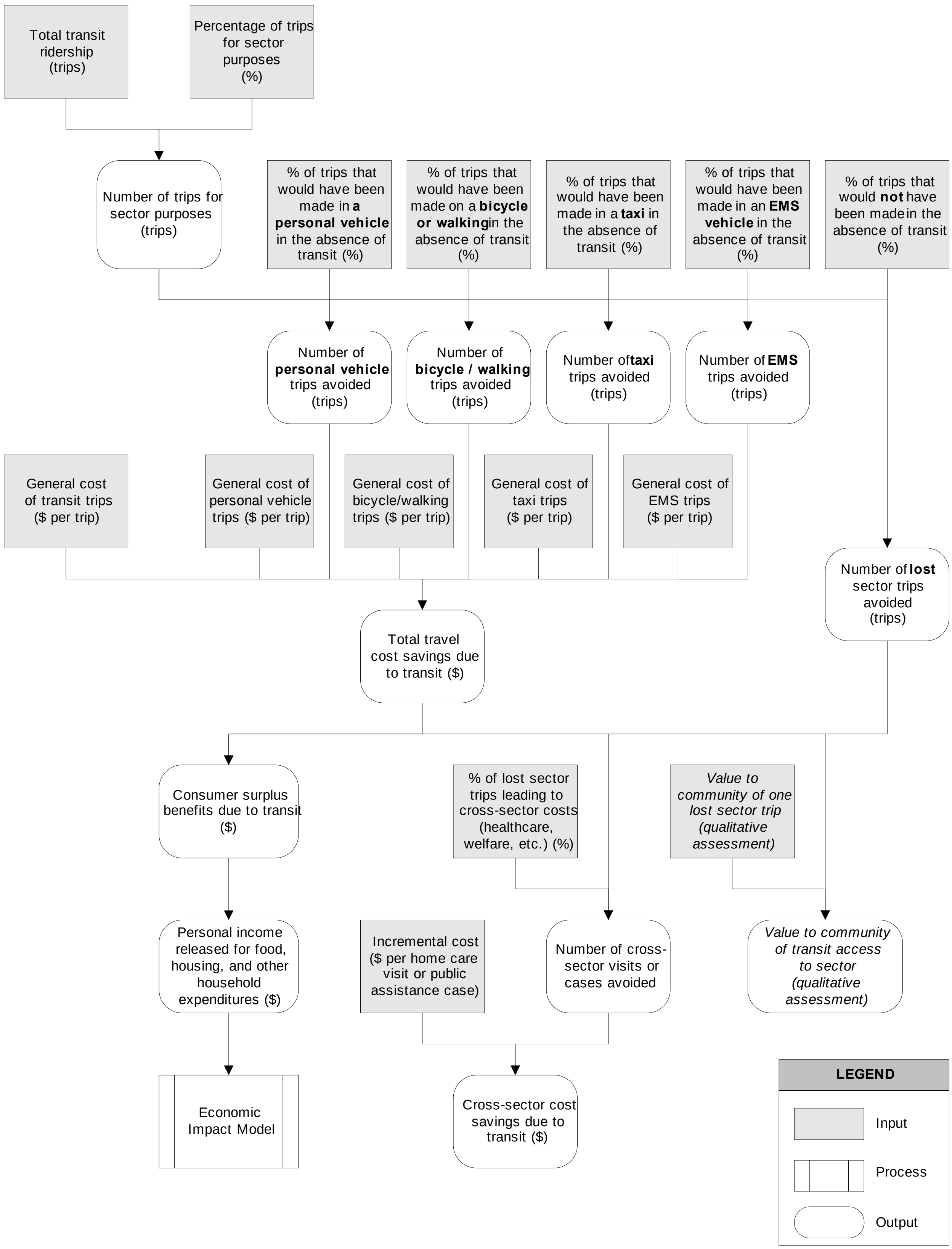
[5] The risk analysis process is described in detail in Appendix 3.

Transportation cost savings are indeed redirected toward purchases in housing, food, and other household expenditures. To estimate these multiplier effects, HDR|HLB utilizes the IMPLAN® model which is an economic impact assessment modeling system (structured as an input-output model) originally developed by the U.S. Forest Service, and now maintained by the Minnesota IMPLAN Group, Inc.[6] By analyzing the change in spending patterns across the 509 industrial sectors that IMPLAN tracks within Wisconsin, the model is able to establish the resulting direct, indirect and induced changes in industrial output, employment, labor income and tax revenue as result of the out-of-pocket savings from transit trips.

Figure 3 on the following page illustrates the methodology used to estimate the benefits of public transportation within each socioeconomic sector. The structure and logic diagram identifies all of the model inputs and the relationships between these inputs.

[6] An input-output ("I/O") approach was followed in this study, drawing on an extensive body of research and experience with successful applications to transportation project analysis. An I/O model calculates impact multipliers, which are then used to compute direct, indirect, and induced effects – output, employment, personal income, and local tax revenue generated per dollar of direct spending for labor, goods, and services.

Figure 3: Estimating Public Transportation Benefits Within Each Sector



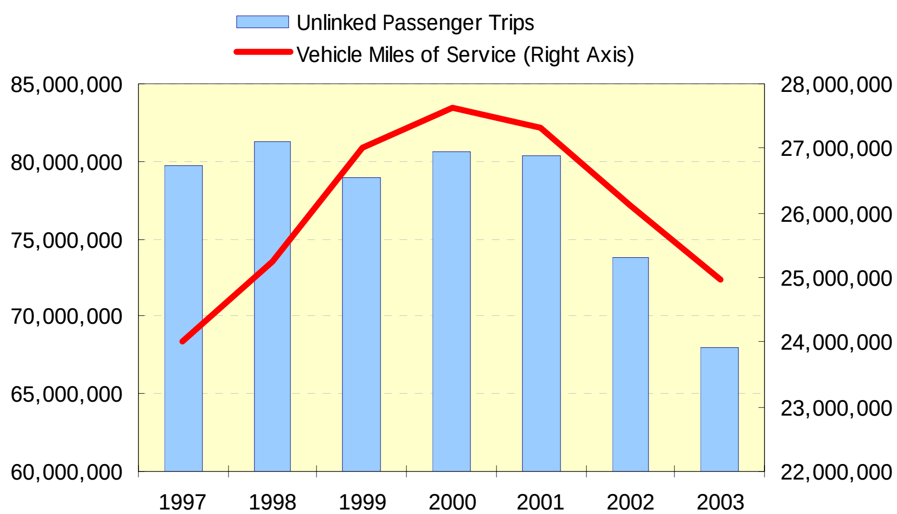
2.3 Transit Funding and Ridership

One key aspect of the methodology is that transit ridership can be *indirectly* estimated by transit funding: the level of transit service depends upon the level of transit funding; and transit ridership depends upon transit service. Transit ridership, in turn, determines the level of transit benefits.

2.3.1 Evidence of the Relationships

Historical data on transit operations was collected from the National Transit Database (NTD) to measure the relationship between transit ridership and the level of funding in Wisconsin.[7] Figure 4 below and Figure 5 on the next page show historical data (1997-2003) on several indicators of bus service supplied for tier A systems and tier B systems separately.[8]

Figure 4: Bus Service Supplied, Tier A Systems (1997–2003)

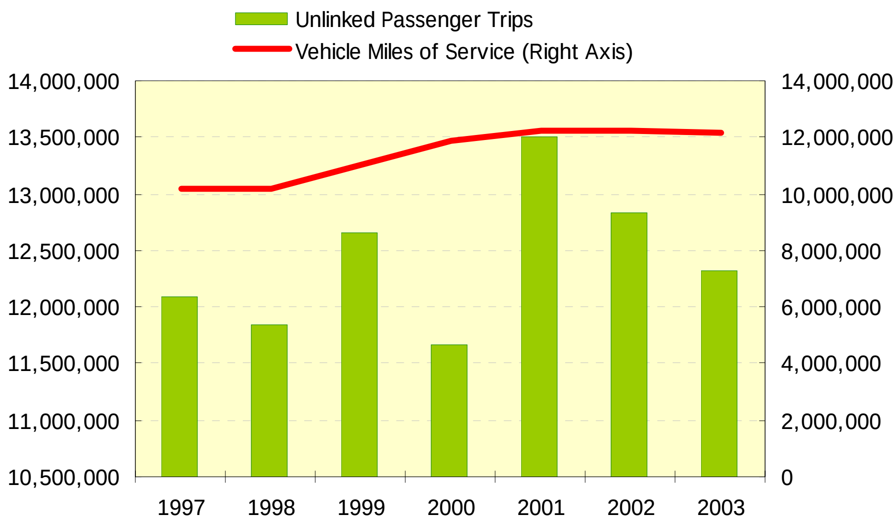


Source: National Transit Database

[7] The National Transit Database can be accessed on the following web site: http://www.ntdprogram.com/NTD/ntdhome.nsf/?Open
Note that the National Transit Database only includes urbanized transit system data (tiers A and B).

[8] Operating data is not available for all modes prior to 2000. In 2003, bus ridership (as measured by unlinked passenger trips) accounted for more than 97 percent of total transit ridership in Wisconsin.

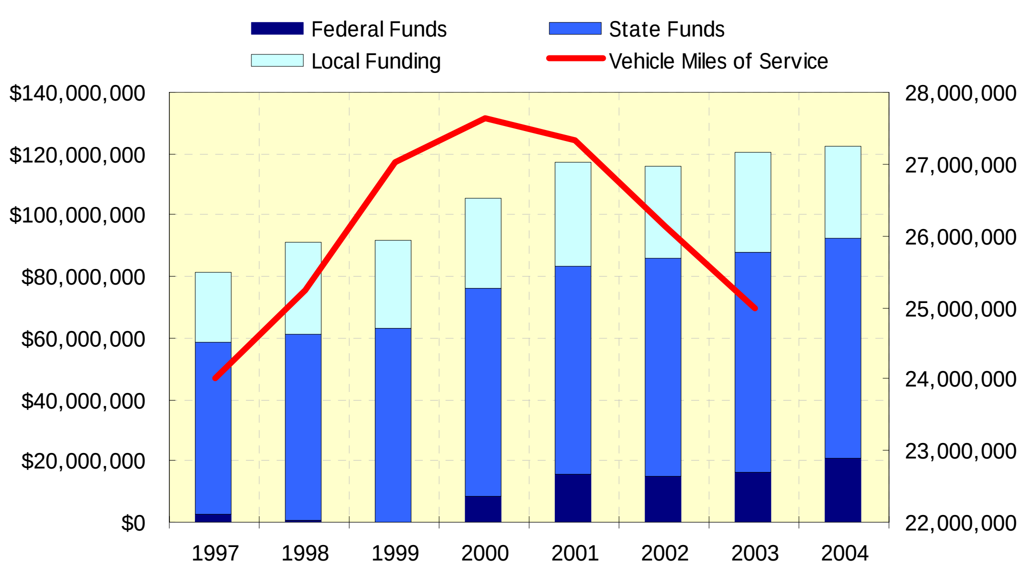
Figure 5: Bus Service Supplied, Tier B and C Systems (1997–2003)



Source: National Transit Database and Wisconsin Department of Transportation

In the same way, Figure 6 below and Figure 7 on the next page show historical data (1997-2004) on bus service supplied (vehicle miles of service) and transit funding (federal, state and local) for tier A systems and tier B systems separately. Note that, due to data limitations, only funding dedicated to operating and maintenance expenses is considered.[9] In 2004, transit capital expenses represented about 8 percent of operating and maintenance expenses in Wisconsin.

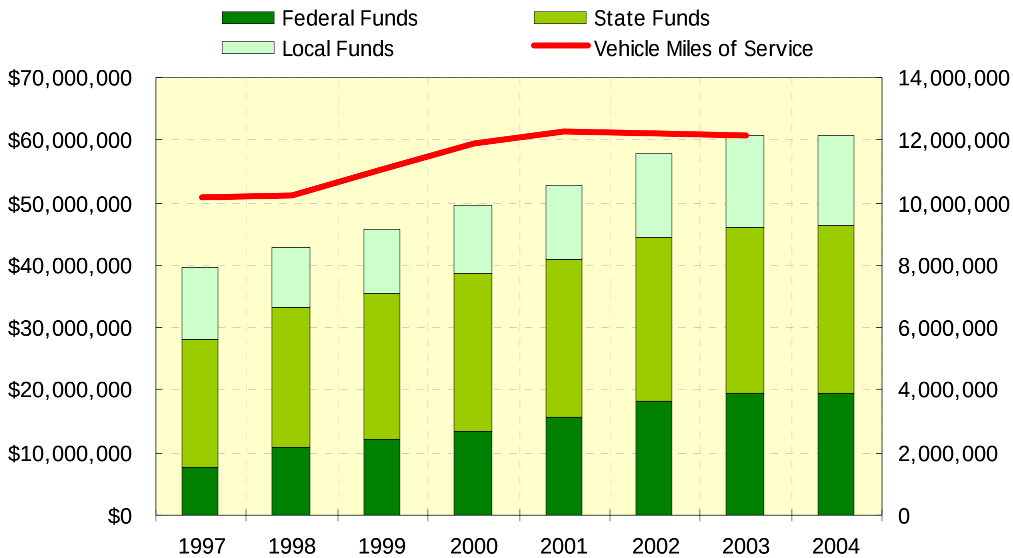
Figure 6: Transit Funding and Bus Service Supplied, Tier A Systems (1997–2004)



Source: National Transit Database and Wisconsin Department of Transportation

[9] Maintenance capitalized costs are not included in the years 1998 and 1999.

Figure 7: Transit Funding and Bus Service Supplied, Tier B Systems (1997–2004)



Source: National Transit Database and Wisconsin Department of Transportation

2.3.2 Measuring the Relationships

The extent of the relationships represented above can be quantitatively assessed by means of two elasticities. The elasticity of transit service with respect to transit funding measures the responsiveness of transit operators to a change in funding, holding everything else constant. For instance, a transit funding elasticity of 0.5 means that a 1 percent increase in funding will lead to a 0.5 percent increase in service. In the same way, the relationship between transit service and transit ridership can be estimated by the elasticity of transit ridership with respect to transit service.

Despite a wide body of literature on transit elasticities, little information is available on the effects of funding on transit service.[10] Nonetheless, the elasticity of transit service with respect to transit funding can be measured via multiple regression analysis with historical data collected from the NTD and the Wisconsin Department of Transportation. Multiple regression analysis relates the dependent variable (e.g., total vehicle miles) to a set of independent, or explanatory, variables (public funding, fare, population, etc.).

[10] Lewis, David and Fred Williams, *Policy and Planning as Public Choice: Mass Transit in the United States*, Ashgate, 1999, pp. 168–172.

2.4 Benefit-Cost Analysis

Benefit-cost analysis evaluates the fundamental merit of undertaking possible investments. The basic idea is straightforward. An investment option '*A*' is worthwhile if its economic benefits exceed its economic costs. Importantly, the benefits of the next best alternative to option '*A*' are viewed as costs of option '*A*'. This is because the alternative benefits are lost if '*A*' is implemented. So the benefit-cost rule is: option 'A' is economically worthwhile only if its net benefits (benefits minus costs) exceed the net benefits of the next best alternative.

2.4.1 Principles of Benefit-Cost Analysis

Benefit-cost analysis counts all the negative and positive economic effects of an investment, regardless of how they are paid for. The fact that the federal government, the State of Wisconsin, the city of Madison or the transit user pays a specific share of a project's costs under different financing plans, does not change the project's fundamental economic merit.

Benefit-cost analysis treats all negative effects as costs. In addition to a project capital outlays, the analysis accounts for the cost of capital (defined by the discount rate)[11] and annual operating and maintenance expenses.

In the same way, benefit-cost analysis treats all positive effects as benefits. The main benefit categories considered in this study are affordable mobility and cross-sector benefits arising in the following socioeconomic sectors: employment; healthcare; education; and retail, recreation and tourism.

Another principle of benefit-cost analysis is that a benefit should not be counted more than once. This is important because the economic value of some effects can arise in more than one category. Given that the generalized cost of transportation used to calculate the benefits of transit comprises vehicle operating, accident and travel time costs, the congestion management benefits for Madison and Milwaukee (see Chapter 3) should not be included in the benefit-cost analysis.

Equally important in benefit-cost analysis is the concept of incrementality: to qualify as "economically worthwhile," a project must generate benefits *over and above* those forthcoming from the base case. The base case should represent, as closely as possible, the most efficient and productive use of existing assets, even if expenditures are required to achieve it. In accordance with this principle, the indirect and induced impacts of out-of-pocket savings to transit riders (see Section 2.2.2) should not be included in the benefit-cost analysis. They do not reflect value creation, but merely value redistribution.

Finally, because the economic evaluation of transportation investments involves judgments, forecasts and assumptions, it should explicitly account for the uncertainty surrounding key factors (e.g., cost estimates, the value of time and public transportation elasticities). This can be done by means of a risk analysis, where each factor is assigned a probability range.

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[11] More precisely, benefit-cost analysis accounts for the opportunity cost of capital. This reflects a combination of interest and the "time-preference" of the community for benefits now vs. greater benefits later.

2.4.2 Valuation

To permit the ready comparison of options, benefit-cost analysis measures benefits and costs on one scale, namely *value*. For convenience, value is expressed in dollars. Not everything of course can be assigned a value in the form of a monetary equivalent. Neither this nor any benefit-cost analysis promises to attach a monetary-equivalent value to every possible negative or positive effect of a project. Some effects must be anticipated in qualitative terms and set out along side "the numbers." Some researchers believe for example, that the additional walking entailed in the use of transit options leads to improved cardiovascular health and a reduction in healthcare costs. While clearly an economic effect, science has yet to measure its monetary equivalent value. Benefit-cost analysis must thus be satisfied with its qualitative presentation.

From a decision-making perspective, however, it is unrealistic to avoid valuation entirely. Whenever option '*A*' is superior to option '*B*' on one count and inferior on another, a refusal to weigh up the relative value of each count implies only one possible decision, "Do both." Doing both is obviously not possible in most circumstances. Benefit-cost analysis is a framework within which practical trade-offs can be considered.

How are the monetary equivalent values measured? The valuation of some effects, both negative and positive, is made easy by the existence of markets and market prices. The valuation of "non-market" effects, such as safety, environmental pollution or predictable journey times, is based on measurements of how much individuals are willing to pay to acquire the benefits or avoid the costs. For example, a California-based study found that people were willing to pay about $0.17 a minute ($10.20 an hour) to save travel time and about twice that rate for a reduction in travel time variability.[12]

In short, values for non-market effects are inferred from peoples' actual behavior. However, the study presented here has not conducted such research. Rather, it relies on consensus valuations[13] from the economic literature coupled, as described in Appendix 3, with allowances for local variation and measurement uncertainty based on the techniques of risk analysis.

2.4.3 Discount Rate

To make benefits and costs fully comparable, it is necessary to convert their values at different times to values at a single point in time (i.e., the "base" year which is typically the year the analysis is conducted). All benefits and costs are discounted to the present using a discount rate that reflects the opportunity cost of capital. Selecting the right discount rate for public projects has been a subject of continuing debate (benefits tend to occur later than costs; therefore, high discount rates tend to decrease the benefits more than the costs). A rule of thumb for private sector investment, also applied to benefit-cost analysis, is that new capital projects should not be undertaken if shareholders would earn more if the capital were to be invested instead in low-risk, interest bearing securities (such as bonds).

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[12] Hickling, Lewis, Brod, Inc. and University of California, Irvine, *Valuation of Travel-Time Savings and Predictability in Congested Conditions for Highway User-Cost Estimation*, NCHRP Report 431, Transportation Research Board, National Research Council, 1999.

[13] Consensus valuations, also called "meta-analysis," are based on expert panel reviews of refereed and published scientific valuation measurements of the non-market effects of transportation projects.

Another important rule is that benefit-cost analysis should be done in real (not nominal) terms, i.e., using dollars and discount rates that do not include the effects of inflation. A real discount rate can be estimated by removing the inflation (as measured by the Consumer Price Index) from a market interest rate for government borrowing. The selected market rate should be based on government bonds with maturities comparable in length to the analysis period used for the benefit-cost analysis. Real discount rates have historically ranged from 2 percent to 5 percent. In January 2005, the U.S. Office of Management and Budget (OMB) reported a 10-year real discount rate of 2.5 percent and a 30-year discount rate of 3.1 percent, based on current Federal borrowing costs.[14] These rates reflect historically low costs of government borrowing. In accordance with the standard practices and policies of the Wisconsin Department of Transportation, the streams of costs and benefits are discounted with an annual real discount rate of 5.0 percent for this study.

2.4.4 Evaluation Benchmarks

A number of evaluation benchmarks, or criteria of economic merit, are used by decision-makers to determine whether transportation investments are economically worthwhile. The most widely used decision criteria are described below.

Net Present Value (NPV) – The principal evaluation criterion of an investment is its benefits minus its costs. More precisely, the net present value is the discounted present-day value of benefits minus the discounted present-day value of costs. The net present value is measured over the life-cycle of the investment under consideration (20 years in this analysis). A net present value greater than zero indicates that the investment is economically worthwhile, and of more value to the community, than the next best alternative. As well, if investment option '*A*' is seen to offer a higher net present value than investment option '*B*', it is correct to conclude that '*A*' is economically superior to '*B*'.

Internal Rate of Return (IRR) – The internal rate of return is directly related to the net present value: it is the discount rate that results in a net present value of zero. Although the internal rate of return gives the same fundamental answer as the net present value, it does give added perspective. For instance, an internal rate of return of 7 percent means that the flow of benefits is sufficient to yield a return of 7 percent each year on that part of the investment that has not been paid out. If a project's rate of return is greater than the return available by investing in low-risk bonds it can be considered economically worthwhile.

Benefit-Cost Ratio – The benefit-cost ratio is simply the present value of benefits divided by the present value of costs. For instance, a benefit-cost ratio of 2 indicates that the project generates $2 of benefits per $1 of cost. Hence, a benefit-cost ratio greater than one means that the project is economically worthwhile.

While the internal rate of return and the benefit-cost ratio provide decision makers with additional useful information, only the net present value should be regarded as the basis for establishing whether or not a prospective investment is worth undertaking.[15] It follows that only

[14] See Appendix C to OMB Circular No. A-94, http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html

[15] For more information on benefit-cost analysis in the context of transportation investments, see Hickling Corporation, *Primer on Transportation, Productivity and Economic Development*, NCHRP Report 342, Transportation Research Board, National Research Council, 1991.

the net present value criterion permits alternative investments to be ranked in order of economic merit.

3. ESTIMATION OF BENEFITS AND COSTS IN 2004

This chapter is an update of the findings of the 2003 study on *The Socioeconomic Benefits of Transit in Wisconsin*. HDR|HLB has estimated the socioeconomic benefits of transit service in the State of Wisconsin with the most recent available data. Ridership data and cost variables have been updated to 2004. The socioeconomic benefits of transit are estimated by trip purpose: 1) healthcare, 2) employment, 3) education, and 4) retail, tourism and recreation. This information will serve as the baseline for the benefit-cost analysis. In addition, the congestion management benefits of transit are estimated for the two most populated cities in Wisconsin: Madison and Milwaukee.

3.1 Benefits Update

HDR|HLB has re-estimated the benefits of transit for each socioeconomic sector (healthcare, employment, education, and retail, tourism and recreation).

3.1.1 Benefits to Healthcare in 2004

An estimated 9.7 million transit trips are made for healthcare purposes in Wisconsin, resulting in $188 million of cost savings as shown in Table 1 below. Of this amount, transit riders save $131 million in transportation costs, while $57 million is saved in home healthcare costs.

In addition to the cost savings, without access to transit 1.3 million trips for medical purposes would not be made. Of these foregone medical trips it is estimated that about 527,000 would result in home healthcare visits, while the others would simply result in no medical treatment.

Table 1: Healthcare Cost Savings in 2004 (Millions of Dollars)

Savings	System Size			Total
	Small	Medium	Large	
Consumer Surplus	$0.35	$1.92	$129.30	$131.57
Home Healthcare Savings	$0.20	$1.27	$55.34	$56.81
Total Savings	**$0.55**	**$3.19**	**$184.65**	**$188.38**

Note: small system – ridership of less than 10,000; medium system – ridership of 10,000-50,000; large system – ridership of more than 50,000.

3.1.2 Benefits to Employment in 2004

Transit users make 46.6 million trips for work purposes annually in Wisconsin. The total savings generated from these work related trips are $333 million as shown in Table 2. The saving per trip from transit service for work purpose travel is thus $7.13.

Of the 46.6 million annual work related trips, transit service allows for 8.5 million trips annually that would not be made otherwise.

Table 2: Work Cost Savings in 2004 (Millions of Dollars)

Savings	System Size			Total
	Small	Medium	Large	
Consumer Surplus	$0.21	$1.93	$259.25	$261.39
Public Assistance	$0.09	$0.71	$70.52	$71.32
Total Savings	**$0.30**	**$2.64**	**$329.77**	**$332.70**

3.1.3 Benefits to Education in 2004

About 22.1 million educational purpose trips are made annually on public transit in Wisconsin. The total savings generated from these educational trips are estimated at $93 million, as shown in Table 3. The saving per tip thus amounts to $4.23.

Of the 22.1 million educational purpose trips, 2.7 million would not occur in the absence of transit services.

Table 3: Education Cost Savings in 2004 (Millions of Dollars)

Savings	System Size		
	Small	Medium	Large
Consumer Surplus	$0.03	$0.22	$93.16
Total Savings Across Systems			**$93.40**

3.1.4 Benefits to Retail, Recreation and Tourism in 2004

An estimated 17.2 million transit trips are made for retail, tourism or recreation purposes in Wisconsin. The total annual savings from these trips are estimated at $111 million, as shown in Table 4. The resulting saving per trip is thus $6.50.

In addition to the cost savings, public transit allows for nearly two million trips for retail, recreation or tourism purposes that would otherwise be forgone.

Table 4: Retail Recreation and Tourism Cost Savings in 2004 (Millions of Dollars)

Savings	System Size		
	Small	Medium	Large
Consumer Surplus	$0.10	$1.89	$109.60
Total Savings Across Systems			**$111.59**

3.1.5 Summary of Socioeconomic Benefits in 2004

The total benefits of public transit to Wisconsin are estimated at $726 million for the year 2004 or $7.59 per trip (a 2.8 percent increase over 2002 due only to inflation).

The vast majority of benefits from public transit in Wisconsin are generated within systems with ridership of 50,000 or more. More precisely, 98.84 percent of total transit benefits accrue to these larger systems (an increase of 3 percentage points over 2002). 1.06 percent of the savings is generated in medium sized systems with ridership of 10,000 to 50,000, while only 0.11 percent originates in small systems with ridership of less than 10,000.

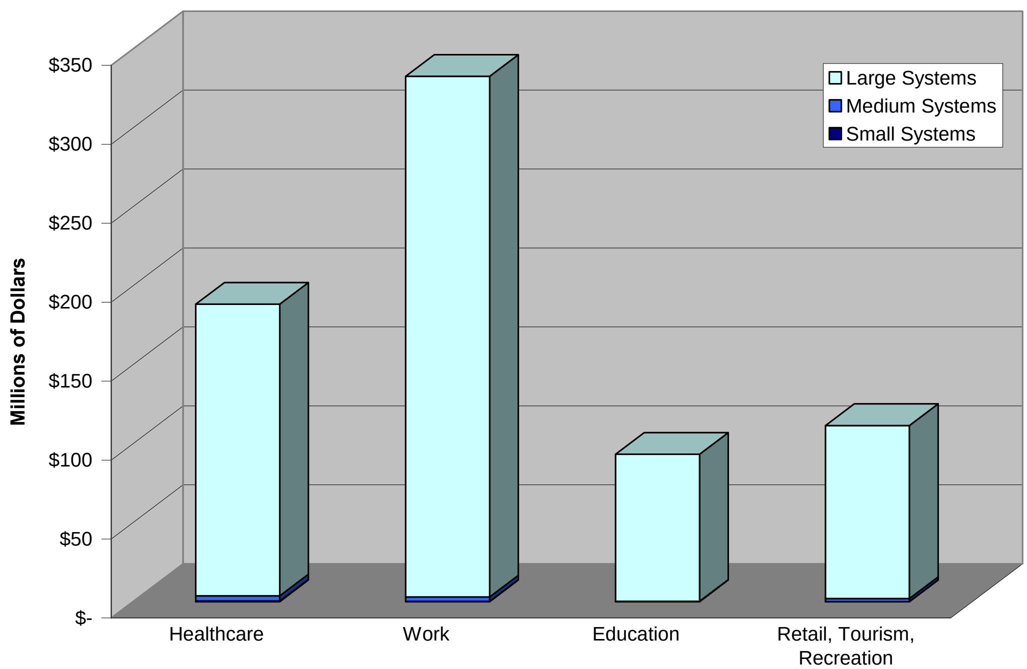
Work purpose trips generate the largest proportion of benefits (45.8 percent). In descending order of importance, transit benefits originated from healthcare purpose trips (26.0 percent), retail, recreation and tourism purpose trips (15.4 percent), and education trips (12.9 percent).

Table 5 and Figure 8 below show the distribution of benefits by trip purpose (work, healthcare, education, and retail, tourism and recreation) and transit system size (large, medium and small).

Table 5: Transit Benefits by Trip Purpose and System Size in 2004 (Millions of Dollars)

Trip Purpose	System Size			Total
	Small	Medium	Large	
Healthcare	$0.55	$3.19	$184.65	**$188.38**
Work	$0.30	$2.64	$329.77	**$332.70**
Education	$0.03	$0.22	$93.16	**$93.40**
Retail, Tourism and Recreation	$0.10	$1.89	$109.60	**$111.59**
Total	**$0.97**	**$7.93**	**$717.18**	**$726.08**

Figure 8: Transit Benefits by Trip Purpose and System Size in 2004



3.2 Congestion Management Benefits

HDR|HLB also estimated the congestion management benefits of transit for Madison Metro Transit System (MMTS) and Milwaukee County Transit System (MCTS). These two public transit systems are the largest at the state level: in 2004, their combined ridership represented more than 80 percent of total ridership in Wisconsin.

Congestion management benefits are the savings in vehicle ownership and operating cost, travel time, accidents and environmental emissions due to less congestion and fewer vehicle miles traveled due to the existence of transit. These savings in resources imply greater disposable household income for other purposes (housing, education, etc.). The two principal benefits are the reduction in travel by personal vehicles, and travel in less congested conditions by vehicles remaining on the roadway. *Congestion management benefits accrue not to transit riders, but to the users who remain on the roadway*.

Table 6 below shows the total congestion management benefits resulting from the presence of transit services in Milwaukee, and the breakdown by cost saving category and transit service (bus and paratransit). Note that all values are in 2004 dollars.

Total congestion management benefits top $111 million in Milwaukee and are attributable as follows: 45.09 percent to vehicle ownership and operating cost savings, 2.86 percent to emission cost savings, 5.85 percent to safety cost savings and 46.20 percent to travel time value. The bulk of these benefits originate from fixed route bus service (93.2 percent).

Table 6: Total Congestion Management Benefits for Milwaukee in 2004 (Millions of Dollars)

Transit Mode	Vehicle Ownership and Operating Cost Savings	Emission Cost Savings	Safety Cost Savings	Travel Time Value Savings	Total Social Cost Savings
Fixed Route Bus	$46.95	$2.98	$6.09	$48.12	$104.14
Transit Plus	$3.40	$0.22	$0.44	$3.49	$7.54
Total	$50.36	$3.20	$6.53	$51.60	**$111.69**

Similarly, Table 7 on the next page shows total congestion management benefits resulting from the presence of transit services in Madison, and the breakdown by cost saving category and transit service (bus and paratransit). Total congestion management benefits amount to $26 million in Madison in 2004 and are attributable as follows: 45.12 percent to vehicle ownership and operating cost savings, 2.87 percent to emission cost savings, 5.85 percent to safety cost savings and 46.16 percent to travel time value savings.

Table 7: Total Congestion Management Benefits for Madison in 2004 (Millions of Dollars)

Transit Mode	Vehicle Ownership and Operating Cost Savings	Emission Cost Savings	Safety Cost Savings	Travel Time Value Savings	Total Social Cost Savings
Fixed Route Bus	$10.79	$0.69	$1.40	$11.03	$23.90
Paratransit Service	$0.84	$0.05	$0.11	$0.86	$1.86
Total	$11.62	$0.74	$1.51	$11.89	**$25.76**

The congestion management benefit results for 2004 are summarized in the table below. Congestion management benefits amount to $2.53 per trip for Madison (a 6.3 percent increase over 2002) and $2.35 per trip for Milwaukee (a 16.3 percent increase over 2002).

Table 8: Summary of Congestion Management Benefits in 2004

	Madison	Milwaukee
Vehicle Ownership and Operating Cost Savings ($M)	$11.62	$50.36
Emission Cost Savings ($M)	$0.74	$3.20
Safety Cost Savings ($M)	$1.51	$6.53
Travel Time Value Savings ($M)	$11.89	$51.60
Total Congestion Management Benefits ($M)	**$25.76**	**$111.69**
Congestion Management Benefits per Trip	**$2.53**	**$2.35**

3.3 Costs Update

Four major revenue sources are used to sustain the continued operation and maintenance of transit systems in Wisconsin: federal, state and local funds, and farebox revenues. In 2004, more than 53 percent of transit operating and maintenance expenses were covered by "external" funding (federal and state).

Table 9 on page 27 shows operating and maintenance expenses by funding source and system size for 2004. The same transit system categories employed for the estimation of transit benefits have been used: large systems have a ridership of at least 50,000; medium systems have a ridership of 10,000−50,000; and small systems have a ridership of less than 10,000. Madison Metro Transit System and Milwaukee County Transit System have been singled out because of their relatively larger size: together they account for nearly 70 percent of total transit operating expenses in Wisconsin. The table shows both the dollar amount (in millions) for each funding source as well as its percentage share of total operating expenses.

The table also shows that, in general, the larger the system and the higher the percentage share of farebox revenues to cover the operating expense. In small systems, farebox revenues cover only about 17 percent of operating expenses, whereas in Milwaukee they cover 31 percent of operating expenses. This can be partly explained by the fact that many small systems operate only demand response services (paratransit or dial-a-ride services), which are typically more costly than fixed-route bus service.

Table 9: Operating and Maintenance Funds by System Size in 2004 (Millions of Dollars)

Systems	Operating Expenses	Federal Share		State Share		Local Share		Farebox Revenues	
Small Systems	$0.54	$0.17	30.4%	$0.19	34.6%	$0.10	17.8%	$0.09	17.2%
Medium Systems	$6.02	$1.67	27.7%	$2.20	36.6%	$0.77	12.7%	$1.39	23.1%
Large Systems	$69.50	$17.76	25.6%	$24.29	35.0%	$13.45	19.4%	$13.99	20.1%
Madison	$36.66	$4.38	12.0%	$15.17	41.4%	$7.43	20.3%	$9.68	26.4%
Milwaukee	$138.85	$16.41	11.8%	$56.81	40.9%	$22.49	16.2%	$43.13	31.1%
TOTAL	**$251.57**	**$40.39**	**16.1%**	**$98.66**	**39.2%**	**$44.23**	**17.6%**	**$68.28**	**27.1%**

Source: Wisconsin Department of Transportation, Bureau of Transit, Local Roads, Railroads and Harbors

Unlike operating and maintenance funds, capital funds originate exclusively from the Federal Transit Administration. Table 10 below shows the capital funds (by program) allocated to Wisconsin transit systems in 2004. Note that Section 5309 capital funds are only used for tier A and tier B systems (large and medium systems), while Section 5311 funds are only used for tier C systems (small systems).[16] CMAQ (Congestion Mitigation Air Quality) capital funds are only used in southeastern Wisconsin for urbanized transit systems. For comparison purposes, capital funds represented only 8.13 percent of operating and maintenance funds in 2004.

Table 10: Capital Funds by Funding Source in 2004 (Millions of Dollars)

	Section 5311	Section 5309	CMAQ	TOTAL
Capital Funds	$1.67	$18.68	$0.11	**$20.46**

[16] The FTA Section 5309 Capital Grants and Loans Program consists of three separate parts: formula apportionments for fixed guideway modernization; discretionary allocations for the construction of new fixed guideway systems and extensions to existing systems; and discretionary allocations for buses. The FTA Section 5311 is a formula assistance program used to provide federal funding to all legal bodies that provide general public transportation in non- urbanized areas of the state, including Indian Tribes.

4. ELASTICITY ESTIMATES

The relationship between transit funding and transit service on one hand, and between transit service and transit ridership on the other hand, can be measured by means of elasticities. This study relied primarily on the literature to derive the elasticity estimates. When the evidence was too scarce the elasticity was estimated via regression analysis.

4.1 Elasticity of Transit Service with Respect to Transit Funding

Despite a wide body of literature on transit elasticities, little information is available on the effects of funding on transit service.[17] As a result, a multiple regression analysis has been conducted to quantify the relationship between transit funding and transit service in Wisconsin. Multiple regression analysis relates the dependent variable (in this case, transit service) to a set of independent, or explanatory, variables.

The analysis reveals that transit service in Wisconsin can be explained by two main factors: transit funding (expressed in real terms)[18] and the economic activity as measured by the state unemployment rate. Other factors such as fare and population may also influence transit service; however the strength of these effects is not statistically discernible over the study period.

The model has been estimated in EViews with annual data (1990−2003), using the Ordinary Least Squares (OLS) method. A double-log functional form was preferred to other functional forms (i.e., linear or semi-log models) because it was found to better fit the data. In a double-log model (or constant elasticity model), the coefficients can be directly interpreted as "elasticity coefficients" i.e., they indicate the percentage change in the dependent variable brought about by a one-percent change in the associated explanatory variable, other things being equal.

Regression results corresponding to the estimation of the model specified above are provided in Figure 9 and Figure 10 on the next page. The R-squared statistic (or coefficient of determination) measures the goodness of fit of the model, or how much of the variations in rental car transactions are attributable to changes in the explanatory variables. As shown in Figure 9, the model has a high R-squared: its value of 0.910977 indicates that the model explains more than 91 percent of the annual variations in vehicle miles.

The large F-statistic further indicates that the *joint* impact of the explanatory variables is statistically different from zero. As indicated by the t-statistics, the explanatory variables, taken *individually*, are statistically significant at the 1 percent level. Their coefficients have a sign conform to expectations. Other things being equal, an increase in transit funds will result in an increase in vehicle miles.

The computed transit funding elasticity is 0.71: for every one percent increase in real transit funds, vehicle miles are expected to increase by 0.71 percent. *Note that, given the small size of the regression sample (14 observations) this estimate should be interpreted with caution*.

[17] Only one reference was found. Lewis and Williams (1999) used a median elasticity of 1.8 to assess the low cost mobility benefits of transit at the national level.
[18] Transit funding has been deflated by the U.S. Consumer Price Index (CPI). This removes all inflationary movements from that variable, allowing transit funding to be expressed in real dollars.

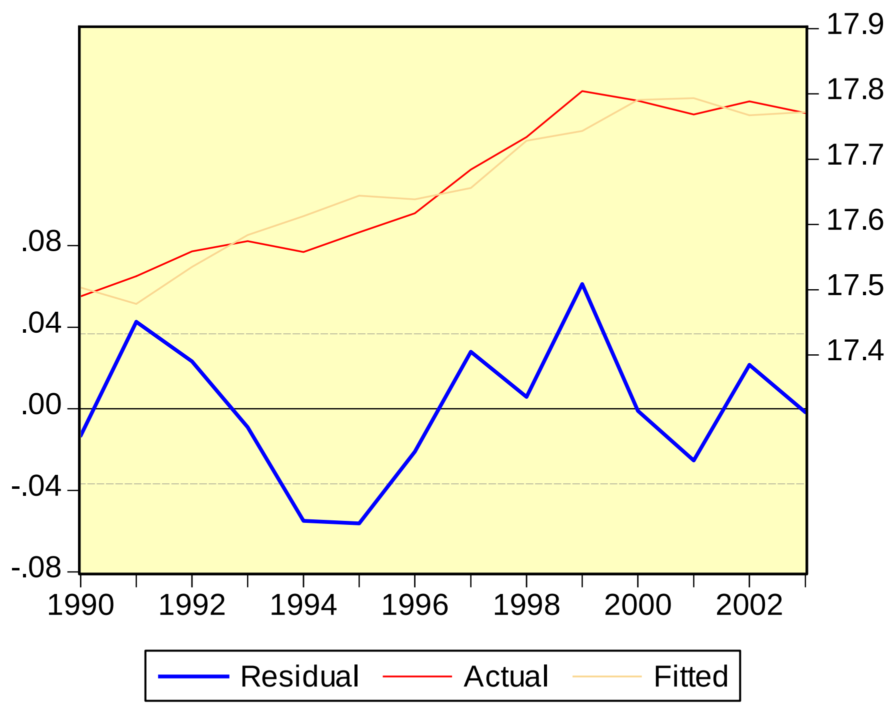
Figure 9: Regression Analysis Output

Dependent Variable: Log(Total Vehicle Miles)
Method: Least Squares
Sample (adjusted): 1990 2003
Included observations: 14 after adjustments

Independent Variable	Coefficient	Standard Error	t-Statistic	Probability of Statistical Insignificance
Constant	4.072315	1.300227	3.132002	0.0095
Log(Real Operating and Maintenance Funds)	0.719377	0.070923	10.143020	0.0000
Log(Unemployment Rate)	-0.159875	0.050812	-3.146437	0.0093
R-squared	0.910977	Mean dependent var		17.660530
Adjusted R-squared	0.894791	S.D. dependent var		0.113494
S.E. of regression	0.036813	Akaike info criterion		-3.578531
Sum squared resid	0.014907	Schwarz criterion		-3.441590
Log likelihood	28.049720	F-statistic		56.281990
Durbin-Watson stat	1.412453	Prob(F-statistic)		0.000002

Figure 10 shows actual vehicle miles (in log), the fitted values (i.e., log of vehicle miles as estimated by the model) and the model residuals (i.e., the discrepancies between the actual and fitted values, or what is left unexplained by the model) over the sample period. Note that actual and fitted values are scaled on the right axis, while residuals are scaled on the left axis. The graph shows the goodness-of-fit of the model, or how well the model tracks the actual data.

Figure 10: Actual, Fitted and Residuals



4.2 Elasticity of Transit Ridership with Respect to Transit Service

Transit service elasticity measures the extent to which transit ridership changes in response to a change in transit vehicle mileage. Various factors affect transit service elasticities, including population density, fare, and service quality (i.e., speed, schedule information, safety and comfort).

A recent study conducted by Pratt and Evans (2004)[19] supports the existence of a positive relationship between transit service and transit ridership: a reduction in service typically generates a reduction in ridership; whereas an increase in service typically generates an increase in ridership. The study prepared for the Transportation Research Board (TRB) relied on a meta-analysis of North American case studies published over the last forty years. It was found that ridership response to bus transit expansion was typically in the 0.6 to 1.0 range, although broader variations were reported (from 0.3 to 1.4). Variations in the ridership response were partly attributed to differences in the system size: "The degree of ridership response to changes in transit service appears to be greater in small cities, in suburbs, and in the off-peak, i.e., wherever and whenever initial transit service levels tend to be lower than average. Large scale suburban service expansions under favorable conditions have produced ridership growth proportionally in excess of service increases over substantial periods of time."

In the same way, a compilation of transportation elasticities by the Victoria Transport Policy Institute (VTPI) found the elasticity of transit ridership with respect to transit service ranging from 0.5 to 0.7 in the short run (first year) and increasing to about 0.7 to 1.1 over the long run (five to ten years).[20] Note that an elasticity higher than 1.0 indicates a demand response which is more than proportionate to the change in transit service. For this study, a central estimate of 0.9 is used throughout the analysis period: for every one percent increase in transit service, transit ridership is expected to increase by 0.9 percent.

[19] Pratt, Richard H. and John E. Evans, *Traveler Response to Transportation System Changes*, TCRP Report 95, Chapter 10—Bus Routing and Coverage, prepared for the Transportation Research Board, Transit Cooperative Research Program, 2004.

[20] Litman, Todd, *Transportation Elasticities, How Prices and Other Factors Affect Travel Behavior*, Victoria Transport Policy Institute, November 2005, pp. 41−42.

5. BENEFIT-COST ANALYSIS RESULTS

This chapter presents the results of the benefit-cost analysis of transit in Wisconsin. Transit benefits have been estimated over a 20-year period, from 2005 to 2024, and compared with projected level of public funding.

Section 5.1 presents (in a risk analysis format) key assumptions used in the benefit-cost analysis model. Estimates of transit ridership, benefits and costs over the period 2005 to 2024 are provided in Section 5.2. Section 5.3 summarizes the results of the benefit-cost analysis.

5.1 Model Assumptions

Key assumptions used in the benefit-cost analysis model are presented in the following tables.

Table 11 below presents the forecasting assumptions for federal, state and local funding. For the sake of simplicity, it is assumed that the average annual compound growth rates are the same across the three system categories considered in the analysis. Three scenarios have been considered for state funding: a "do minimal" or Base Case scenario where state funding would grow at the rate of inflation,[21] an optimistic scenario (Scenario A) and a pessimistic scenario (Scenario B). Note again that, throughout the benefit-cost analysis, benefits and costs are expressed in *real* (or constant) dollars (i.e., they are adjusted for inflation).[22]

Table 11: Transit Public Funding Assumptions

<table>
<tr><th colspan="2">Variable</th><th>Median</th><th>Lower 10% Limit</th><th>Upper 10% Limit</th></tr>
<tr><td colspan="2">Average annual compound growth rate in real federal funding (2005-2024)</td><td>3.5%</td><td>2.5%</td><td>4.5%</td></tr>
<tr><td rowspan="3">Average annual compound growth rate in real state funding (2005-2024)</td><td><u>Base Case</u></td><td>0.0%</td><td>0.0%</td><td>0.0%</td></tr>
<tr><td><u>Scenario A</u></td><td>2.5%</td><td>1.5%</td><td>3.5%</td></tr>
<tr><td><u>Scenario B</u></td><td>-2.5%</td><td>-3.5%</td><td>-1.5%</td></tr>
<tr><td colspan="2">Average annual compound growth rate in real local funding (2005-2024)</td><td>0.0%</td><td>-1.0%</td><td>1.0%</td></tr>
</table>

Table 12, on the following page, shows the model assumptions pertaining to the elasticity of transit ridership with respect to transit service, and the elasticity of transit service with respect to (*real*) public funding. The median estimate for the elasticity of transit service with respect to (*real*) public funding has been derived from a regression analysis of transit service in Wisconsin (annual vehicle miles has been regressed on annual real public funding and other socioeconomic variables); ranges have been determined based on a survey of existing transit elasticities. Estimates for the elasticity of transit ridership with respect to transit service have been derived from a literature survey.

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[21] In other words, the average annual compound growth rate in *real* state funding would be 0 percent.
[22] A two percent annual inflation rate can be assumed in Wisconsin over the analysis period.

Table 12: Elasticity Assumptions

Variable	Median	Lower 10% Limit	Upper 10% Limit
Elasticity of transit ridership with respect to transit service	0.90	0.70	1.80
Elasticity of transit service with respect to (real) public funding	0.75	0.60	1.60

Sources: Victoria Transport Institute and HDR|HLB Decision Economics Inc.

5.2 Transit Ridership, Benefits and Costs (2005 – 2024)

Transit benefits have been estimated from 2005 to 2024 and compared with projected public funding. Note that this section reports only the mean expected outcome (or "most likely" outcome) of the simulation. Complete risk analysis results are provided in Appendix 4. As a reminder (see Section 2.4.1), congestion management benefits for Madison and Milwaukee as well as the macroeconomic effects of out-of-pocket savings are excluded from the benefit-cost analysis. Results for these benefits are presented in Appendix 2 and Appendix 5 respectively.

Table 13 through Table 15 below show total ridership (in millions) by system size and trip purpose over 2005-2024, for each scenario. The distribution of ridership by trip purpose and system size is assumed constant throughout the period. Under the Base Case, ridership in Wisconsin totals 2.16 billion (including 2.13 billion for large systems). Under Scenario A, total ridership tops 2.60 billion, a 20.41 percent increase over the Base Case. Under Scenario B, total ridership is estimated at 1.87 billion, a 13.33 percent decrease over the Base Case.

Table 13: Ridership by System Size and Trip Purpose, in Millions (2005 – 2014) – Base Case

Trip Purpose	System Size			Total
	Large	Medium	Small	
Trips for Medical Purposes	214.56	4.95	0.97	220.48
Trips for Work Purposes	1,044.66	8.94	1.06	1,054.66
Trips for Education Purposes	494.77	4.35	0.23	499.36
Trips for Shopping, Tourism or Recreation Purposes	380.82	7.37	0.44	388.63
Total Ridership	2,134.81	25.61	2.71	2,163.13

Table 14: Ridership by System Size and Trip Purpose, in Millions (2005 – 2014) – Scenario A

Trip Purpose	System Size			Total
	Large	Medium	Small	
Trips for Medical Purposes	258.55	5.65	1.12	265.32
Trips for Work Purposes	1,258.74	10.22	1.22	1,270.18
Trips for Education Purposes	596.12	4.96	0.27	601.35
Trips for Shopping, Tourism or Recreation Purposes	458.79	8.42	0.51	467.72
Total Ridership	2,572.19	29.26	3.12	2,604.57
% Change with Respect to Base Case	20.49%	14.23%	15.29%	20.41%

Table 15: Ridership by System Size and Trip Purpose, in Millions (2005 – 2014) – Scenario B

Trip Purpose	System Size			Total
	Large	Medium	Small	
Trips for Medical Purposes	185.84	4.48	0.88	191.19
Trips for Work Purposes	904.87	8.09	0.95	913.91
Trips for Education Purposes	428.60	3.93	0.21	432.74
Trips for Shopping, Tourism or Recreation Purposes	329.84	6.66	0.40	336.91
Total Ridership	1,849.16	23.16	2.44	1,874.75
% Change with Respect to Base Case	-13.38%	-9.58%	-9.93%	-13.33%

In accordance with the methodology laid down in Chapter 2, these ridership estimates are subsequently used to measure the benefits of transit in the employment, healthcare, education, and retail, recreation and tourism sectors.

The following charts show annual transit benefits and costs in real dollars over the study period for the Base Case, Scenario A and Scenario B respectively. Note that, in the graphs, the portion of operating and maintenance costs covered by farebox revenues is excluded. This is to ensure that transit fare is not double-counted in the benefit-cost analysis. Transit costs are already accounted for in the estimation of benefits (see Section 2.2.2, page 11). Transit costs in 2024 are expected to reach $255.5 million under the Base Case, $319.9 million under Scenario A, and $214.5 million under Scenario B.

Figure 11: Total Transit Benefits and Costs, in Real Dollars (2005 – 2024) – Base Case

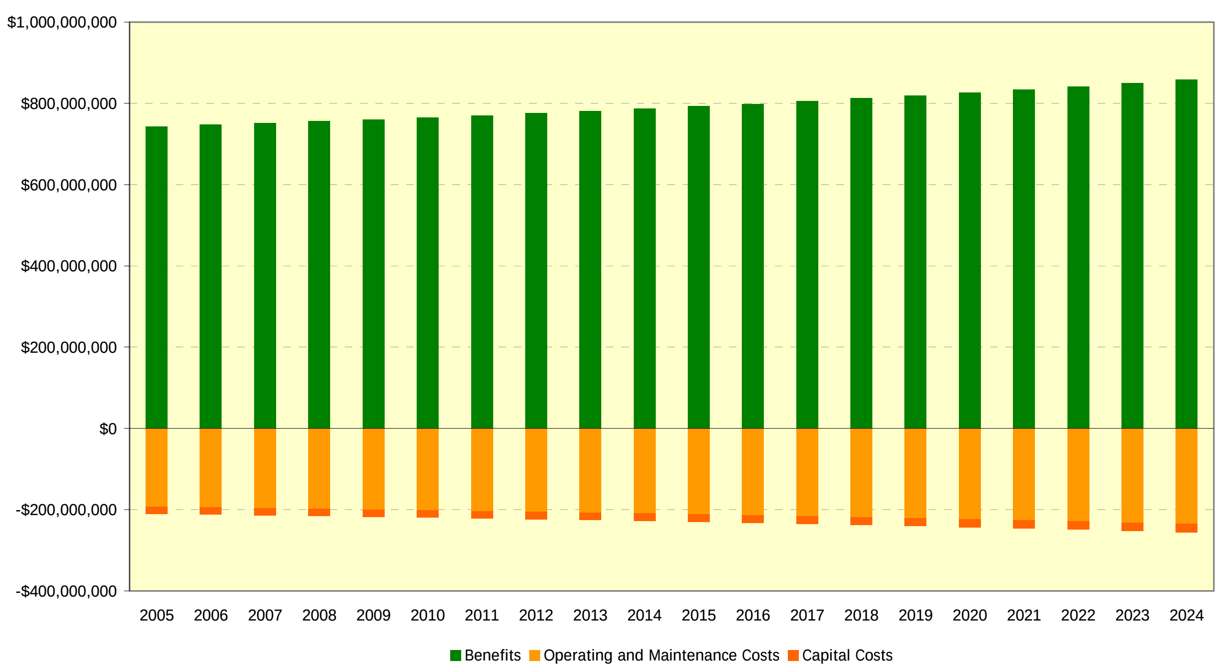


Figure 12: Total Transit Benefits and Costs, in Real Dollars (2005 – 2024) – Scenario A

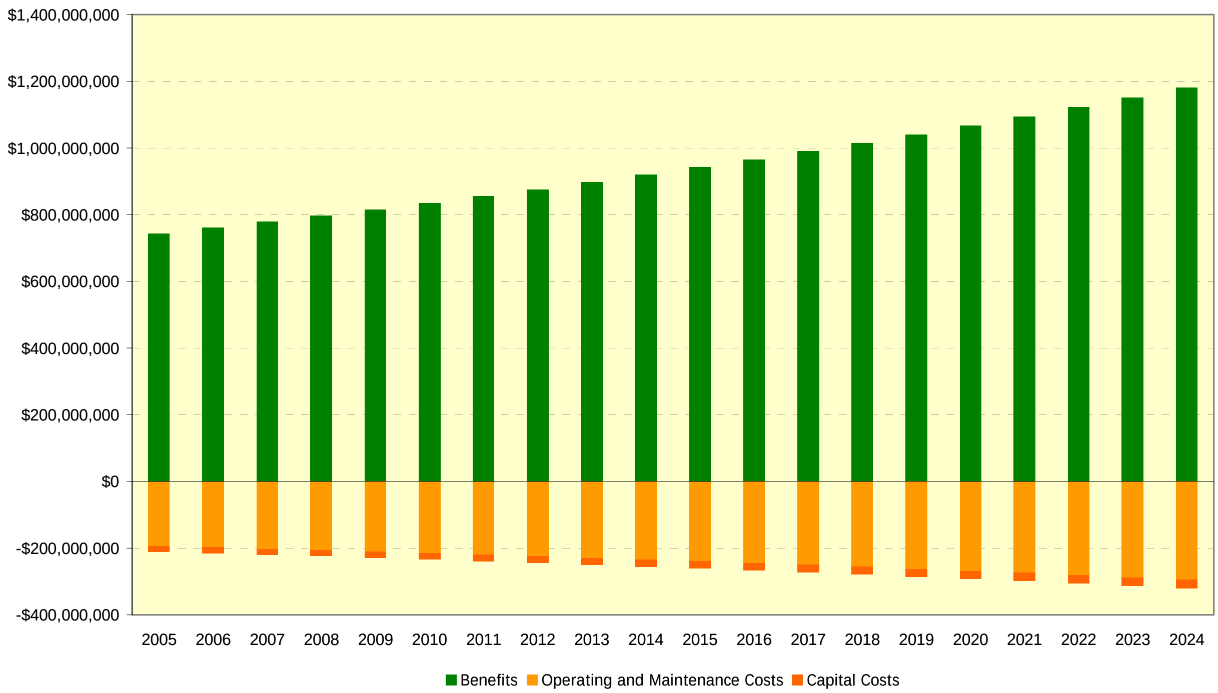


Figure 13: Total Transit Benefits and Costs, in Real Dollars (2005 – 2024) – Scenario B

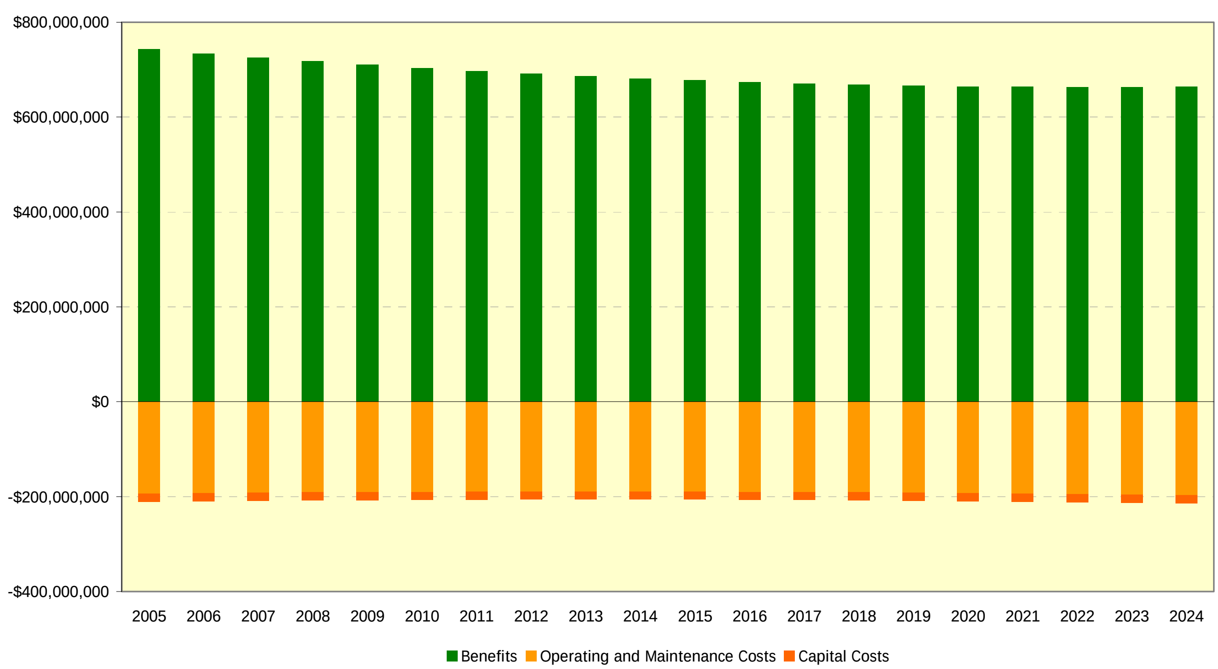


Figure 14 through Figure 16 show transit benefits in real dollars over the same period. Benefits are broken down by socioeconomic sector: employment; healthcare; education; and retail, tourism and recreation. The red line in the chart represents total transit ridership. Transit benefits in Wisconsin in 2024 are expected to total $858.4 million under the Base Case, $1.2 billion under Scenario A, and $664.2 million under Scenario B. It is noteworthy that, under Scenario B, transit ridership increases from 2020 onwards. This means that, starting in 2020, the increase in local and federal funding more than offsets the decrease in state funding, which leads to an increase in ridership.

Figure 14: Transit Benefits by Sector, in Real Dollars (2005 – 2024) – Base Case

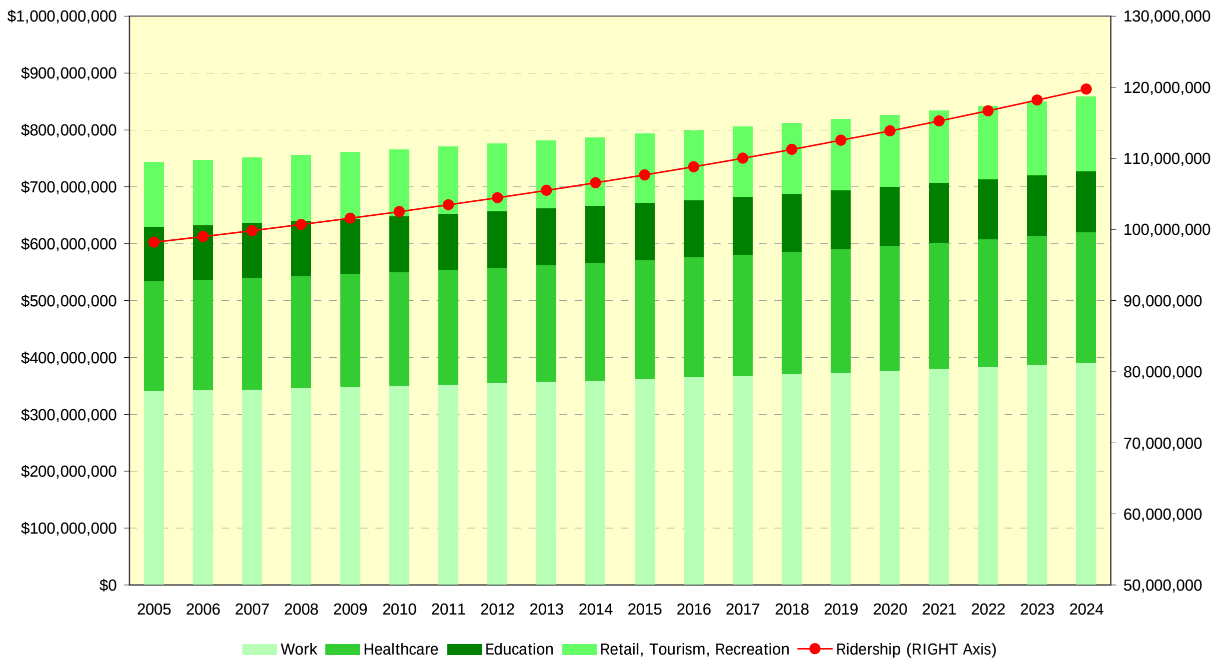


Figure 15: Transit Benefits by Sector, in Real Dollars (2005 – 2024) – Scenario A

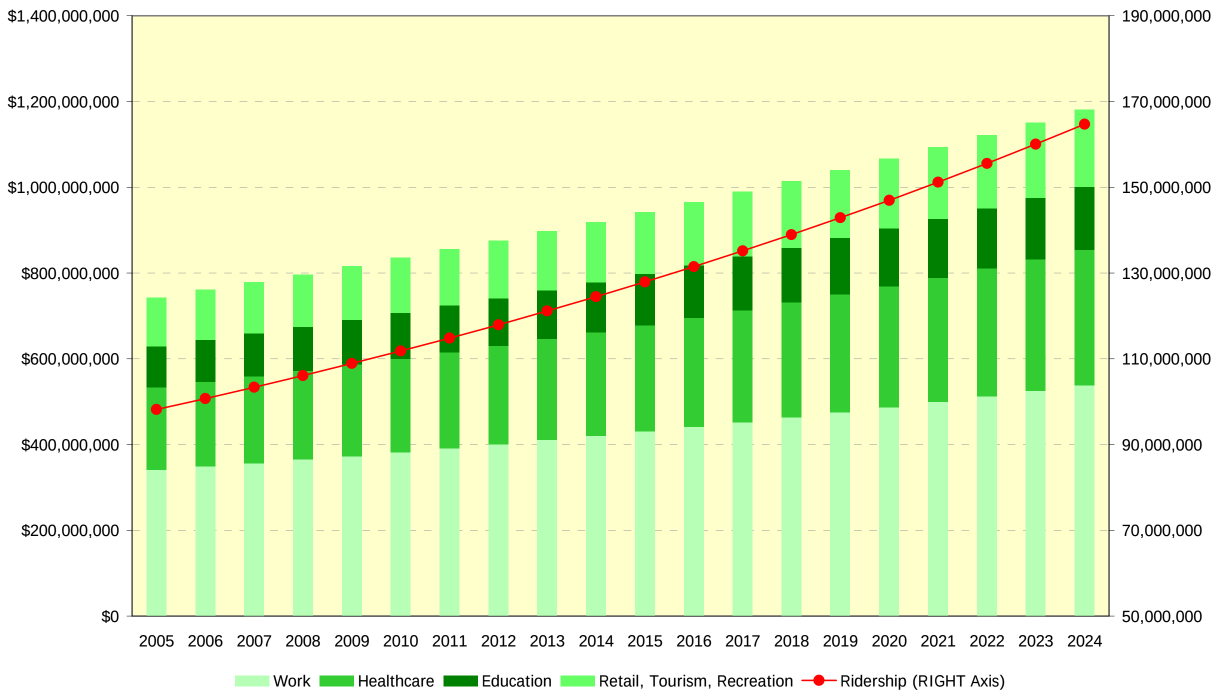


Figure 16: Transit Benefits by Sector, in Real Dollars (2005 – 2024) – Scenario B

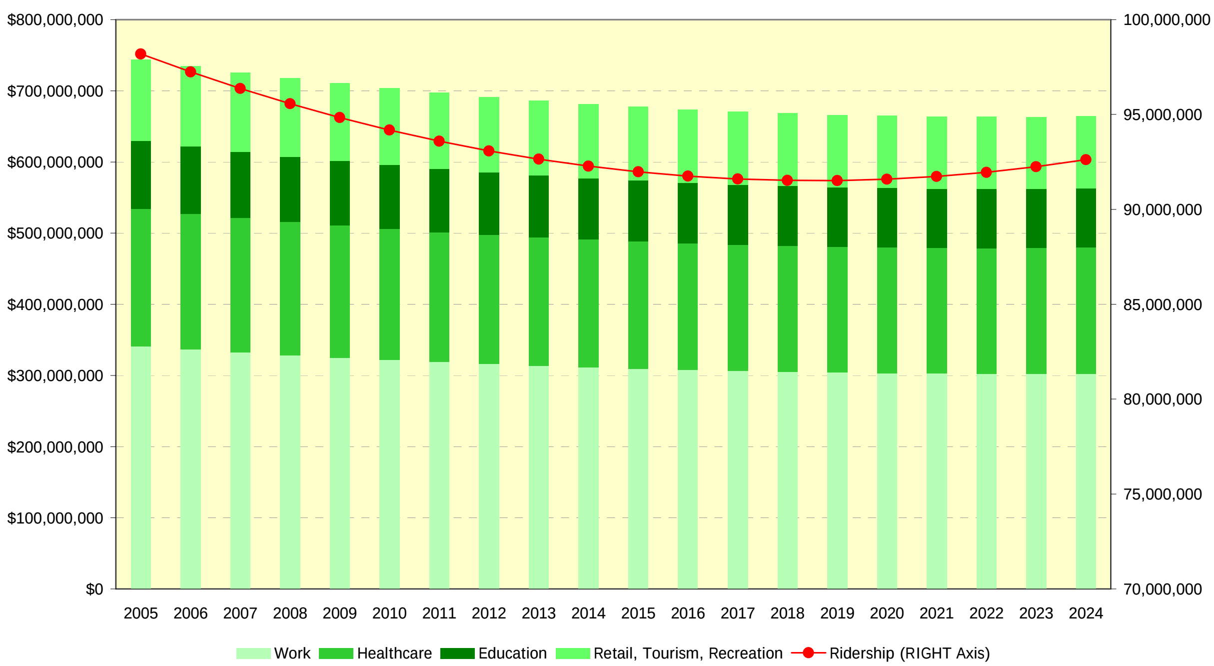


Table 16 below shows the benefit estimates, under the Base Case, at the beginning (2005), the middle (2015) and the end (2024) of the analysis period. Transit benefits are expressed in millions of real dollars, and broken down by socioeconomic sector and system size. Total annual benefits are expected to increase by just 15.5 percent between 2005 and 2024. Given that transit benefits depend indirectly on the level of funding, whose rate of growth is assumed the same across all system sizes, the percentage of total benefits originating in large systems remains constant over time (98.7 percent).

Table 16: Transit Benefits by System Size and Socioeconomic Sector, in Millions of Real Dollars (2005, 2015 and 2024) – Base Case

Benefit Categories	**2005**	**2015**	**2024**
Large Systems			
Healthcare	$189.17	$204.26	$223.79
Work	$337.35	$358.65	$386.99
Education	$95.21	$100.13	$106.86
Retail, Tourism and Recreation	$112.11	$118.98	$128.17
Subtotal Large Systems	**$733.84**	**$782.02**	**$845.80**
Medium Systems			
Healthcare	$3.42	$3.91	$4.55
Work	$2.83	$3.20	$3.68
Education	$0.23	$0.26	$0.29
Retail, Tourism and Recreation	$2.03	$2.29	$2.62
Subtotal Medium Systems	**$8.51**	**$9.66**	**$11.15**
Small Systems			
Healthcare	$0.59	$0.71	$0.86
Work	$0.32	$0.38	$0.46
Education	$0.03	$0.03	$0.04
Retail, Tourism and Recreation	$0.10	$0.12	$0.14
Subtotal Small Systems	**$1.04**	**$1.24**	**$1.49**
TOTAL BENEFITS	**$743.39**	**$792.92**	**$858.44**

Similarly, Table 17 and Table 18 on page 38 show the benefit estimates under Scenario A and Scenario B. Between 2005 and 2024, total annual benefits are expected to increase by 58.9 percent for Scenario A, and decline by 10.7 percent for Scenario B. Note that, since the level of funding is already known for 2005, annual transit benefits are the same for that year for all three funding alternatives.

Table 17: Transit Benefits by System Size and Socioeconomic Sector, in Millions of Real Dollars (2005, 2015 and 2024) – Scenario A

Benefit Categories	2005	2015	2024
Large Systems			
Healthcare	$189.17	$242.86	$308.33
Work	$337.35	$426.42	$533.18
Education	$95.21	$119.05	$147.23
Retail, Tourism and Recreation	$112.11	$141.47	$176.59
Subtotal Large Systems	**$733.84**	**$929.79**	**$1,165.33**
Medium Systems			
Healthcare	$3.42	$4.42	$5.66
Work	$2.83	$3.61	$4.58
Education	$0.23	$0.29	$0.37
Retail, Tourism and Recreation	$2.03	$2.58	$3.26
Subtotal Medium Systems	**$8.51**	**$10.90**	**$13.86**
Small Systems			
Healthcare	$0.59	$0.80	$1.06
Work	$0.32	$0.43	$0.56
Education	$0.03	$0.04	$0.05
Retail, Tourism and Recreation	$0.10	$0.14	$0.18
Subtotal Small Systems	**$1.04**	**$1.40**	**$1.85**
TOTAL BENEFITS	**$743.39**	**$942.09**	**$1,181.03**

Table 18: Transit Benefits by System Size and Socioeconomic Sector, in Millions of Real Dollars (2005, 2015 and 2024) – Scenario B

Benefit Categories	2005	2015	2024
Large Systems			
Healthcare	$189.17	$174.38	$172.89
Work	$337.35	$306.19	$298.97
Education	$95.21	$85.48	$82.56
Retail, Tourism and Recreation	$112.11	$101.58	$99.02
Subtotal Large Systems	**$733.84**	**$667.64**	**$653.44**
Medium Systems			
Healthcare	$3.42	$3.52	$3.87
Work	$2.83	$2.88	$3.13
Education	$0.23	$0.23	$0.25
Retail, Tourism and Recreation	$2.03	$2.06	$2.23
Subtotal Medium Systems	**$8.51**	**$8.69**	**$9.48**
Small Systems			
Healthcare	$0.59	$0.64	$0.73
Work	$0.32	$0.34	$0.39
Education	$0.03	$0.03	$0.03
Retail, Tourism and Recreation	$0.10	$0.11	$0.12
Subtotal Small Systems	**$1.04**	**$1.11**	**$1.28**
TOTAL BENEFITS	**$743.39**	**$677.45**	**$664.20**

5.3 Benefit-Cost Analysis Results

The benefit-cost analysis results are summarized for each funding scenario in Table 19 through Table 21 below. Note that only the mean expected values are reported in this section. Complete risk analysis results (mean expected outcome, lower 10 percent estimate and upper 10 percent estimate) are provided in Appendix 4.

Under the Base Case, total transit benefits are expected to reach $9.7 billion in present value terms over the analysis period. Employment related benefits, with an expected $4.5 billion, account for more than 45 percent of these benefits. The net present value is expected to reach $6.9 billion (in real dollars), which represents an annual return on investment of 6.25 percent over the period 2005-2024.

Table 19: Benefit-Cost Analysis Results, in Millions of Real Dollars (2005 – 2024) – Base Case

Category	Mean Expected Value
Present Value of Healthcare Benefits	$2,572
Present Value of Employment Benefits	$4,451
Present Value of Education Benefits	$1,233
Present Value of Retail, Tourism and Recreation Benefits	$1,491
Present Value of Total Benefits	$9,746
Present Value of Operating and Maintenance Costs	$2,602
Present Value of Capital Costs	$233
Present Value of Total Costs	$2,835
Net Present Value	**$6,912**
Benefit/Cost Ratio	**3.44**
Return on Investment (Annualized)	**6.25%**

Note: Present values are calculated based on an expected real discount rate of 5.0 percent.

In the same way, under Scenario A, the net present value is expected to reach $8.2 billion (in real dollars), which represents an annual return on investment of 6.51 percent over the period 2005-2024; and under Scenario B, the net present value is expected to reach only $6.0 billion (in real dollars), which represents an annual return on investment of 6.03 percent over the period 2005-2024. Compared to the base case, the net present value rises by $1.3 billion (+ 18.9 percent) with a 2.5 percent increase in state funding, but it declines by $0.9 billion (-12.6 percent) with a 2.5 percent decrease in state funding.

Under each scenario the benefits outweigh the costs (i.e., the net present value is positive) and the return on investment is higher than the opportunity cost of capital of 5.0 percent used in the analysis. However, *choosing Scenario A will maximize both the net benefits and the return on investment.* Therefore, investing in transit in Wisconsin is economically worthwhile.

Table 20: Benefit-Cost Analysis Results, in Millions of Real Dollars (2005 – 2024) – Scenario A

Category	Mean Expected Value
Present Value of Healthcare Benefits	$3,001
Present Value of Employment Benefits	$5,190
Present Value of Education Benefits	$1,437
Present Value of Retail, Tourism and Recreation Benefits	$1,737
Present Value of Total Benefits	$11,366
Present Value of Operating and Maintenance Costs	$2,886
Present Value of Capital Costs	$258
Present Value of Total Costs	$3,144
Net Present Value	**$8,221**
Benefit/Cost Ratio	**3.61**
Return on Investment (Annualized)	**6.51%**

Note: Present values are calculated based on an expected real discount rate of 5.0 percent.

Table 21: Benefit-Cost Analysis Results, in Millions of Real Dollars (2005 – 2024) – Scenario B

Category	Mean Expected Value
Present Value of Healthcare Benefits	$2,280
Present Value of Employment Benefits	$3,949
Present Value of Education Benefits	$1,095
Present Value of Retail, Tourism and Recreation Benefits	$1,323
Present Value of Total Benefits	$8,648
Present Value of Operating and Maintenance Costs	$2,391
Present Value of Capital Costs	$214
Present Value of Total Costs	$2,605
Net Present Value	**$6,043**
Benefit/Cost Ratio	**3.32**
Return on Investment (Annualized)	**6.03%**

Note: Present values are calculated based on an expected real discount rate of 5.0 percent.

APPENDIX 1: TRANSIT BENEFITS FROM 2003 STUDY

Table A–1: Healthcare Cost Savings (Millions of Dollars)

Savings	System Size			Total
	Small	Medium	Large	
Consumer Surplus	$2.21	$5.84	$125.86	$133.92
Home Healthcare Savings	$1.28	$3.85	$53.76	$58.89
Total Savings	**$3.48**	**$9.69**	**$179.63**	**$192.80**

Table A–2: Work Cost Savings (Millions of Dollars)

Savings	System Size			Total
	Small	Medium	Large	
Consumer Surplus	$1.31	$5.86	$251.87	$259.05
Public Assistance	$0.60	$2.23	$71.42	$74.26
Total Savings	**$1.92**	**$8.10**	**$323.30**	**$333.31**

Table A–3: Education Cost Savings (Millions of Dollars)

Savings	System Size		
	Small	Medium	Large
Consumer Surplus	$0.17	$0.65	90.48
Total Savings Across Systems			**$91.30**

Table A–4: Retail Recreation and Tourism Cost Savings (Millions of Dollars)

Savings	System Size		
	Small	Medium	Large
Consumer Surplus	$0.60	$5.74	$106.42
Total Savings Across Systems			**$112.76**

Table A–5: Transit Benefits by Trip Purpose and System Size (Millions of Dollars)

Trip Purpose	System Size			Total
	Small	Medium	Large	
Healthcare	$3.48	$9.69	$179.63	$192.80
Work	$1.92	$8.11	$323.30	$333.31
Education	$0.17	$0.66	$90.48	$91.30
Retail, Tourism and Recreation	$0.60	$5.74	$106.42	$112.76
Total	**$6.17**	**$24.21**	**$699.83**	**$730.16**

APPENDIX 2: CONGESTION MANAGEMENT BENEFITS (2004 – 2024)

Table A-6 through Table A-8 summarize the congestion management benefits for Madison Metro Transit System (MMTS) and Milwaukee County Transit System (MCTS) in 2004, 2014 and 2024.

Table A–6: Summary of Congestion Management Benefits in 2004 (Millions of Real Dollars)

	Madison	Milwaukee
Vehicle Ownership and Operating Cost Savings	$11.62	$50.36
Emission Cost Savings	$0.74	$3.20
Safety Cost Savings	$1.51	$6.53
Travel Time Value Savings	$11.89	$51.60
Total Congestion Management Benefits	**$25.76**	**$111.69**

Table A–7: Summary of Congestion Management Benefits in 2014 (Millions of Real Dollars)

	Madison	Milwaukee
Vehicle Ownership and Operating Cost Savings	$12.93	$56.02
Emission Cost Savings	$0.82	$3.56
Safety Cost Savings	$1.68	$7.26
Travel Time Value Savings	$13.23	$57.41
Total Congestion Management Benefits	**$28.66**	**$124.25**

Table A–8: Summary of Congestion Management Benefits in 2024 (Millions of Real Dollars)

	Madison	Milwaukee
Vehicle Ownership and Operating Cost Savings	$14.51	$62.88
Emission Cost Savings	$0.92	$3.99
Safety Cost Savings	$1.88	$8.15
Travel Time Value Savings	$14.85	$64.44
Total Congestion Management Benefits	**$32.17**	**$139.47**

APPENDIX 3: PRIMER ON RISK ANALYSIS

Economic forecasts traditionally take the form of a single "expected outcome" supplemented with alternative scenarios. The limitation of a forecast with a single expected outcome is clear -- while it may provide the single best statistical estimate, it offers no information about the range of other possible outcomes and their associated probabilities. The problem becomes acute when uncertainty surrounding the forecast's underlying assumptions is material.

A common approach is to create "high case" and "low case" scenarios to bracket the central estimate. This scenario approach can exacerbate the problem of dealing with risk because it gives no indication of likelihood associated with the alternative outcomes. The commonly reported "high case" may assume that most underlying assumptions deviate in the same direction from their expected value, and likewise for the "low case." In reality, the likelihood that all underlying factors shift in the same direction simultaneously is just as remote as that of everything turning out as expected.

Another common approach to providing added perspective on reality is "sensitivity analysis." Key forecast assumptions are varied one at a time in order to assess their relative impact on the expected outcome. A problem here is that the assumptions are often varied by arbitrary amounts. A more serious concern with this approach is that, in the real world, assumptions do not veer from actual outcomes one at a time. It is the impact of simultaneous differences between assumptions and actual outcomes that is needed to provide a realistic perspective on the riskiness of a forecast.

Risk Analysis provides a way around the problems outlined above. It helps avoid the lack of perspective in "high" and "low" cases by measuring the probability or "odds" that an outcome will actually materialize. This is accomplished by attaching ranges (probability distributions) to the forecasts of each input variable. The approach allows all inputs to be varied simultaneously within their distributions, thus avoiding the problems inherent in conventional sensitivity analysis. The approach also recognizes interrelationships between variables and their associated probability distributions.

The Risk Analysis Process involves four steps:

Step 1: Define the structure and logic of the forecasting problem;

Step 2: Assign estimates and ranges (probability distributions) to each variable and forecasting coefficient in the forecasting structure and logic;

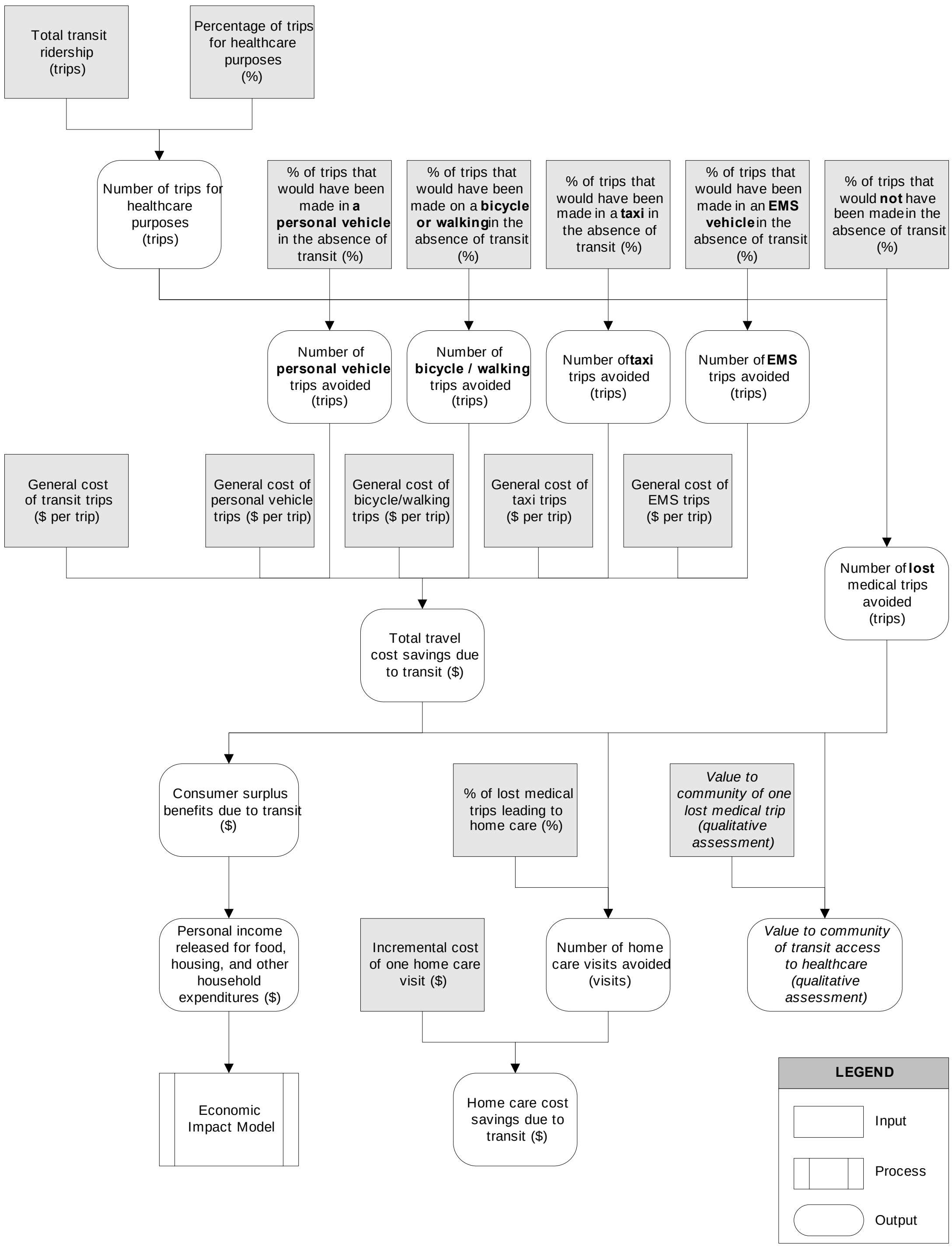
Step 3: Engage experts and stakeholders in assessment of model and assumption risks (the "RAP Session"); and

Step 4: Issue forecast risk analysis.

Step 1: Define Structure and Logic of the Forecasting Problem

A "structure and logic model" depicts the variables and cause and effect relationships that underpin the forecasting problem at-hand (Figure A-1). Although the structure and logic model is written down mathematically to facilitate analysis, it is also depicted diagrammatically in order to permit stakeholder scrutiny and modification in Step 3 of the process (see below).

Figure A–1: Example of Structure and Logic Model



Step 2: Assign Central Estimates and Conduct Probability Analysis

Each variable is assigned a central estimate and a range (a probability distribution) to represent the degree of uncertainty. Special data sheets are used (see Table A-9) to record the estimates. The first column gives an initial median while the second and third columns define an uncertainty range representing an 80 percent confidence interval. This is the range within which there exists an 80 probability finding the actual outcome. The greater the uncertainty associated with a forecast variable the wider the range.

Table A–9: Example of Data Sheet, Percentage of Trips for Healthcare Purposes

Variable	Median	10% Lower Limit	10% Upper Limit
Percentage of trips for healthcare purposes	10%	7%	13%

Probability ranges are established on the basis of both statistical analysis and subjective probability. Probability ranges need not be normal or symmetrical -- that is, there is no need to assume the bell shaped normal probability curve. The bell curve assumes an equal likelihood of being too low and being too high in forecasting a particular value. It might well be, for example, that if a projected percentage deviates from expectations; circumstances are such that it is more likely to be higher than the median expected outcome than lower.

The RAP computer program transforms the ranges as depicted above into formal probability distributions (or "probability density functions"). This liberates the non-statistician from the need to appreciate the abstract statistical depiction of probability and thus enables stakeholders to understand and participate in the process whether or not they possess statistical training.

From where do the central estimates and probability ranges for each assumption in the forecasting structure and logic framework come? There are two sources. The first is an historical analysis of statistical uncertainty in all variables and an error analysis of the forecasting "coefficients." "Coefficients" are numbers that represent the measured impact of one variable (say, income) on another (such as retail sales). While these coefficients can only be known with uncertainty, statistical methods help uncover the magnitude of such error (using diagnostic statistics such as "standard deviation," "standard error," "confidence intervals" and so on).

The uncertainty analysis outlined above is known in the textbooks as "frequentist" probability. The second line of uncertainty analysis employed in risk analysis is called "subjective probability" (also called "Bayesian" statistics, for the mathematician Bayes who developed it). Whereas a frequentist probability represents the measured frequency with which different outcomes occur (i.e., the number of heads and tails after thousands of tosses) the Bayesian probability of an event occurring is the degree of belief held by an informed person or group that it will occur. Obtaining subjective probabilities is the subject of Step 3.

Step 3: Conduct Expert Evaluation: The RAP Session

Step 3 involves the formation of an expert panel and the use of facilitation techniques to elicit, from the panel, risk and probability beliefs about:

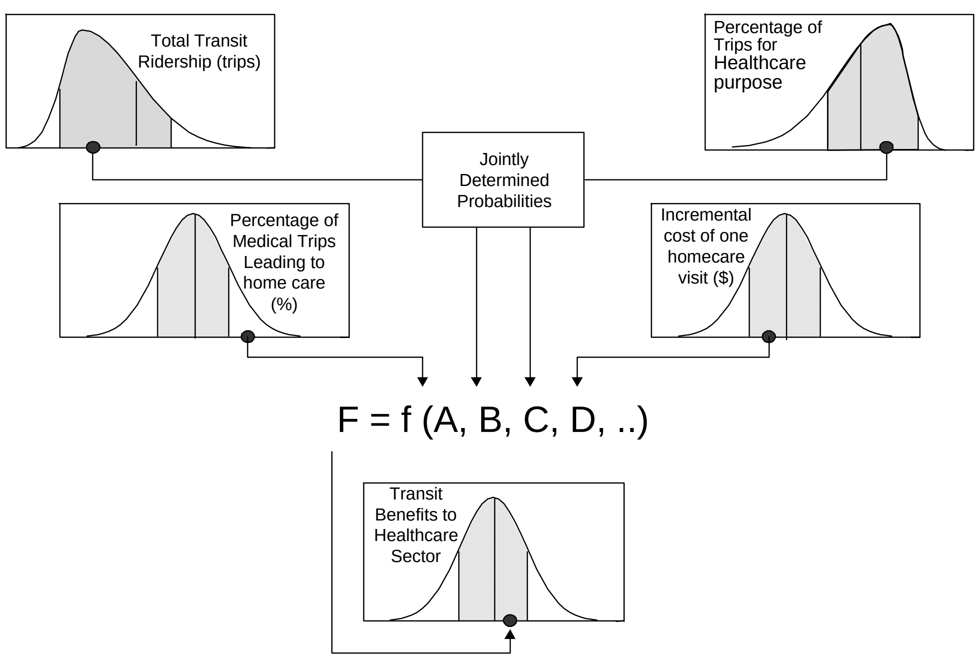
- The structure of the forecasting framework; and
- The degree of uncertainty attached to each variable and forecasting coefficient within the framework.

In (1), experts are invited to add variables and hypothesized causal relationships that may be material, yet missing from the model. In (2), panelists are engaged in a discursive protocol during which the frequentist-based central estimates and ranges, provided to panelists in advance of the session, are modified according to subjective expert beliefs. This process is aided with an interactive "groupware" computer tool that permits the visualization of probability ranges under alternative belief systems.

Step 4: Issue Risk Analysis

The final probability distributions are formulated by the risk analyst (HDR|HLB) and represent a combination of "frequentist" and subjective probability information drawn from Step 3. These are combined using a simulation technique (Monte Carlo analysis) that allows each variable and forecasting coefficient to vary simultaneously according to its associated probability distribution (see Figure A–2, below).

Figure A–2: Combining Probability Distributions



The end result is a central forecast, together with estimates of the probability of achieving alternative outcomes given uncertainties in underlying variables and coefficients (see Figure A–3 and Table A–10, below).

Figure A–3: Risk Analysis of Homecare Cost Savings, *an Illustration*

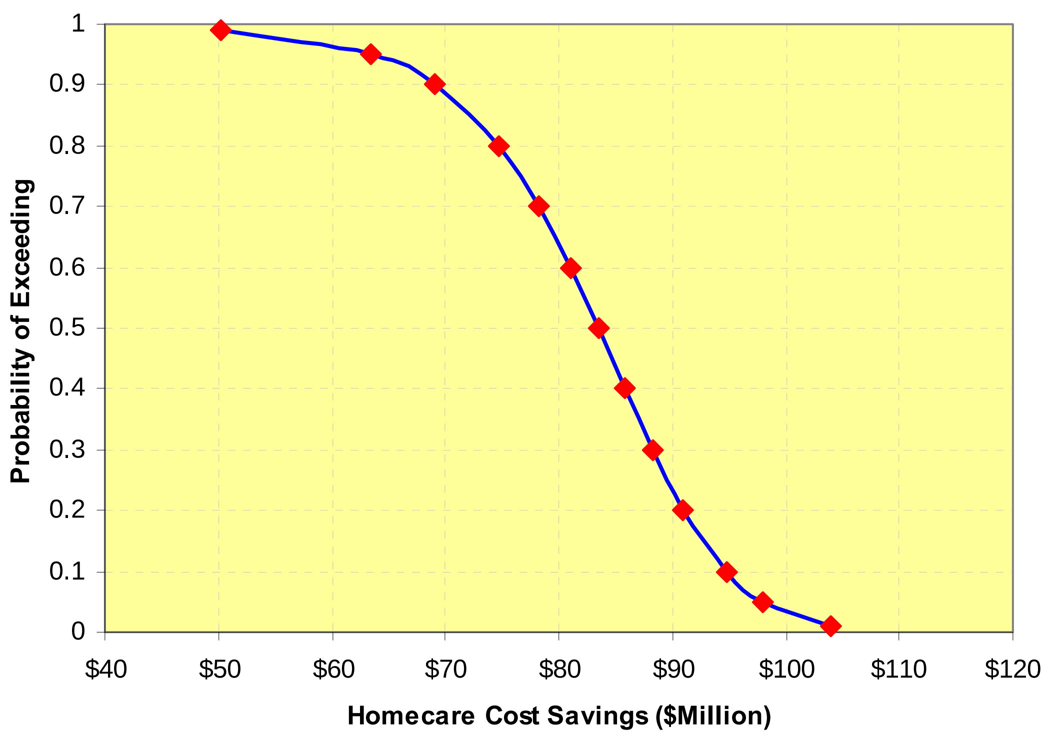


Table A–10: Risk Analysis of Homecare Cost Savings, *an Illustration*

Homecare Cost Savings (In Millions of Dollars)	Probability of Exceeding Value Shown at Left
$50.2	0.99
$63.4	0.95
$69.0	**0.90**
$74.7	0.80
$78.3	0.70
$81.1	0.60
$83.5	**0.50**
$85.8	0.40
$88.2	0.30
$91.0	0.20
$94.8	**0.10**
$98.0	0.05
$104.0	0.01
$82.3	**Mean Expected Outcome**

APPENDIX 4: RISK ANALYSIS RESULTS

The complete benefit-cost analysis results are summarized for each funding scenario in Table A-11 through Table A-13 below. The results are presented in a risk analysis format: the mean expected value (or most likely outcome) is given along with lower and upper bounds representing an 80 percent confidence interval.

Table A–11: Benefit-Cost Analysis Results, in Millions of Real Dollars (2005 – 2024) – Base Case

Category	Mean Expected Value	Lower 10%	Upper 10%
Present Value of Healthcare Benefits	$2,572	$2,068	$3,085
Present Value of Employment Benefits	$4,451	$3,391	$5,520
Present Value of Education Benefits	$1,233	$833	$1,654
Present Value of Retail, Tourism and Recreation Benefits	$1,491	$1,073	$1,912
Present Value of Total Benefits	$9,746	$7,656	$11,986
Present Value of Operating and Maintenance Costs	$2,602	$2,727	$2,479
Present Value of Capital Costs	$233	$244	$222
Present Value of Total Costs	$2,835	$2,971	$2,701
Net Present Value	**$6,912**	**$4,844**	**$9,135**
Benefit/Cost Ratio	**3.44**	**2.72**	**4.20**
Return on Investment (Annualized)	**6.25%**	**4.95%**	**7.48%**

Note: Present values are calculated based on an expected real discount rate of 5.0 percent.

Table A–12: Benefit-Cost Analysis Results, in Millions of Real Dollars (2005 – 2024) – Scenario A

Category	Mean Expected Value	Lower 10%	Upper 10%
Present Value of Healthcare Benefits	$3,001	$2,286	$3,795
Present Value of Employment Benefits	$5,190	$3,779	$6,751
Present Value of Education Benefits	$1,437	$920	$1,971
Present Value of Retail, Tourism and Recreation Benefits	$1,737	$1,196	$2,335
Present Value of Total Benefits	$11,366	$8,409	$14,659
Present Value of Operating and Maintenance Costs	$2,886	$3,058	$2,724
Present Value of Capital Costs	$258	$274	$244
Present Value of Total Costs	$3,144	$3,332	$2,968
Net Present Value	**$8,221**	**$5,291**	**$11,441**
Benefit/Cost Ratio	**3.61**	**2.70**	**4.57**
Return on Investment (Annualized)	**6.51%**	**4.95%**	**8.02%**

Note: Present values are calculated based on an expected real discount rate of 5.0 percent.

Table A–13: Benefit-Cost Analysis Results, in Millions of Real Dollars (2005 – 2024) – Scenario B

Category	Mean Expected Value	Lower 10%	Upper 10%
Present Value of Healthcare Benefits	$2,280	$1,872	$2,725
Present Value of Employment Benefits	$3,949	$3,048	$4,897
Present Value of Education Benefits	$1,095	$735	$1,446
Present Value of Retail, Tourism and Recreation Benefits	$1,323	$964	$1,695
Present Value of Total Benefits	$8,648	$6,872	$10,544
Present Value of Operating and Maintenance Costs	$2,391	$2,517	$2,269
Present Value of Capital Costs	$214	$225	$203
Present Value of Total Costs	$2,605	$2,742	$2,472
Net Present Value	**$6,043**	**$4,264**	**$7,912**
Benefit/Cost Ratio	**3.32**	**2.65**	**4.04**
Return on Investment (Annualized)	**6.03%**	**4.82%**	**7.21%**

Note: Present values are calculated based on an expected real discount rate of 5.0 percent.

The distributions of the Monte Carlo simulation results for the net present value and the return on investment are shown on page 50 and page 51. Figure A-4 through Figure A-6 depict the *decumulative* probability distribution of the net present value under each funding alternative. For instance, Figure A-4 shows that while there is a 50 percent chance that the present value will be higher or lower than $6.9 billion, there is only a 10 percent chance that the net present value will not exceed $4.8 billion. Under each scenario the benefits outweigh the costs regardless of the probability level (i.e., the net present value is always positive); however, choosing Scenario A will maximize the benefits.

Figure A–4: Risk Analysis of Net Present Value, in Millions of Real Dollars (2005 – 2024) – Base Case

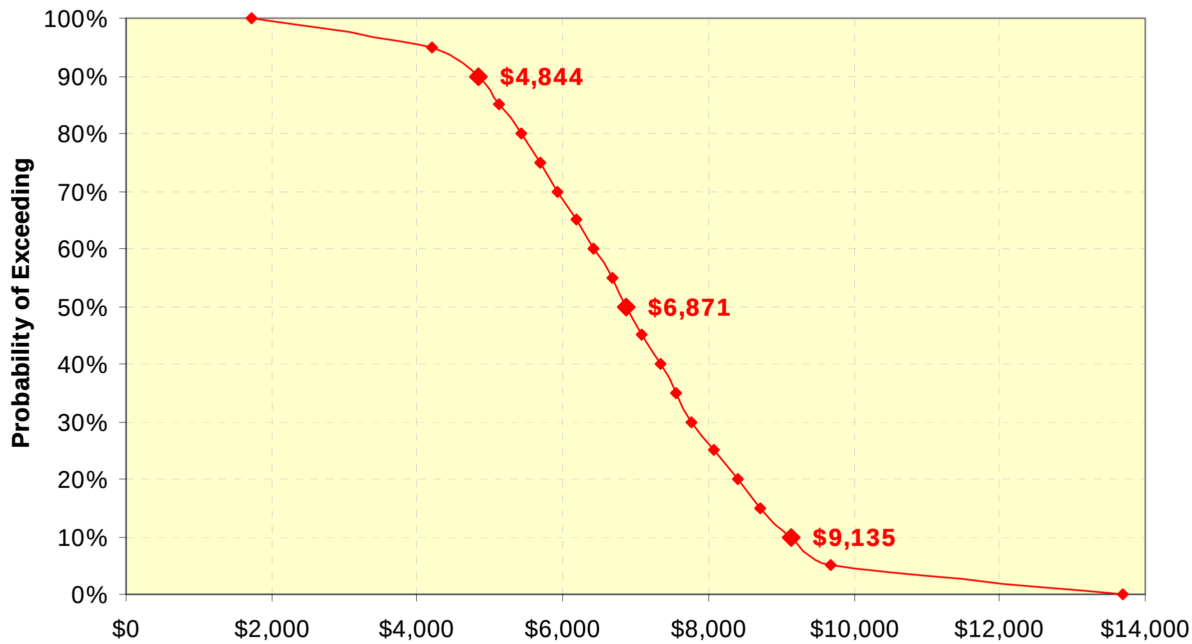


Figure A–5: Risk Analysis of Net Present Value, in Millions of Real Dollars (2005 – 2024) – Scenario A

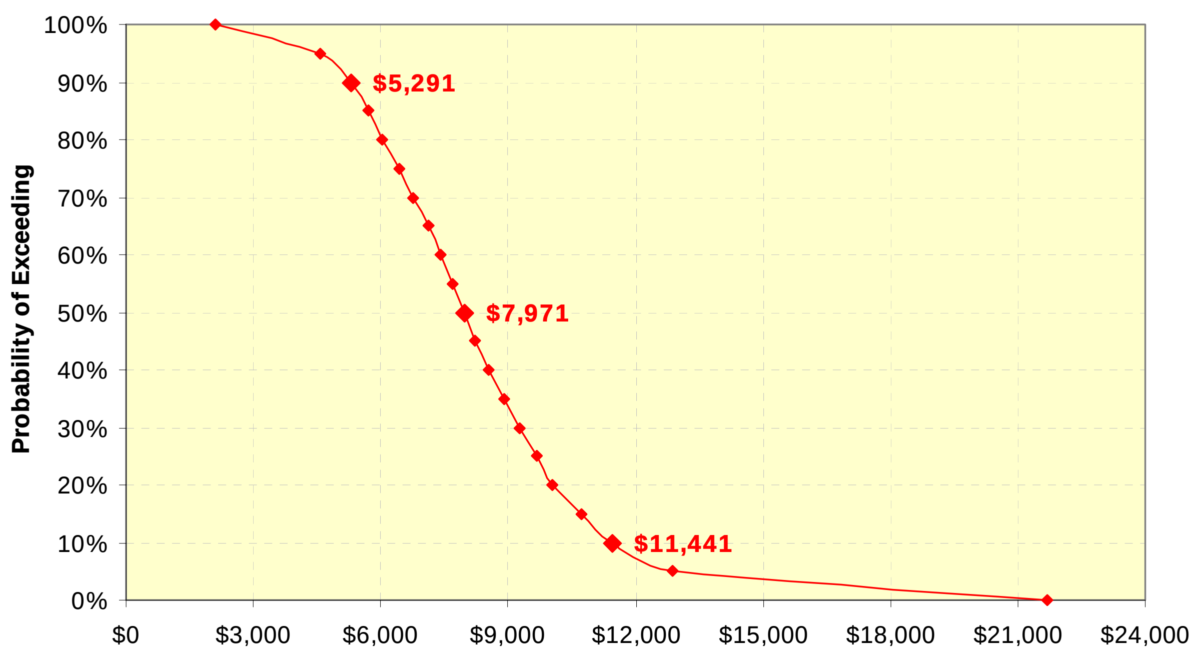
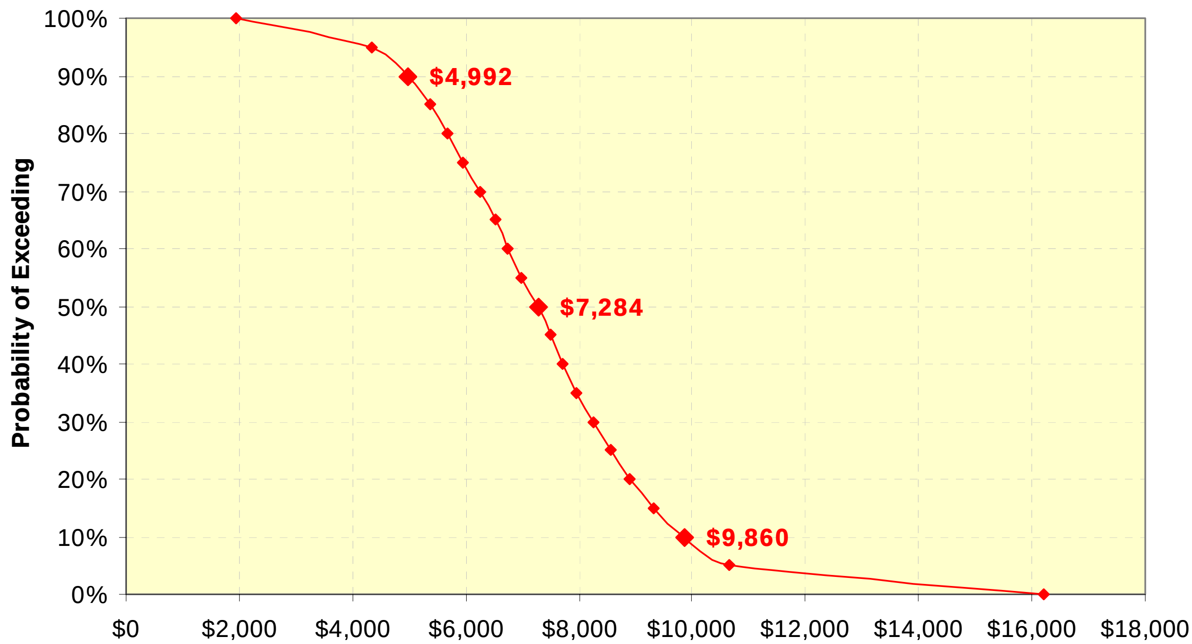


Figure A–6: Risk Analysis of Net Present Value, in Millions of Real Dollars (2005 – 2024) – Scenario B



The risk analysis also reveals that, with an 80 percent confidence interval, the return on investment ranges from 4.9 percent to 7.5 percent for the Base Case over the 20-year analysis period (see Figure A-7 on the next page). This is well above the opportunity cost of capital of 5.0 percent used in this analysis. As shown in Figure A-9, the return of investment has a somewhat lower range under Scenario B (from 4.8 percent to 7.2 percent). However, its central estimate is still above the opportunity cost of 5.0 percent. The return on investment is maximized under Scenario A, with a median estimate of 6.51 percent.

Figure A–7: Risk Analysis of Return on Investment (2005 – 2024) – Base Case

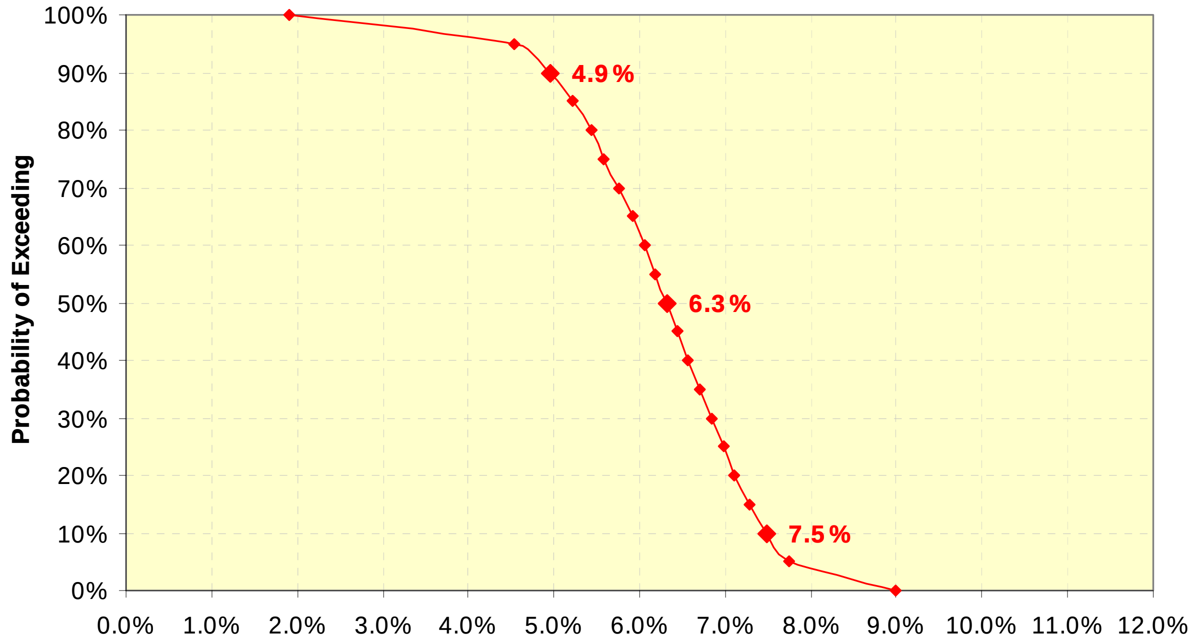


Figure A–8: Risk Analysis of Return on Investment (2005 – 2024) – Scenario A

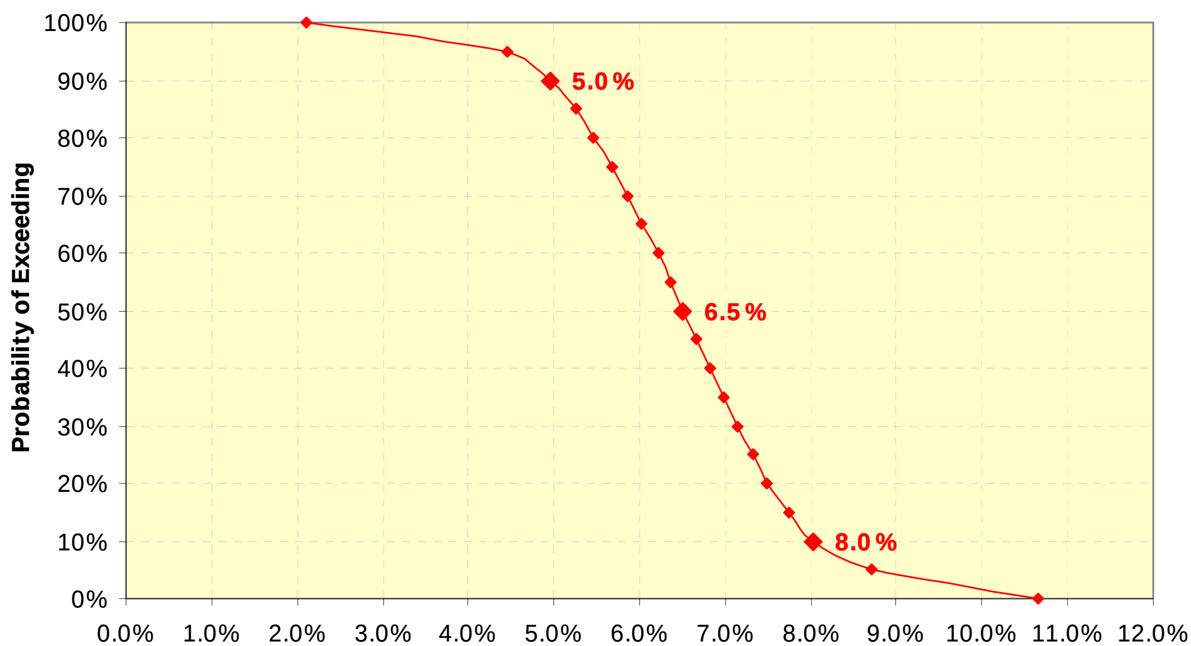
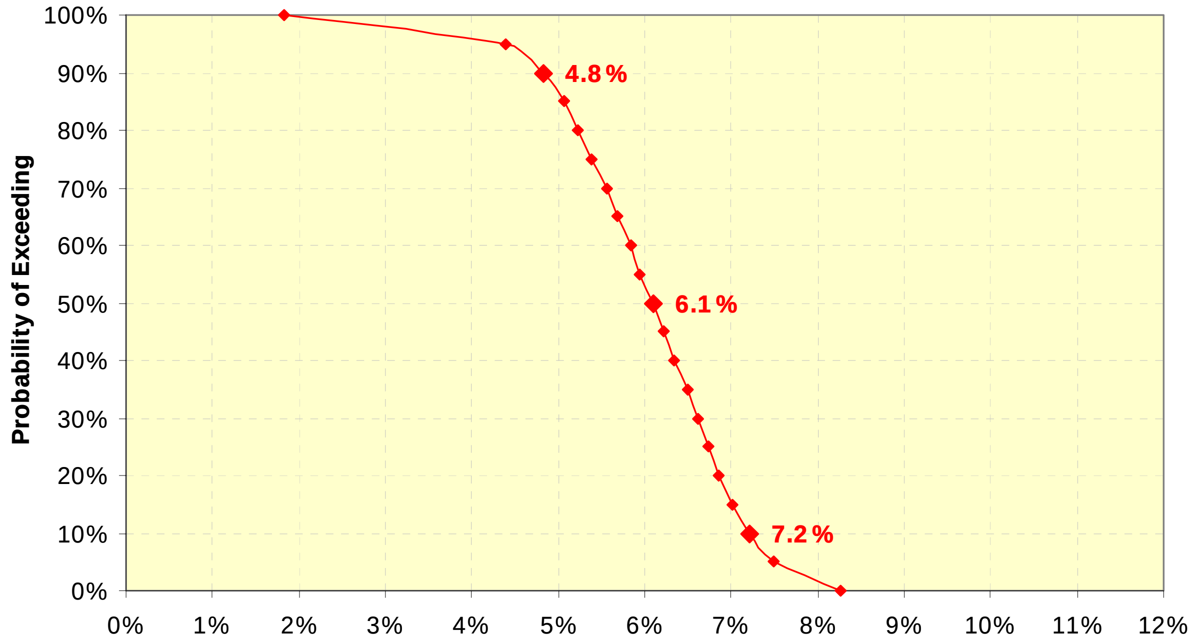


Figure A–9: Risk Analysis of Return on Investment (2005 – 2024) – Scenario B



APPENDIX 5: MACROECONOMIC IMPACTS (2004)

The tables below summarize the macroeconomic impacts (direct, indirect and induced effects) of transit benefits for the year 2004. The impacts are broken down by industrial sector (2-digit NAICS). All dollar amounts are expressed in millions of dollars.

Table A–14: Economic Impacts – Output (Millions of Dollars)

Industry	Direct	Indirect	Induced	Total
Agriculture, forestry, fish & hunting	$0.03	$0.01	$0.01	$0.05
Mining	$0.05	$0.66	$0.14	$0.85
Utilities	$10.60	$3.57	$2.80	$16.97
Construction	$0.00	$2.30	$0.48	$2.78
Manufacturing	$18.77	$16.87	$6.95	$42.60
Wholesale trade	$21.30	$7.65	$5.57	$34.52
Transportation & warehousing	$7.25	$7.46	$3.04	$17.75
Retail trade	$61.51	$3.95	$12.49	$77.94
Information	$10.33	$6.90	$3.43	$20.65
Finance & insurance	$38.90	$16.19	$10.57	$65.66
Real estate & rental	$22.44	$16.37	$6.90	$45.71
Professional - scientific & technical services	$5.76	$12.37	$3.70	$21.83
Management of companies	$0.00	$4.34	$0.86	$5.20
Administrative & waste services	$1.63	$9.36	$2.27	$13.26
Educational services	$4.45	$0.95	$1.63	$7.03
Health & social services	$90.82	$0.28	$19.88	$110.99
Arts - entertainment & recreation	$3.51	$0.93	$0.99	$5.44
Accommodation & food services	$32.30	$2.77	$6.71	$41.78
Other services	$24.56	$5.12	$6.66	$36.33
Government & non NAICs	$61.44	$1.62	$14.15	$77.21
Institutions	$226.00	$0.00	$0.00	$226.00
Total	**$641.66**	**$119.66**	**$109.22**	**$870.55**

Table A–15: Economic Impacts – Value Added (Millions of Dollars)

Industry	Direct	Indirect	Induced	Total
Agriculture, forestry, fish & hunting	$0.01	$0.00	$0.00	$0.02
Mining	$0.01	$0.08	$0.02	$0.11
Utilities	$6.18	$2.10	$1.63	$9.92
Construction	$0.00	$1.01	$0.21	$1.22
Manufacturing	$6.36	$5.94	$2.41	$14.71
Wholesale trade	$14.30	$5.14	$3.74	$23.18
Transportation & warehousing	$3.73	$4.48	$1.69	$9.90
Retail trade	$36.55	$2.39	$7.43	$46.37
Information	$5.59	$3.54	$1.80	$10.92
Finance & insurance	$21.00	$9.68	$5.73	$36.41
Real estate & rental	$15.79	$11.73	$4.91	$32.43
Professional - scientific & technical services	$4.25	$9.51	$2.80	$16.55
Management of companies	$0.00	$3.32	$0.66	$3.97
Administrative & waste services	$1.09	$6.83	$1.64	$9.56
Educational services	$3.01	$0.66	$1.10	$4.76
Health & social services	$50.42	$0.09	$10.86	$61.37
Arts - entertainment & recreation	$2.36	$0.56	$0.65	$3.57
Accommodation & food services	$15.44	$1.44	$3.25	$20.12
Other services	$13.05	$2.59	$3.55	$19.18
Government & non NAICs	$46.14	$0.87	$10.59	$57.59
Institutions	$0.00	$0.00	$0.00	$0.00
Total	**$245.28**	**$71.94**	**$64.66**	**$381.89**

Table A–16: Economic Impacts – Employment

Industry	Direct	Indirect	Induced	Total
Agriculture, forestry, fish & hunting	0	0	0	1
Mining	0	4	1	5
Utilities	13	4	4	21
Construction	0	22	5	27
Manufacturing	77	85	32	193
Wholesale trade	141	51	37	229
Transportation & warehousing	72	86	33	190
Retail trade	1,223	79	248	1,551
Information	52	48	20	120
Finance & insurance	204	124	62	390
Real estate & rental	133	82	39	254
Professional - scientific & technical services	52	123	36	211
Management of companies	0	27	5	32
Administrative & waste services	26	192	45	263
Educational services	88	16	32	136
Health & social services	990	2	234	1,226
Arts - entertainment & recreation	104	32	29	166
Accommodation & food services	802	68	166	1,036
Other services	355	67	101	523
Government & non NAICs	45	12	12	68
Institutions	0	0	0	0
Total	**4,380**	**1,122**	**1,139**	**6,641**

Table A–17: Economic Impacts – Tax Revenue (Millions of Dollars)

Industry	Federal Government Non-Defense	State/Local Government Non-Education	Total
Employee Compensation	$21.99	$0.20	**$22.20**
Proprietary Income	$1.07	$0.00	**$1.07**
Household Expenditures	$16.54	$6.69	**$23.23**
Enterprises (Corporations)	$6.39	$0.95	**$7.34**
Indirect Business Taxes	$5.23	$33.12	**$38.35**
Total	$51.22	$40.97	**$92.19**

APPENDIX 6: OVERVIEW OF BENEFIT-COST ANALYSIS MODEL

The benefit-cost analysis model (WISDOT Model with Control Panel.xls) was developed as a Microsoft Excel workbook with four sets of worksheets, easily identifiable by their tab color. These sheets are described briefly below.

- **Violet Tab Worksheets**

1. CAPITAL FUNDS 1993-2005: Historical data on transit capital funding in Wisconsin by funding source (Section 5311, Section 5309 and CMAQ) from 1993 to 2005;
2. O&M FUNDS 1997-2005: Historical data on transit operating and maintenance funding in Wisconsin by funding source (federal, state, local and farebox) and system size (small, medium and large) from 1997 to 2005;

- **Red Tab Worksheet**

3. CONTROL PANEL: User-specified input values and summary output results and charts (see Figure A-10);

- **Blue Tab Worksheets**

4. ASSUMPTIONS: Detailed input variables by system size, with probability ranges -- lower, median and upper values;
5. ESTIMATION: Estimation of transit benefits by system size and socioeconomic sector (healthcare, education, work, and retail, tourism and recreation), transit operating and maintenance costs, transit capital costs and benefit-cost analysis evaluation criteria from 2005 through 2024 (see Figure A-11);
6. RISKOUTPUT VARIABLES: Table of risk variables for @RISK output;
7. @RISK RESULTS: @RISK output details report with chart of decumulative probability function of selected risk output variable;
8. SUMMARY TABLES: Table of transit benefits by system size and socioeconomic sector in millions of real dollars (2005, 2015 and 2024); and table of benefit-cost analysis results in millions of real dollars (2005 – 2024);

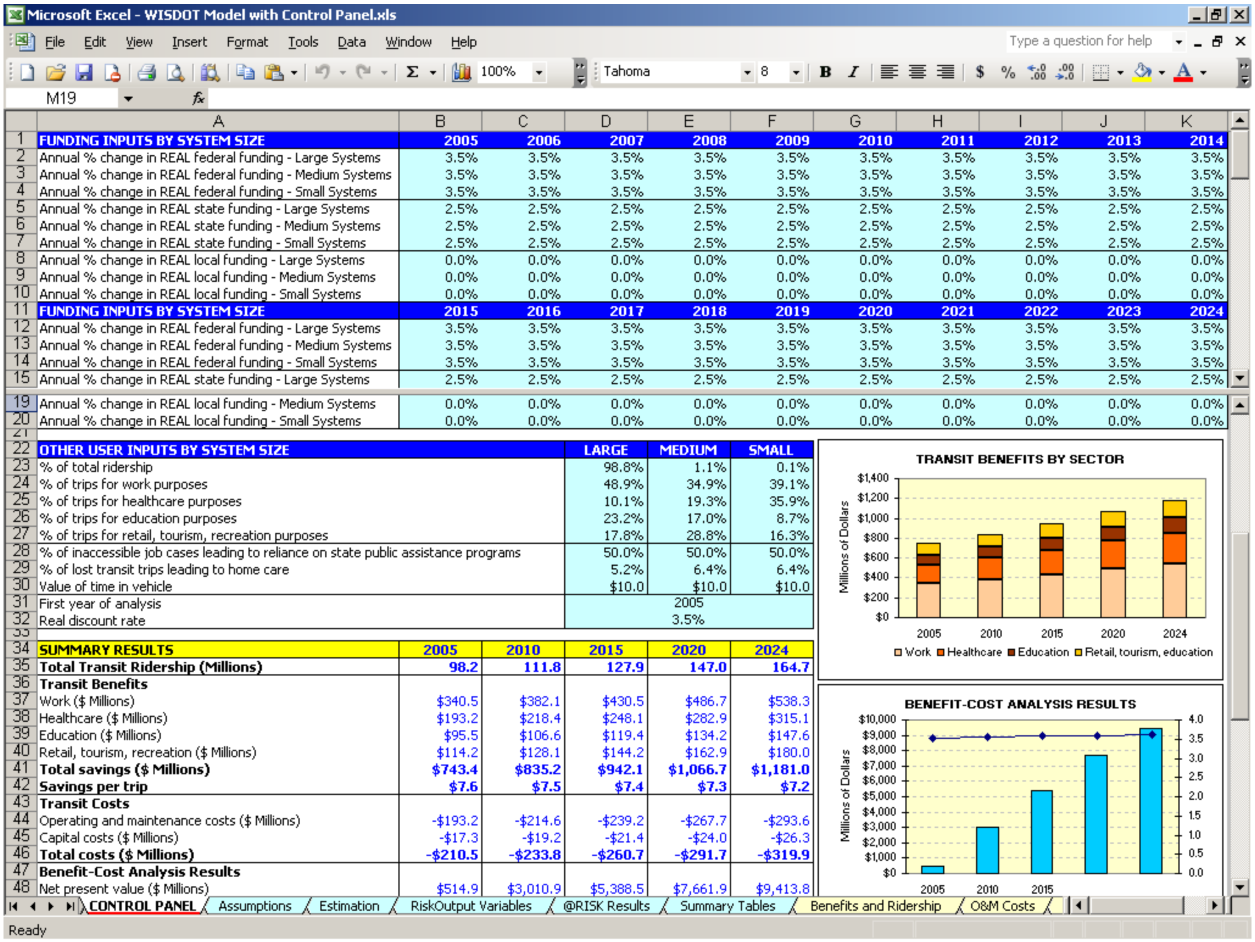
- **Yellow Tab Worksheets**

9. BENEFITS AND RIDERSHIP: Chart of total ridership and total benefits by socioeconomic sector from 2005 through 2024;
10. O&M COSTS: Chart of transit operating and maintenance costs by system size from 2005 through 2024; and

11. **COSTS AND BENEFITS**: Chart of total benefits, transit operating and maintenance costs and transit capital costs from 2005 through 2024 (see Figure A-12).

Note that the '**CONTROL PANEL**' sheet is the only worksheet that should be updated by the user. It contains all major input values (annual percent change in public funding, discount rate, etc.). Only the cells highlighted in blue should be edited. The sheet is reproduced below.

Figure A–10: Control Panel Sheet



Microsoft Excel - WISDOT Model with Control Panel.xls

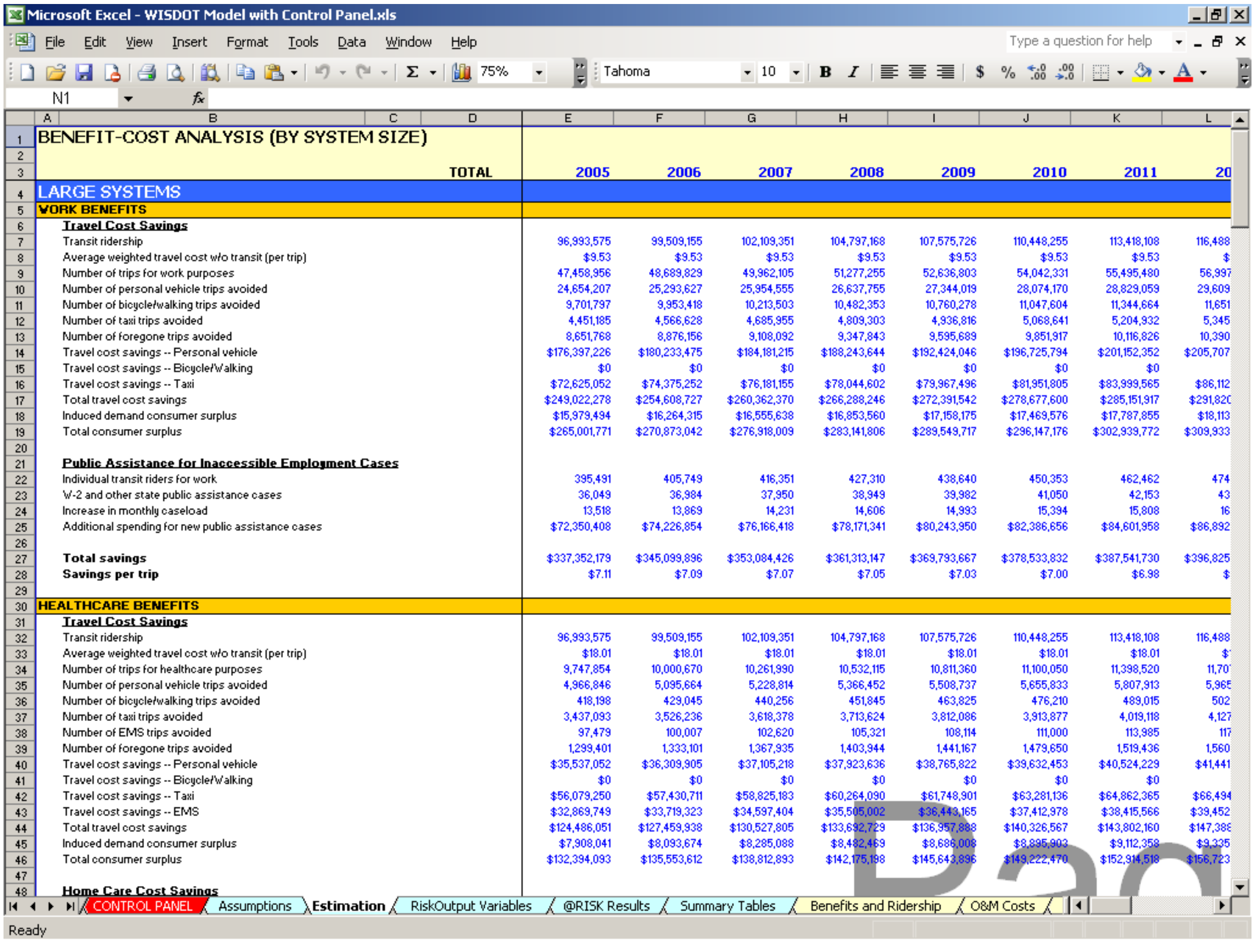
	A	B	C	D	E	F	G	H	I	J	K
1	FUNDING INPUTS BY SYSTEM SIZE	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
2	Annual % change in REAL federal funding - Large Systems	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
3	Annual % change in REAL federal funding - Medium Systems	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
4	Annual % change in REAL federal funding - Small Systems	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
5	Annual % change in REAL state funding - Large Systems	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
6	Annual % change in REAL state funding - Medium Systems	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
7	Annual % change in REAL state funding - Small Systems	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
8	Annual % change in REAL local funding - Large Systems	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
9	Annual % change in REAL local funding - Medium Systems	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
10	Annual % change in REAL local funding - Small Systems	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
11	FUNDING INPUTS BY SYSTEM SIZE	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
12	Annual % change in REAL federal funding - Large Systems	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
13	Annual % change in REAL federal funding - Medium Systems	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
14	Annual % change in REAL federal funding - Small Systems	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
15	Annual % change in REAL state funding - Large Systems	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
19	Annual % change in REAL local funding - Medium Systems	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
20	Annual % change in REAL local funding - Small Systems	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

		LARGE	MEDIUM	SMALL
22	OTHER USER INPUTS BY SYSTEM SIZE	LARGE	MEDIUM	SMALL
23	% of total ridership	98.8%	1.1%	0.1%
24	% of trips for work purposes	48.9%	34.9%	39.1%
25	% of trips for healthcare purposes	10.1%	19.3%	35.9%
26	% of trips for education purposes	23.2%	17.0%	8.7%
27	% of trips for retail, tourism, recreation purposes	17.8%	28.8%	16.3%
28	% of inaccessible job cases leading to reliance on state public assistance programs	50.0%	50.0%	50.0%
29	% of lost transit trips leading to home care	5.2%	6.4%	6.4%
30	Value of time in vehicle	$10.0	$10.0	$10.0
31	First year of analysis		2005	
32	Real discount rate		3.5%	

	SUMMARY RESULTS	2005	2010	2015	2020	2024
35	**Total Transit Ridership (Millions)**	**98.2**	**111.8**	**127.9**	**147.0**	**164.7**
36	**Transit Benefits**					
37	Work ($ Millions)	$340.5	$382.1	$430.5	$486.7	$538.3
38	Healthcare ($ Millions)	$193.2	$218.4	$248.1	$282.9	$315.1
39	Education ($ Millions)	$95.5	$106.6	$119.4	$134.2	$147.6
40	Retail, tourism, recreation ($ Millions)	$114.2	$128.1	$144.2	$162.9	$180.0
41	**Total savings ($ Millions)**	**$743.4**	**$835.2**	**$942.1**	**$1,066.7**	**$1,181.0**
42	**Savings per trip**	**$7.6**	**$7.5**	**$7.4**	**$7.3**	**$7.2**
43	**Transit Costs**					
44	Operating and maintenance costs ($ Millions)	-$193.2	-$214.6	-$239.2	-$267.7	-$293.6
45	Capital costs ($ Millions)	-$17.3	-$19.2	-$21.4	-$24.0	-$26.3
46	**Total costs ($ Millions)**	**-$210.5**	**-$233.8**	**-$260.7**	**-$291.7**	**-$319.9**
47	**Benefit-Cost Analysis Results**					
48	Net present value ($ Millions)	$514.9	$3,010.9	$5,388.5	$7,661.9	$9,413.8

Transit benefits and costs as well as benefit-cost evaluation criteria are calculated in the '**ESTIMATION**' sheet and updated automatically whenever an input value is changed in the '**CONTROL PANEL**' (or '**ASSUMPTIONS**') sheet. All benefit calculations are shown step-by-step. The '**ESTIMATION**' sheet is reproduced in Figure A-11 on the next page.

Figure A–11: Estimation Sheet

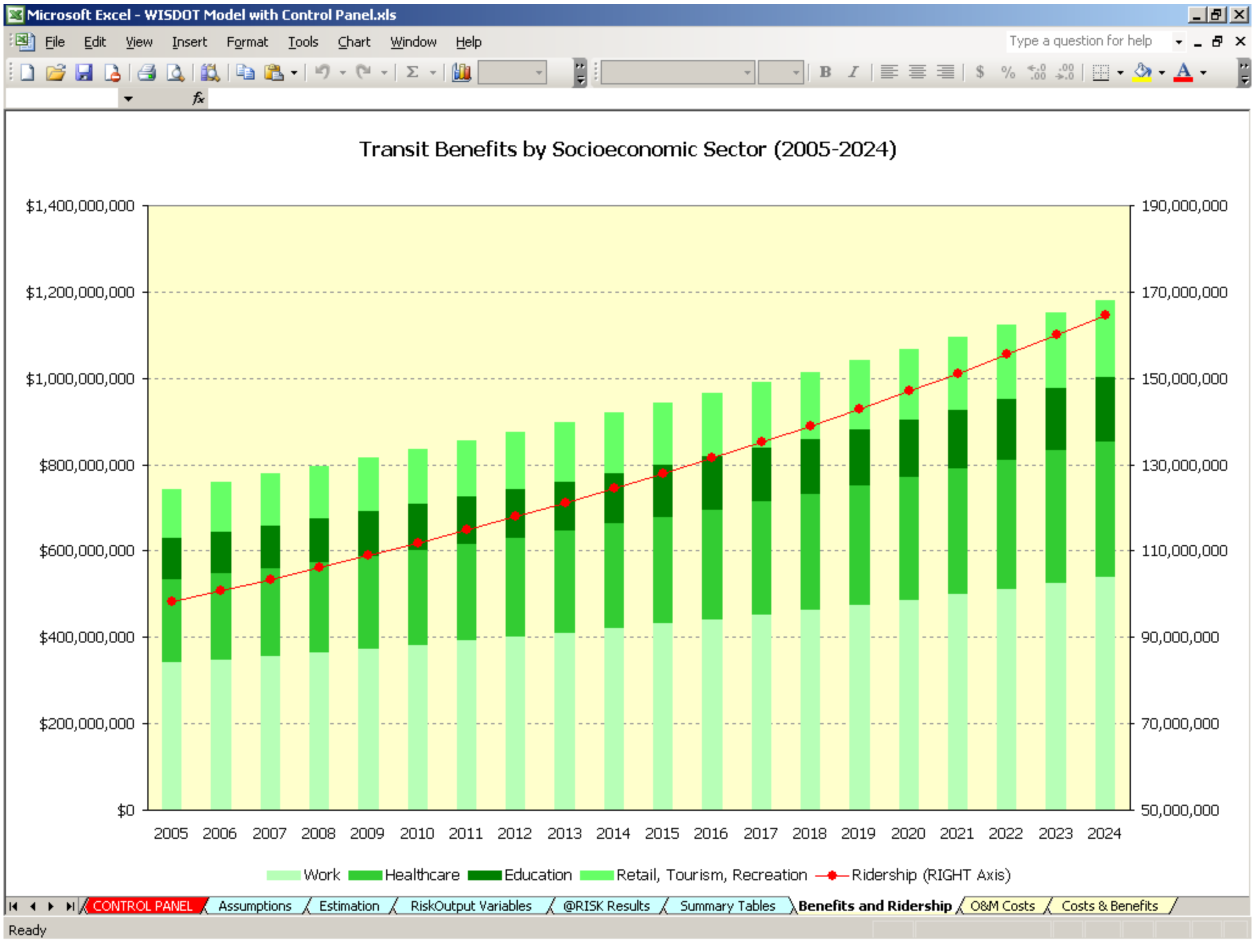


	A–B	D	E	F	G	H	I	J	K	L
1	BENEFIT-COST ANALYSIS (BY SYSTEM SIZE)									
2										
3		TOTAL	2005	2006	2007	2008	2009	2010	2011	20
4	LARGE SYSTEMS									
5	WORK BENEFITS									
6	**Travel Cost Savings**									
7	Transit ridership		96,993,575	99,509,155	102,109,351	104,797,168	107,575,726	110,448,255	113,418,108	116,488
8	Average weighted travel cost w/o transit (per trip)		$9.53	$9.53	$9.53	$9.53	$9.53	$9.53	$9.53	$
9	Number of trips for work purposes		47,458,956	48,689,829	49,962,105	51,277,255	52,636,803	54,042,331	55,495,480	56,997
10	Number of personal vehicle trips avoided		24,654,207	25,293,627	25,954,555	26,637,755	27,344,019	28,074,170	28,829,059	29,609
11	Number of bicycle/walking trips avoided		9,701,797	9,953,418	10,213,503	10,482,353	10,760,278	11,047,604	11,344,664	11,651
12	Number of taxi trips avoided		4,451,185	4,566,628	4,685,955	4,809,303	4,936,816	5,068,641	5,204,932	5,345
13	Number of foregone trips avoided		8,651,768	8,876,156	9,108,092	9,347,843	9,595,689	9,851,917	10,116,826	10,390
14	Travel cost savings -- Personal vehicle		$176,397,226	$180,233,475	$184,181,215	$188,243,644	$192,424,046	$196,725,794	$201,152,352	$205,707
15	Travel cost savings -- Bicycle/Walking		$0	$0	$0	$0	$0	$0	$0	
16	Travel cost savings -- Taxi		$72,625,052	$74,375,252	$76,181,155	$78,044,602	$79,967,496	$81,951,805	$83,999,565	$86,112
17	Total travel cost savings		$249,022,278	$254,608,727	$260,362,370	$266,288,246	$272,391,542	$278,677,600	$285,151,917	$291,820
18	Induced demand consumer surplus		$15,979,494	$16,264,315	$16,555,638	$16,853,560	$17,158,175	$17,469,576	$17,787,855	$18,113
19	Total consumer surplus		$265,001,771	$270,873,042	$276,918,009	$283,141,806	$289,549,717	$296,147,176	$302,939,772	$309,933
20										
21	**Public Assistance for Inaccessible Employment Cases**									
22	Individual transit riders for work		395,491	405,749	416,351	427,310	438,640	450,353	462,462	474
23	W-2 and other state public assistance cases		36,049	36,984	37,950	38,949	39,982	41,050	42,153	43
24	Increase in monthly caseload		13,518	13,869	14,231	14,606	14,993	15,394	15,808	16
25	Additional spending for new public assistance cases		$72,350,408	$74,226,854	$76,166,418	$78,171,341	$80,243,950	$82,386,656	$84,601,958	$86,892
26										
27	**Total savings**		$337,352,179	$345,099,896	$353,084,426	$361,313,147	$369,793,667	$378,533,832	$387,541,730	$396,825
28	**Savings per trip**		$7.11	$7.09	$7.07	$7.05	$7.03	$7.00	$6.98	$
29										
30	HEALTHCARE BENEFITS									
31	**Travel Cost Savings**									
32	Transit ridership		96,993,575	99,509,155	102,109,351	104,797,168	107,575,726	110,448,255	113,418,108	116,488
33	Average weighted travel cost w/o transit (per trip)		$18.01	$18.01	$18.01	$18.01	$18.01	$18.01	$18.01	$1
34	Number of trips for healthcare purposes		9,747,854	10,000,670	10,261,990	10,532,115	10,811,360	11,100,050	11,398,520	11,70
35	Number of personal vehicle trips avoided		4,966,846	5,095,664	5,228,814	5,366,452	5,508,737	5,655,833	5,807,913	5,965
36	Number of bicycle/walking trips avoided		418,198	429,045	440,256	451,845	463,825	476,210	489,015	502
37	Number of taxi trips avoided		3,437,093	3,526,236	3,618,378	3,713,624	3,812,086	3,913,877	4,019,118	4,127
38	Number of EMS trips avoided		97,479	100,007	102,620	105,321	108,114	111,000	113,985	117
39	Number of foregone trips avoided		1,299,401	1,333,101	1,367,935	1,403,944	1,441,167	1,479,650	1,519,436	1,560
40	Travel cost savings -- Personal vehicle		$35,537,052	$36,309,905	$37,105,218	$37,923,636	$38,765,822	$39,632,453	$40,524,229	$41,441
41	Travel cost savings -- Bicycle/Walking		$0	$0	$0	$0	$0	$0	$0	
42	Travel cost savings -- Taxi		$56,079,250	$57,430,711	$58,825,183	$60,264,090	$61,748,901	$63,281,136	$64,862,365	$66,494
43	Travel cost savings -- EMS		$32,869,749	$33,719,323	$34,597,404	$35,505,002	$36,443,165	$37,412,978	$38,415,566	$39,452
44	Total travel cost savings		$124,486,051	$127,459,938	$130,527,805	$133,692,729	$136,957,888	$140,326,567	$143,802,160	$147,388
45	Induced demand consumer surplus		$7,908,041	$8,093,674	$8,285,088	$8,482,469	$8,686,008	$8,895,903	$9,112,358	$9,335
46	Total consumer surplus		$132,394,093	$135,553,612	$138,812,893	$142,175,198	$145,643,896	$149,222,470	$152,914,518	$156,723
47										
48	**Home Care Cost Savings**									

@RISK-related worksheets ('**RISKOUTPUT VARIABLES**' and '**@RISK RESULTS**') are of use only if the user has installed @RISK, an add-in to Microsoft Excel, on his/her computer. @RISK is a risk analysis tool that uses statistical probabilities to show all the possible outcomes of a situation.

The yellow tab worksheets (charts) are linked to the '**ESTIMATION**' sheet. Transit benefits by socioeconomic sector are displayed in the '**BENEFITS AND RIDERSHIP**' sheet, as illustrated in Figure A-12 on the next page.

Figure A–12: Benefits and Ridership Sheet



APPENDIX 7: REFERENCES AND DATA SOURCES

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