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Michigan Department of Transportation

**ECONOMIC AND COMMUNITY
BENEFITS OF LOCAL BUS
TRANSIT SERVICE
(PHASE TWO)**

User Guide

September 9, 2010

ECONOMIC AND COMMUNITY BENEFITS OF LOCAL BUS TRANSIT SERVICE (PHASE TWO)

USER GUIDE

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1. USER GUIDE

This User Guide provides a full description of the different model components along with detailed instructions on how to use the model. The overall structure of the model is presented in Section 1.2, while Sections 1.3.1 through 1.3.7 provide guidance on how to use each component of the model.

1.1 Introduction

The purpose of the model developed by HDR for the Michigan Department of Transportation is to quantify the benefits of local bus transit service,¹ which consist of the following:

- Transportation cost savings (out-of-pocket cost savings; travel time cost savings; accident cost savings; and environmental emission cost savings); and
- Low-cost mobility benefits, which consist of (i) affordable mobility benefits (the economic value to access services such as healthcare, education, retail and attractions) and (ii) cross-sector benefits (budget savings for welfare and social services, such as unemployment and homecare, due to the presence of transit).

These benefits are estimated for all key socioeconomic sectors based on a breakdown of ridership by trip purpose: work; healthcare; education; shopping, recreation and tourism; and other. They can also be estimated at different geographical or jurisdictional levels. More precisely, the model assesses the benefits of transit at the agency level, at the agency type level, at the urban/nonurban level or at the state level (i.e., all agencies combined). Transit agencies are aggregated into seven agency types based on the classification currently used in the Public Transportation Management System (PTMS): urban metro, urban large, urban medium, urban small, nonurban county, nonurban city and nonurban township.

In addition to transit benefits, the model measures the impacts on the State economy resulting from: (i) transit operation and maintenance expenses (excluding depreciation); and (ii) out-of-pocket cost savings accruing to transit riders.

1.2 Overview of the Model

The economic model is a “stand alone” spreadsheet-based model designed so that it can be used with minimal direction and minimal data entry. In other words, it is not linked to external files, contains all the model inputs and requires minimal proficiency in Excel.

The economic model was developed as a Microsoft Excel workbook with fifteen (15) sheets that are briefly described below. To facilitate both user navigation and the update of the model, color codes are used. In general, blue font denotes a cell that contains a formula and thus should not be updated. Black font denotes a cell that does not contain a formula (e.g., model inputs). Sheet tabs are also color coded (red, yellow, green, etc.) to help the user.

¹ Note that detailed information on the data and the methodology used to develop the model can be found in the final report for Phase 1 prepared by HDR for Michigan Department of Transportation, *Economic and Community Benefits of Local Bus Transit Service (Phase One) Final Report*, June 2009.

1. START: General structure and logic of the model; brief description of model components; and hyperlinks to each sheet.

Control Panel sheets (Red sheet tabs):

2. INSTRUCTIONS: Step-by-step instructions for using the Control Panel.
3. CONTROL PANEL: Selection of level of analysis and other options (year of analysis, risk analysis and estimation of emissions cost savings); user-specified input values for quick update or scenario analysis; and summary output tables and charts.

Input sheets (Yellow sheet tabs):

4. OPERATIONS: Operations statistics at the agency level.
5. I-O RESULTS: Input-output results for different economic impact metrics (output, value added, employment and tax revenue) over the 2008 – 2012 period.
6. OTHER DATA: Other model inputs (such as trip purpose) by transit agency type.
7. METRO SURVEY: Survey results for Detroit Department of Transportation and SMART.

Calculation sheets (Green sheet tabs):

8. BEN-AGENCY: Calculations of transit benefits by socioeconomic sector and benefit category at the agency level only.
9. BEN-URBAN: Calculations of transit benefits by socioeconomic sector and benefit category for urban agencies.
10. BEN-NONURBAN: Calculations of transit benefits by socioeconomic sector and benefit category for nonurban agencies.
11. IMPACTS: Calculations of economic impacts resulting from transit operating and maintenance expenses and the re-spending of out-of-pocket cost savings accruing to transit riders.
12. @RISK: List of risk variables and detailed risk analysis statistics from @RISK.

Though the Calculation sheets can be viewed, they are protected to ensure the integrity of the formulas and the methodology. Their contents cannot be modified unless the protection is deactivated. The current password to unprotect/protect the sheets is 'rapid'. It can be changed by the user after the sheets have been unprotected.

Results sheets (Blue sheet tabs):

13. TABLES: Tables summarizing all the results of the analysis.

14. GRAPHS: Graphs representing key analysis results.
15. SOURCES: List of data sources and references used in the model.

The only sheets that should be modified by the user are the 'CONTROL PANEL', 'OPERATIONS' and 'OTHER DATA' sheets.

1.3 Detailed Presentation and Instructions

The following sub-sections explain in detail the different model components and provide instructions on how to install the economic model (Section 1.3.1) and enter/update input values (Sections 1.3.3 and 1.3.4).

1.3.1 Installation

There is no installation per se. The model is a stand-alone, spreadsheet-based model. Simply copy the file “MDOT Transit Benefit Model.xls” to a local folder and double click to open it.

It is highly recommended to make a backup copy of the original file. It is also recommended to make copies of the file whenever major updates are made to the model inputs.

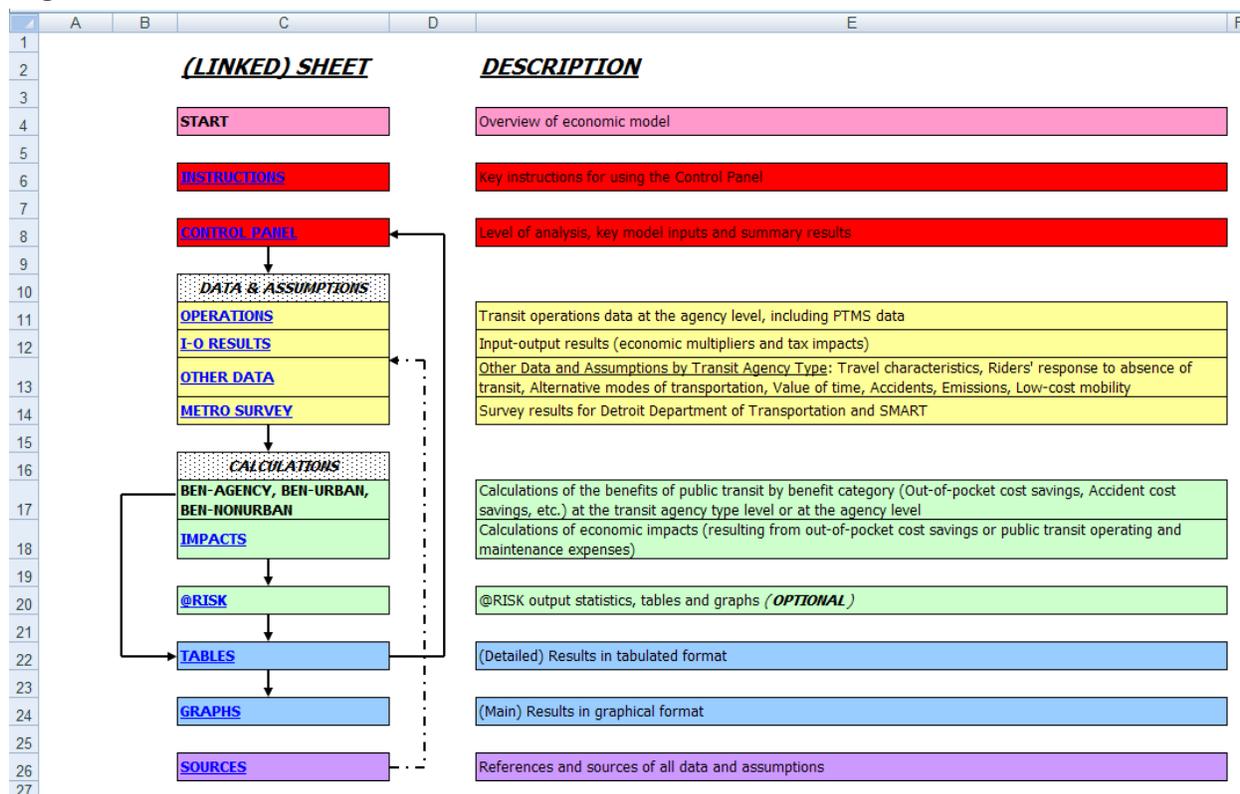
1.3.2 Model Structure

The first sheet, ‘START,’ shows the structure and the general organization of the workbook, just like a table of contents. The purpose of this sheet is to help the user navigate through the model. The ‘START’ sheet contains: (i) a flowchart representing the estimation process and how the different worksheets are linked together; and (ii) a brief description of each sheet.

Note that each element of the flowchart contains a hyperlink that enables the user to go directly to the desired sheet (think of the hyperlink as a shortcut). When pointing to a cell that contains a hyperlink, the pointer becomes a hand , indicating that the cell is something that can be clicked. For instance, by clicking on ‘CONTROL PANEL’, the user can go directly to the ‘CONTROL PANEL’ sheet. At the upper left corner of every sheet there is also a hyperlink to return directly to the ‘START’ sheet at any time.

A snapshot of the ‘START’ sheet is shown in Figure 1 on the following page.

Figure 1: START Sheet



1.3.3 Control Panel

The Control Panel is the main model component. At a minimum, the ‘CONTROL PANEL’ sheet is the only sheet that needs to be used. It contains a few necessary inputs that are requested to conduct the analysis: the user needs to select the level of analysis (a 2-step process described below), the type of service and the year of analysis (for economic impacts). In addition, the user has the option to conduct a risk analysis in @RISK² and to estimate emissions cost savings. Once this is done, the estimation of transit benefits and economic impacts is completed.

In addition, the ‘CONTROL PANEL’ sheet displays key results of the analysis in tabular and graphical formats and enables the user to modify a few key model variables (such as the percentage of trips for work purposes) to test “what if” scenarios at the agency level or transit agency type level. Note that any user input value entered in the ‘CONTROL PANEL’ sheet will be accounted for in the calculation of benefits without changing the corresponding default value (in ‘OPERATIONS’ and ‘OTHER DATA’ sheets).

For systems that have urban and non-urban portions, the analysis can only be performed one at a time. Therefore, the results should be combined by the user to obtain the benefits for the entire system.

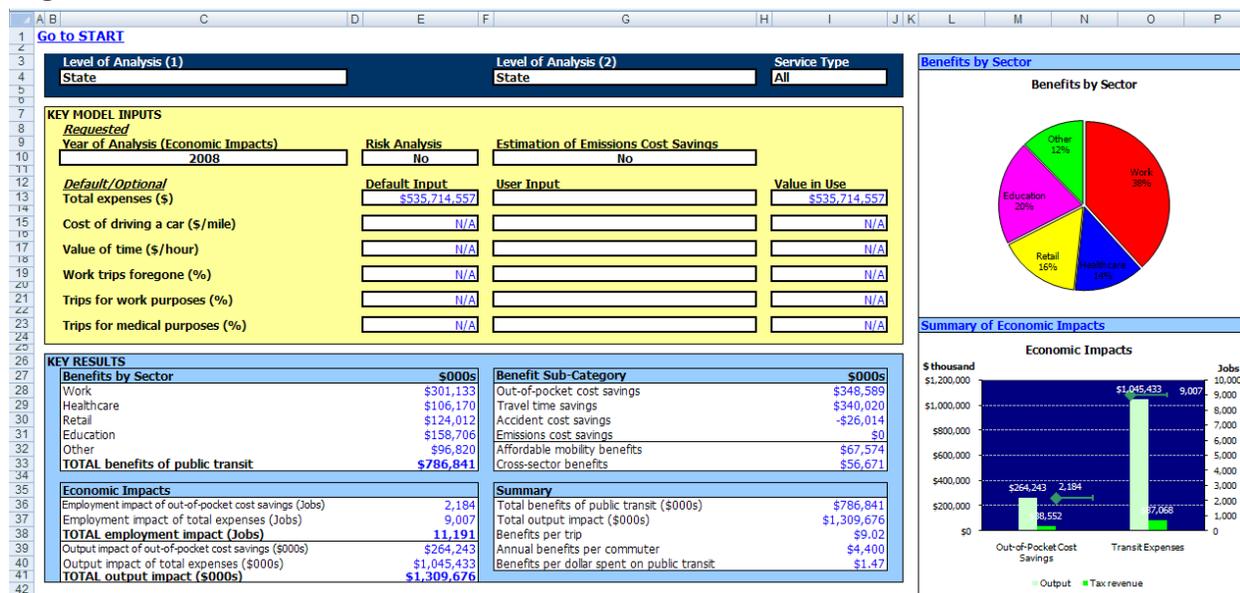
² @RISK a risk analysis tool that works as an add-in for Microsoft Excel. It can be purchased from Palisade Corporation.

Detailed instructions on how to use the Control Panel are provided in the ‘INSTRUCTIONS’ sheet and are reproduced below:

1. On the worksheet named CONTROL PANEL, first select the Level of Analysis (1). This allows the user to choose whether to estimate the benefits at the transit agency level, at the state level, or at some other aggregation level. Click on cell C4 and using the drop down menu, select State, Transit Agency Type, Agency or Urban/Non-Urban.
2. Next, on the CONTROL PANEL sheet, click on cell G4. Using the drop down menu that appears, select the secondary Level of Analysis (2). If State was selected in Step 1, State must be selected here as well. If Transit Agency Type was selected, choose one of the 7 transit agency types. If Urban/Non-Urban was selected, choose Urban or Non-Urban. If Agency was selected, choose one of the transit agencies.
3. Choose the Service Type to be analyzed using the drop down menu in cell I4. Select Line Haul, Demand Response, or All.
4. Choose the Year of Analysis using the drop down menu in cell C10. The Year of Analysis determines the correct set of multipliers to be used in the economic impact analysis. If 2010 is selected, the multipliers for 2010 will be used in the calculations and the economic impacts will be expressed in 2010 dollars.
5. To estimate benefits at the most likely values, choose No in the drop down menu in cell E10 under Risk Analysis. To estimate benefits in a risk analysis framework, choose Yes here. *Users who wish to conduct a risk analysis need to install the @RISK application (a MS Excel add-in) on their machines and unprotect the worksheets before running a simulation.*
6. To estimate emissions cost savings, choose Yes in the drop down menu in cell G10 under Estimation of Emissions Cost Savings. Otherwise choose No.
7. Review the default inputs given for your selections made in Steps 1-5 shown in cells E13, E15, E17, E19, E21 and E23. Rather than modifying these values in the appropriate model input sheet, these values can instead be updated in the User Input column. This overrides the Default Input and makes the User Input the Value in Use. This will allow users to perform “what if” scenario analysis.
8. View benefits estimated for selections made in the section labeled Key Results, as well as the pie graphs shown on this sheet.

A snapshot of the ‘CONTROL PANEL’ sheet is shown in Figure 2 on the following page.

Figure 2: CONTROL PANEL Sheet



1.3.4 Model Inputs

Model data and assumptions are stored in four separate sheets: ‘I-O RESULTS’, ‘OPERATIONS’, ‘OTHER DATA’ and ‘METRO SURVEY’.

Economic multipliers to estimate the impacts of out-of-pocket cost savings and transit operation and maintenance expenses (excluding depreciation) are available in ‘I-O RESULTS’. These multipliers are the results of the input-output analysis conducted by HDR in IMPLAN (see Section 3.2 of Phase 1 Final Report).³ They are broken down by impact metric (output, value added, employment and tax revenue), by type of effect (direct, indirect and induced) and by year (2008 through 2012). These results should not be modified, therefore the sheet is protected.

A snapshot of the ‘I-O RESULTS’ sheet is shown in Figure 3 on the following page.

³ The multipliers are estimated for \$1 million in transit O&M expenses (excluding depreciation) and \$1 million in out-of-pocket cost savings (accruing to households using public transit). More precisely, the multipliers tell us the effects on the Michigan economy of: 1) \$1 million spent in the public transit sector; and 2) the portion of \$1 million in savings that is actually re-spent by households using public transit. More information on economic impact analysis is provided in Section 3.2 of Phase 1 Final Report.

Figure 3: I-O RESULTS Sheet

1	2	3	4	A	B	C	D	E	F	G
1				Go to START						
2				OUT-OF-POCKET COST SAVINGS						
3				State = MI; Expenditure = \$1,000,000; Sector = Households \$35-\$50k; Year = 2008						
4				OUTPUT IMPACT						
5				NAICS Code	Industry	Direct	Indirect	Induced	Total	
6				11	Agriculture, forestry, fishing and hunting	\$1,959	\$3,201	\$966	\$6,125	
7				21	Mining	\$317	\$2,458	\$533	\$3,308	
8				22	Utilities	\$13,575	\$5,579	\$3,650	\$22,805	
9				23	Construction	\$0	\$4,939	\$1,041	\$5,981	
10				31-33	Manufacturing	\$40,230	\$20,655	\$11,569	\$72,454	
11				42	Wholesale trade	\$20,615	\$5,767	\$5,260	\$31,642	
12				48-49	Retail trade	\$71,056	\$1,450	\$14,713	\$87,220	
13				44-45	Transportation and warehousing	\$6,449	\$6,591	\$2,887	\$15,928	
14				51	Information	\$12,580	\$8,313	\$4,095	\$24,988	
15				52	Finance and insurance	\$32,753	\$23,181	\$10,953	\$66,888	
16				53	Real estate and rental	\$89,561	\$21,081	\$22,604	\$133,247	
17				54	Professional - Scientific and technical services	\$7,450	\$19,891	\$5,654	\$32,996	
18				55	Management of companies	\$0	\$6,774	\$1,359	\$8,133	
19				56	Administrative and waste services	\$1,813	\$11,491	\$2,761	\$16,065	
20				61	Educational services	\$5,510	\$251	\$1,782	\$7,544	
21				62	Health and social services	\$90,557	\$1,362	\$19,491	\$111,410	
22				71	Arts, entertainment and recreation	\$8,043	\$886	\$2,104	\$11,033	
23				72	Accommodation and food services	\$33,524	\$3,331	\$7,295	\$44,151	
24				81	Other services	\$19,120	\$4,452	\$5,596	\$29,168	
25				92	Government and non NAICS	\$5,133	\$2,933	\$1,653	\$9,719	
26				3001	Institutions	\$17,232	\$0	\$0	\$17,232	
27					TOTAL	\$477,480	\$154,589	\$125,967	\$758,036	
28				VALUE ADDED IMPACT						
29				NAICS Code	Industry	Direct	Indirect	Induced	Total	
30				11	Agriculture, forestry, fishing and hunting	\$1,014	\$1,243	\$432	\$2,689	
31				21	Mining	\$161	\$1,249	\$271	\$1,680	
32				22	Utilities	\$8,592	\$3,653	\$2,319	\$14,564	
33				23	Construction	\$0	\$2,371	\$500	\$2,871	

Transit operations data at the agency level should be entered in the ‘OPERATIONS’ sheet (to the right of column C, as shown in Figure 4). Transit agency names and associated agency types are provided in column B and column C, respectively. Agencies should have all the operations data readily available. Most of it can also be extracted from PTMS (population, passengers, total miles, fatal accidents, total expenses and fare revenue). ***Users should ensure that the PTMS data provided in the ‘OPERATIONS’ sheet is up-to-date and accurate before conducting an analysis.*** The other information (average trip length, injuries, distribution of the fleet by power source, etc.) can be obtained from FTA’s National Transit Database (NTD). Note that data on rural transit systems is now available (upon request) from the NTD.

Figure 4: OPERATIONS Sheet

	A	B	C	D	E	F	G	H
1	Go to START							
2	<i>Notes: Key variables that should be updated annually are highlighted in orange</i>							
3	<i>The definition of most variables can be viewed by clicking on the headings (row 4)</i>							
4	ID	Agency	Transit Agency Type	Population	Passengers			
5					Line Haul	Demand Response	Total	Line Haul
6	1	ALTRAN Transit Authority	Nonurban Cnty	9,735		86,596	86,596	
7	2	Adrian Dial-A-Ride	Nonurban City	22,580		82,711	82,711	
8	3	Allegan County - Transportation Services	Nonurban Cnty	110,000		34,452	34,452	
9	4	Alma Dial-A-Ride	Nonurban City	13,600		53,456	53,456	
10	5	Ann Arbor Transportation Authority - Nonurban	Nonurban Twp			47,397	47,397	
11	6	Ann Arbor Transportation Authority - Urban	Urban Lrg	273,312	5,950,982	167,254	6,118,236	2,494,612
12	7	Antrim County Transportation	Nonurban Cnty	23,110		46,067	46,067	
13	8	Arenac/Bay Service	Nonurban Cnty	0		50,502	50,502	
14	9	Barry County Transit	Nonurban Cnty	56,755		82,936	82,936	
15	10	Battle Creek Transit	Urban Medium	53,369	498,105	27,402	525,507	419,004
16	11	Bay Area Transportation Authority	Nonurban Cnty	98,773		322,567	226,842	683,540
17	12	Bay Metro Transportation Authority - Nonurban	Nonurban Cnty			173,457	15,513	613,910
18	13	Bay Metro Transportation Authority - Urban	Urban Medium	112,934	408,161	47,360	455,521	421,601
19	14	Belding Dial-A-Ride	Nonurban City	6,049		24,827	24,827	
20	15	Benzie Transportation Authority	Nonurban Cnty	15,998		68,385	68,385	
21	16	Berrien County	Nonurban Cnty	79,398		110,980	110,980	
22	17	Big Rapids Dial-A-Ride	Nonurban City	10,849		58,060	58,060	
23	18	Blue Water Transportation Commission - Urban	Urban Medium	53,588	587,475	290,326	877,801	395,832
24	19	Blue Water Transportation Commission - Nonurban	Nonurban Cnty			157,310	157,310	
25	20	Branch Area Transit Authority	Nonurban Cnty	40,347		98,746	98,746	
26	21	Buchanan Dial-A-Ride - Urban	Urban Small	4,969		1,397	1,397	
27	22	Buchanan Dial-A-Ride - Nonurban	Nonurban City			10,246	10,246	

Once the operations data is entered, it is automatically aggregated (sum or weighted average depending on the type of variable) by agency type at the bottom of the sheet, as shown in Figure 5 below.

Figure 5: OPERATIONS Sheet – Totals

	A	B	C	D	E	F	G	H
1	Go to START							
2	<i>Notes: Key variables that should be updated annually are highlighted in orange</i>							
3	<i>The definition of most variables can be viewed by clicking on the headings (row 4)</i>							
4	ID	Agency	Transit Agency Type	Population	Passengers			
5					Line Haul	Demand Response	Total	Line Haul
102								
103	7	Urban Metro	Urban Metro	3,359,292	52,262,183	1,261,159	53,523,342	34,064,068
104	4	Urban Lrg	Urban Lrg	1,460,029	30,677,625	1,587,525	32,265,150	12,690,878
105	8	Urban Medium	Urban Medium	980,753	6,585,573	644,319	7,229,892	4,004,738
106	6	Urban Small	Urban Small	185,375	209,843	709,011	918,854	379,700
107	47	Nonurban Cnty	Nonurban Cnty	1,670,593	723,237	4,245,730	4,968,967	1,625,335
108	21	Nonurban City	Nonurban City	312,736	0	1,255,237	1,255,237	0
109	3	Nonurban Twp	Nonurban Twp	13,574	0	290,681	290,681	0
110	96	State	State	7,982,352	90,458,461	9,993,662	100,452,123	52,764,719
111	25	Urban	Urban	5,985,449	89,735,224	4,202,014	93,937,238	51,139,384
112	71	Non-Urban	Non-Urban	1,996,903	723,237	5,791,648	6,514,885	1,625,335
113								

The remaining model inputs are stored in the ‘OTHER DATA’ sheet (Figure 6), which is organized by agency type (column G through column AA) and the ‘METRO SURVEY’ sheet (survey results for Detroit Department of Transportation and SMART only). Note, however, that many assumptions are common to all agency types. This is the case for all emissions rates (e.g., NO_x emissions per vehicle mile for diesel powered buses). The values in use, based on the level of analysis selected in the ‘CONTROL PANEL’ sheet (see Section 1.3.3), are automatically shown in columns C through F.

To conduct a risk analysis, the most likely value along with low (or “pessimistic”) and high (or “optimistic”) values associated with each variable are required. Otherwise, only the median value (or most likely value) is necessary. For more information, refer to the Primer on Risk Analysis (Appendix C of Phase 1 Final Report).

Figure 6: OTHER DATA Sheet

1	2	3	A	B	C	D	E	F	G	H
	1		Go to START							
	2									
	3									
	4									
	5		Travel Characteristics							
	6	T1	Trips for work purposes (%)							
	7	T2	Trips for medical purposes (%)							
	8	T3	Trips for shopping/recreation/tourism purposes (%)							
	9	T4	Trips for educational purposes (%)							
	10	T5	Trips for other purposes (%)							
	11	T6	Vehicle ownership and operating cost (\$/mile)							
	12	T7	Parking cost (\$/trip)							
	13	T8	Taxi base fare (\$/trip)							
	14	T9	Taxi fare per mile (\$/mile)							
	15	T10	Cost of operating a bicycle (\$/mile)							
	16	T11	Average ambulance cost (\$/trip)							
	17	T12	Private vehicle occupancy, work							
	18	T13	Private vehicle occupancy, healthcare							
	19	T14	Private vehicle occupancy, shopping/recreational							
	20	T15	Private vehicle occupancy, school							
	21	T16	Private vehicle occupancy, other							
	22	T17	Number of work trips per rider annually							
	23	T18	Number of medical trips per rider annually							
	24	T19	Number of shopping/recreational trips per rider annually							
	25	T20	Number of school trips per rider annually							
	26	T21	Number of other trips per rider annually							
	27		Riders' Response to Absence of Transit							
	28	R1	% work trips, private vehicle							
	29	R2	% work trips, bicycle/walking							
	30	R3	% work trips, taxi							
	31	R4	% medical trips, private vehicle							
	32	R5	% medical trips, bicycle/walking							
	33	R6	% medical trips, taxi							

1.3.5 Calculations

The calculations for estimating transit benefits and economic impacts are performed in ‘BEN-AGENCY’ (Figure 7), ‘BEN-URBAN’, ‘BEN-NONURBAN’ and ‘IMPACTS’ (Figure 8), respectively. Transit benefits are broken down by socioeconomic sector (work, healthcare, retail, education and other) and by benefit category (out-of-pocket cost savings, travel time savings, accident cost savings, emissions cost savings and low-cost mobility benefits). Economic impacts are broken down by impact metric (output, value added, employment and tax revenue) and by type of effect (direct, indirect and induced).

Though these sheets can be viewed, they are protected to ensure the integrity of the formulas and the methodology. Their contents cannot be modified unless the protection is deactivated. Even though the user does not need to do anything on these sheets, they contain very detailed information that could prove useful for the analysis. For instance, economic impacts are disaggregated by economic sector at the 2-digit NAICS level.

Figure 7: BEN-AGENCY Sheet

1 2	A	B	C	D	E	F	G
1	Go to START						
2							
3							
4	Level of Analysis → Sector →	Detroit Department of Transportation					
5	Travel Characteristics	Work	Healthcare	Retail	Education	Other	TOTAL
6	Unlinked passenger trips, excluding transfers	13,147,575	3,642,204	5,097,883	11,599,294	5,248,542	38,735,498
7	Linked passenger trips, including transfers	10,553,631	2,923,617	4,092,099	9,310,817	4,213,034	31,093,198
8	Passenger miles	64,536,090	17,878,097	25,023,434	56,936,210	25,762,955	190,136,787
9	Line haul vehicle miles, diesel	6,635,062	1,838,077	2,572,701	5,853,706	2,648,732	19,548,278
10	Line haul vehicle miles, CNG/LPG	0	0	0	0	0	0
11	Line haul vehicle miles, hybrid	0	0	0	0	0	0
12	Line haul vehicle miles, gasoline	135,409	37,512	52,504	119,463	54,056	398,944
13	Demand response vehicle miles, LDT gasoline	0	0	0	0	0	0
14	Demand response vehicle miles, LDT diesel	584,491	161,918	226,632	515,660	233,330	1,722,031
15	TOTAL transit vehicle miles	7,354,962	2,037,507	2,851,837	6,488,829	2,936,118	21,669,253
16	Linked passenger trips foregone	3,507,521	856,870	867,309	3,310,163	875,364	9,417,227
17	Diverted linked passenger trips, private vehicle	4,431,719	1,157,589	1,491,102	3,940,217	1,797,859	12,818,487
18	Diverted linked passenger trips, bicycle/walking	1,422,962	387,682	728,367	1,470,048	937,587	4,946,646
19	Diverted linked passenger trips, taxi	928,349	288,407	657,313	391,241	391,788	2,657,097
20	Diverted linked passenger trips, ambulance	n/a	18,337	n/a	n/a	n/a	18,337
21	TOTAL diverted linked passenger trips	6,783,030	1,852,015	2,876,783	5,801,506	3,127,235	20,440,567
22	Diverted unlinked passenger trips, private vehicle	5,520,978	1,442,110	1,857,596	4,908,670	2,239,750	15,969,103
23	Diverted unlinked passenger trips, bicycle/walking	1,772,707	482,969	907,390	1,831,366	1,168,034	6,162,467
24	Diverted unlinked passenger trips, taxi	1,156,524	359,293	818,872	487,403	488,085	3,310,177
25	Diverted unlinked passenger trips, ambulance	n/a	22,844	n/a	n/a	n/a	22,844
26	TOTAL diverted unlinked passenger trips	8,450,209	2,307,215	3,583,858	7,227,439	3,895,868	25,464,590
27	Diverted vehicle miles, private vehicle	29,823,541	5,307,145	5,550,381	20,230,539	10,781,617	71,693,223

Figure 8: IMPACTS Sheet

	A	B	C	D	E	F
1	Go to START					
2	OUT-OF-POCKET COST SAVINGS				Year: 2008	
3					Level of Analysis: State	
4	OUTPUT IMPACT					
5	NAICS Code	Industry	Direct	Indirect	Induced	Total
6	11	Agriculture, forestry, fishing and hunting	\$682,886	\$1,115,834	\$336,737	\$2,135,110
7	21	Mining	\$110,503	\$856,833	\$185,798	\$1,153,133
8	22	Utilities	\$4,732,100	\$1,944,780	\$1,272,351	\$7,949,580
9	23	Construction	\$0	\$1,721,683	\$362,881	\$2,084,913
10	31-33	Manufacturing	\$14,023,749	\$7,200,113	\$4,032,830	\$25,256,691
11	42	Wholesale trade	\$7,186,169	\$2,010,315	\$1,833,580	\$11,030,063
12	48-49	Retail trade	\$24,769,363	\$505,455	\$5,128,795	\$30,403,961
13	44-45	Transportation and warehousing	\$2,248,053	\$2,297,552	\$1,006,377	\$5,552,331
14	51	Information	\$4,385,254	\$2,897,823	\$1,427,473	\$8,710,550
15	52	Finance and insurance	\$11,417,346	\$8,080,649	\$3,818,099	\$23,316,443
16	53	Real estate and rental	\$31,220,009	\$7,348,612	\$7,879,513	\$46,448,482
17	54	Professional - Scientific and technical services	\$2,596,990	\$6,933,790	\$1,970,924	\$11,502,053
18	55	Management of companies	\$0	\$2,361,344	\$473,733	\$2,835,077
19	56	Administrative and waste services	\$631,992	\$4,005,640	\$962,455	\$5,600,088
20	61	Educational services	\$1,920,727	\$87,496	\$621,186	\$2,629,758
21	62	Health and social services	\$31,567,203	\$474,779	\$6,794,355	\$38,836,337
22	71	Arts, entertainment and recreation	\$2,803,704	\$308,850	\$733,432	\$3,845,986
23	72	Accommodation and food services	\$11,686,109	\$1,161,151	\$2,542,959	\$15,390,567
24	81	Other services	\$6,665,028	\$1,551,920	\$1,950,706	\$10,167,653
25	92	Government and non NAICs	\$1,789,309	\$1,022,412	\$576,218	\$3,387,940
26	3001	Institutions	\$6,006,891	\$0	\$0	\$6,006,891
27		TOTAL	\$166,444,431	\$53,888,075	\$43,910,751	\$264,243,257
28						

The risk analysis of transit benefits and economic impacts is performed in the '@RISK' sheet (Figure 9), which is hidden and can be unhidden by the user only. The sheet contains both the risk variables (i.e., the variables that are included in the simulation) and detailed statistics on simulation results for these variables (percentile values in increments of 5 percent). Detailed statistics from @RISK should be pasted in this sheet. ***Note that risk analysis is optional. Users who wish to conduct a risk analysis need to install the @RISK application on their machines.***

Figure 9: @RISK Sheet

	A	B	C	D	E	F
1	Go to START		Notes: Paste @RISK results in F11			
2			Iterations = 5,000			
3	@RISK OUTPUT VARIABLES		@RISK OUTPUT DETAILS REPORT			
4	Work cost savings, \$thousand	\$301,133	Output Statistics			
5	Healthcare cost savings, \$thousand	\$106,170				
6	Retail cost savings, \$thousand	\$124,012				
7	Education cost savings, \$thousand	\$158,706				
8	Other cost savings, \$thousand	\$96,820				
9	Out-of-pocket cost savings, \$thousand	\$348,589	Name	1	2	
10	Travel time savings, \$thousand	\$340,020	Description	Work cost savings, \$thousand	Healthcare cost savings, \$thousand	
11	Accident cost savings, \$thousand	-\$26,014	Statistics / Cell	Output	Output	
12	Emissions cost savings, \$thousand	\$0		@RISK1B4	@RISK1B5	
13	Transportation cost savings, \$thousand	\$662,596	Minimum	\$180,594	\$57,617	
14	Affordable mobility benefits, \$thousand	\$67,574	Maximum	\$410,729	\$230,098	
15	Cross-sector benefits, \$thousand	\$56,671	Mean	\$297,084	\$126,244	
16	Affordable mobility & cross-sector benefits, \$thousand	\$124,245	Standard Deviation	\$37,804	\$32,973	
17	TOTAL cost savings, \$thousand	\$786,841	Variance	1429132000	1087221000	
18	Total foregone trips, million	21	Skewness	0.01223171	0.5140973	
19	Additional VMT, million	135	Kurtosis	3.029932	2.99068	
20	Out-of-pocket cost savings - output, \$thousand	\$264,243	Number of Errors	0	0	
21	Out-of-pocket cost savings - value added, \$thousand	\$147,387	Mode	\$259,782	\$116,486	
22	Out-of-pocket cost savings - employment	2,184	5%	\$235,005	\$77,998	
23	Out-of-pocket cost savings - tax revenue, \$thousand	\$38,552	10%	\$247,577	\$86,634	
24	Transit expenses - output, \$thousand	\$1,045,433	15%	\$259,061	\$92,154	
25	Transit expenses - value added, \$thousand	\$304,299	20%	\$264,486	\$96,903	
26	Transit expenses - employment	9,007	25%	\$268,297	\$102,060	
27	Transit expenses - tax revenue, \$thousand	\$87,068	30%	\$276,256	\$107,685	
28			35%	\$282,049	\$111,543	
29			40%	\$285,917	\$115,382	
30			45%	\$292,565	\$117,621	
31			50%	\$298,358	\$122,582	
			55%	\$304,450	\$126,216	
			60%	\$307,770	\$131,151	

The simulation results for any given risk variable can be graphically represented (bottom chart in GRAPHS) by entering the corresponding ID number in cell C68, as shown in Figure 10 below. ID numbers associated with risk variables are shown on the same sheet in row 7. This will automatically update the values in the chart data range (cells D69 through D91). The results are also summarized in TABLES.

Figure 10: @RISK Sheet – Choice of Risk Variable to Be Graphically Represented

	A	B	C	D
67				
68		Risk Variable (1, 2,...) →	1	
69			Probability of Exceeding	Work Cost Savings, \$Million
70			100%	0.3
71			95%	0.4
72			90%	0.4
73			85%	0.4
74			80%	0.4
75			75%	0.4
76			70%	0.5
77			65%	0.5
78			60%	0.5
79			55%	0.5
80			50%	0.5
81			45%	0.5
82			40%	0.5
83			35%	0.5
84			30%	0.5
85			25%	0.5
86			20%	0.5
87			15%	0.5
88			10%	0.5
89			5%	0.6
90			0%	0.6
91			Mean	0.5
92				

1.3.6 Results

The results of the analysis are presented both in tabular format and in graphical format. The ‘TABLES’ and ‘GRAPHS’ sheets are linked to the calculation sheets (‘IMPACTS’, ‘BEN-AGENCY’, ‘BEN-URBAN’ and ‘BEN-NONURBAN’). They are automatically updated when an input is changed.

The ‘TABLES’ sheet contains eleven (11) tables summarizing the results. The first table at the top of the sheet (Figure 11) shows a sample of intermediary results (e.g., additional vehicle miles in the absence of transit).

Figure 11: TABLES Sheet – Intermediary Results

Intermediary Results: Effects of the Absence of Transit

Foregone work passenger trips	7,110,749
Foregone medical passenger trips	1,788,488
Foregone shopping/recreation/tourism passenger trips	2,905,473
Foregone educational passenger trips	6,742,498
Foregone other passenger trips	2,072,328
Additional vehicle miles	135,181,702
Additional delay hours	17,452,279
Additional fatalities	1
Additional injuries	210
Additional PDO accidents	179
Additional HC emissions (tons)	0
Additional CO emissions (tons)	0
Additional NOx emissions (tons)	0
Additional CO2 emissions (tons)	0
Additional SO2 emissions (tons)	0
Additional PM 2.5 emissions (tons)	0
Number of riders who would lose their jobs	16,692
Additional home care visits	348,232

All other tables show the final results (transit benefits and economic impacts) in various configurations. As shown in Figure 12, the benefits of transit are presented by:

- Socioeconomic sector: work, healthcare, retail, education and other; or
- Benefit category:
 - Transportation cost savings: out-of-pocket cost savings, travel time savings, accident cost savings and emissions cost savings;
 - Low-cost mobility benefits: affordable mobility benefits and cross-sector benefits.

Figure 12: TABLES Sheet – Transit Benefits

Transportation Cost Savings

Benefit Sub-Category	
Out-of-pocket cost savings	\$348,589
Travel time savings	\$340,020
Accident cost savings	\$13,012
Emissions cost savings	\$0
TOTAL	\$701,622

All amounts are in thousands of dollars.

Low-cost Mobility Benefits

Benefit Sub-Category	
Affordable mobility benefits	\$67,574
Cross-sector benefits	\$56,671
TOTAL	\$124,245

All amounts are in thousands of dollars.

Benefits by Socioeconomic Sector

Socioeconomic Sector	
Work	\$301,133
Healthcare	\$106,170
Retail	\$124,012
Education	\$158,706
Other	\$96,820
TOTAL	\$786,841

All amounts are in thousands of dollars.

A number of benefit ratios (Figure 13) are also calculated. Total transit benefits are expressed per trip, per rider (annually) and per dollar spent on transit O&M. These ratios can be useful to make comparisons over time and between agencies or groups of agencies (agency types).

Figure 13: TABLES Sheet – Benefit Ratios

Benefit Ratios

Ratio	
Benefits per trip	\$9.02
Annual benefits per commuter	\$4,400
Benefits per dollar spent on public transit	\$1.47

Economic impacts (Figure 14) are aggregated for all industries but are broken down by impact metric (output, value added, employment and tax revenue) and by type of effect (direct, indirect and induced). The risk-adjusted results (mean, 10th percentile and 90th percentile estimates) for the economic impact analyses are also summarized. If the risk analysis option was not selected in ‘CONTROL PANEL’, the tables will show “N/A” instead of the risk analysis results.

Figure 14: TABLES Sheet – Economic Impacts

Economic Impacts of Out-of-Pocket Cost Savings

Impact Category	Direct	Indirect	Induced	TOTAL
Output	\$166,444	\$53,888	\$43,911	\$264,243
Value added	\$92,377	\$29,986	\$25,024	\$147,387
Employment	1,442	359	382	2,184
Tax revenue	N/A	N/A	N/A	\$38,552

All dollar amounts are in thousands of dollars.

Economic Impacts of Public Transit Total Expenses

Impact Category	Direct	Indirect	Induced	TOTAL
Output	\$535,715	\$290,807	\$218,911	\$1,045,433
Value added	\$31,215	\$148,329	\$124,754	\$304,299
Employment	5,550	1,550	1,906	9,007
Tax revenue	N/A	N/A	N/A	\$87,068

All dollar amounts are in thousands of dollars.

Summary of Economic Impacts

Impact Category	Out-of-Pocket Cost Savings	Transit Expenses
Output	\$264,243	\$1,045,433
Value added	\$147,387	\$304,299
Employment	2,184	9,007
Tax revenue	\$38,552	\$87,068

All dollar amounts are in thousands of dollars.

The ‘GRAPHS’ sheet contains seven charts, including five pie charts showing the breakdown of benefits in percentages (Figure 15 and Figure 16). Output, employment and tax revenue impacts for out-of-pocket cost savings and transit O&M are represented on the same chart. Risk analysis results (decumulative probability distribution) are also shown for the desired risk output variable (see Section 1.3.5).

Figure 15: GRAPHS Sheet – Pie Charts

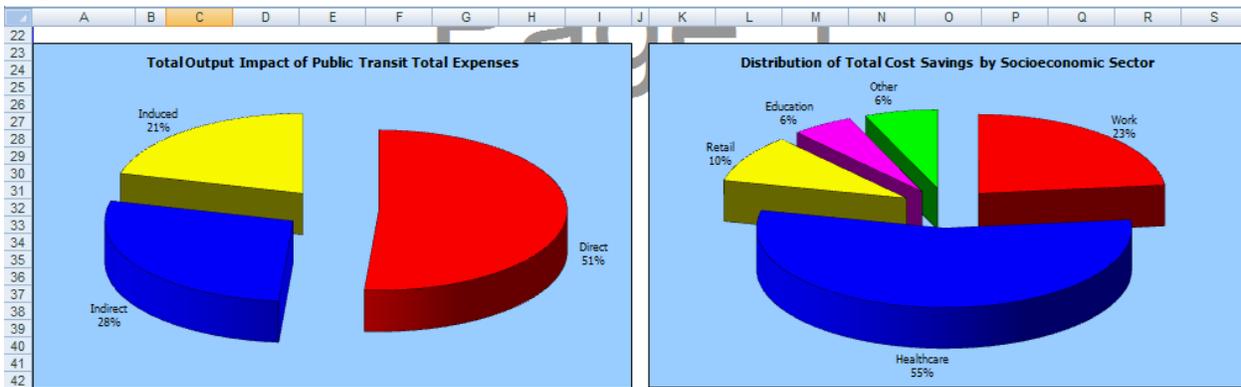
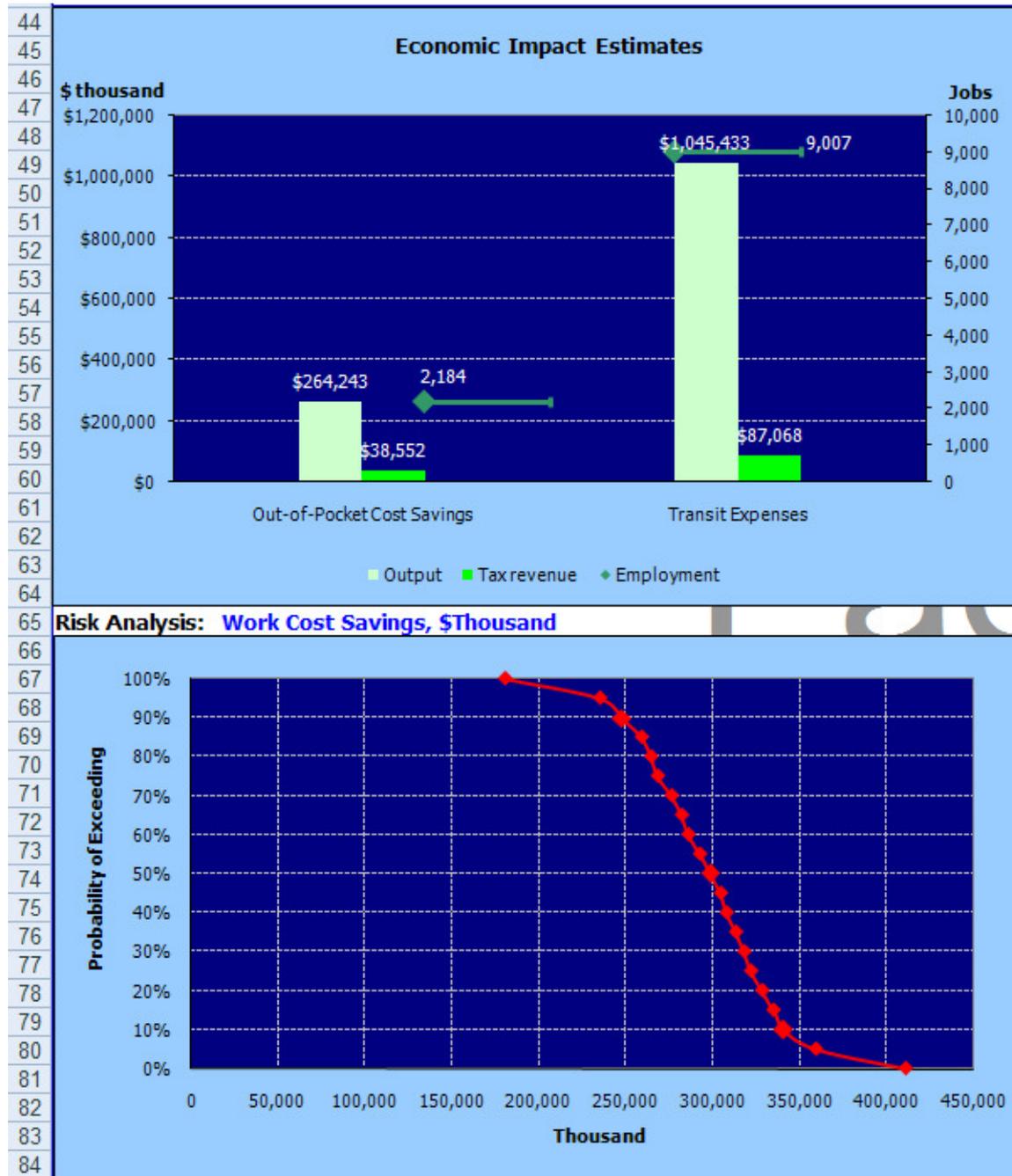


Figure 16: GRAPHS Sheet – Economic Impacts and Risk Analysis Results



1.3.7 Sources

The 'SOURCES' sheet contains a list of the different references and data sources identified by HDR to derive the model inputs. Whenever possible, hyperlinks were provided to facilitate future updates of model inputs.

A snapshot of the 'SOURCES' sheet is shown in Figure 17 on the following page.

Figure 17: SOURCES Sheet

1	2	A	B	C	D	E
1		Go to START				
2						
3						
4		Variable	Year of Data	Publication Date	Frequency	Source
5		Travel Characteristics				
6	•	Trip purpose and riders' response to the absence of transit, by transit agency type	2009	Nov 2009	n/a	HDR Decision Economics
7	•	Vehicle ownership and operating cost	2008	Mar 2009	Annual	American Automobile Association, <i>Your Driving Costs 2008</i>
8	•	Parking cost	2008	n/a	n/a	City of Jackson, Engineering Department, <i>Parking Management</i>
9	•		2008	n/a	n/a	Downtown Kalamazoo Inc., <i>Parking Rates</i>
10	•		2008	n/a	n/a	City of Lansing, Transportation and Parking Office, <i>Parking Rate</i>
11	•		2008	n/a	n/a	City of Grand Rapids, Parking Services Department, <i>Parking Rates</i>
12	•		2008	n/a	n/a	City of Detroit, Municipal Parking Department, <i>Public Parking Fees</i>
13	•	Ambulance cost	2004	May 2007	n/a	U.S. Government Accountability Office, Office of Transportation, <i>Expected Medicare Margins Vary Greatly</i> , Report to Congress
14	•		2008	Apr 2010	Monthly	Bureau of Labor Statistics, <i>Producer Price Index</i>
15		Value of Time				
16	•	Value of time	2000	Feb 2003	n/a	U.S. Department of Transportation, Office of the Secretary of Transportation, <i>Valuation of Travel Time in Economic Analysis</i>
17	•		2008	Oct 2009	Annual	U.S. Department of Commerce, Economics and Statistics Administration, <i>American Community Survey 3-Year Estimates</i>
18	•	Average vehicle occupancy by trip purpose in Michigan	2009	2010	n/a	Federal Highway Administration, <i>2009 National Household Travel Survey</i>