Transportation Insecurity Analysis Tool (TIAT)

User Guide

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U.S. Department of Transportation
Office of the Secretary of Transportation

Bureau of Transportation Statistics

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Acronyms

ACS   American Community Survey

BEA   Bureau of Economic Analysis

BTS   Bureau of Transportation Statistics

CEX   Consumer Expenditure Survey

DOT   Department of Transportation

EPA   U.S. Environmental Protection Agency

GIS   Geographic Information Systems

HTS   Household travel survey

LEHD   Longitudinal Employer-Household Dynamics

LODES   LEHD Origin-Destination Employment Statistics

MPO   Metropolitan planning organization

NHTS   National Household Travel Survey

PopSim   PopulationSim (an open-source software platform for population synthesis)

RPP   Regional Price Parity

TIAT   Transportation Insecurity Analysis Tool

U.S. DOT   U.S. Department of Transportation

USGS   U.S. Geological Survey

VMT   Vehicle Miles Traveled

💡 Introduction

Welcome to the user guide for the U.S. Department of Transportation (U.S. DOT or the Department) Transportation Insecurity Analysis Tool (TIAT). Transportation affordability is essential for households to access vital services and activities such as healthcare, education, employment, and social engagement. One key metric for evaluating transportation affordability is the transportation cost burden, which is the percentage of household income allocated to transportation expenses. According to data from the Bureau of Labor Statistics Consumer Expenditure Survey (CEX), transportation costs rank as the second-largest expenditure for most households, trailing only housing expenses.[1]

The TIAT provides estimates of local-level transportation cost burden to help U.S. DOT, state, and local agencies prioritize programs, policies, and investments targeting transportation affordability. The TIAT provides estimates of transportation cost burden at the local level (Census tracts) for 25 different household profile types nationwide. The TIAT provides cost burden estimates for the reference year 2021, the most recent year based on data availability. The Department developed pre-pandemic estimates for the reference year 2019 and made them available as a downloadable data file.

This document begins with instructions on accessing and interacting with the TIAT to view, customize, or download cost burden estimates. The subsequent sections describe how the Department developed the inputs to the tool. It provides a brief overview of key concepts and definitions and then presents a high-level overview of the modeling approach and framework used for estimating household transportation cost burden. Example use cases are provided to illustrate potential applications of the transportation cost burden estimates. The guide addresses frequently asked questions, providing clear explanations for common queries. For more detailed information on the data sources, estimation methodologies, and other technical details, please refer to the separate Transportation Insecurity Analysis Tool (TIAT) Technical Documentation report.

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[1] Bureau of Transportation Statistics. (2021). Household Spending on Transportation, Average Household Spending. Retrieved from https://data.bts.gov/stories/s/ida7-k95k#average-household-transportation-expenditures-consumer-expenditure-survey.

TIAT Accessibility for Users with Disabilities

The TIAT complies with Web Content Accessibility Guidelines (WCAG) (2.0 & 2.1 & 2.2 AA) and the Revised Section 508 requirements. Maps are typically not screen reader compatible and are an identified exception to general accessibility guidelines. A separate downloadable version of the data sets that are displayed on the TIAT map serves as an accessible alternative to the map-based interface of the TIAT.

The TIAT application uses the Esri ArcGIS Experience Builder platform. Esri publishes documentation regarding the accessibility considerations of that platform.[2] Table 1 summarizes the Widgets used within the TIAT app and their accessibility status.

Table 1: TIAT Accessibility for Users with Disabilities

TIAT Widget	Accessibility Status
Sidebar Panel	Supported
Filter (Vertical arrangement style)	Supported with limits
Map	Most actions are not supported (pan, zoom, select, etc.)
Edit Transportation Costs	Supported
Export	Supported
Summary 'Score' Cards	Supported
Household Profile Selector	Supported
Information Window	Supported
Map Pop-Ups	Not supported

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[2] *Esri ArcGIS Experience Builder Accessibility*. Retrieved from
https://doc.arcgis.com/en/experience-builder/latest/get-started/accessibility.htm.

🔑 Key Concepts and Definitions

Income: Household income includes the total annual earnings, before deductions for taxes and other items, of all individuals residing within a specific household. This covers wages, salaries, government assistance, and other sources of revenue contributing to the household's financial resources.[3]

Transportation Cost: Transportation costs cover various expenses associated with mobility and travel. These primarily include the costs of vehicle ownership (e.g., purchasing, leasing, insurance), vehicle operation (e.g., fuel, maintenance, repairs), costs related to the use of taxi and ride-hailing services, and costs associated with the use of regional public transit systems. The Department develops transportation cost estimates using the data sources and methods described in the "Summary Overview of Model Framework" section of this User Guide that is presented below.

Transportation Cost Burden: Transportation cost burden refers to the percentage of a household's income spent on transportation. The Department calculates the burden by dividing the total household transportation expenditures by its household income. The Department considers a household to be transportation cost burdened if they spend more than 15 percent of their income on transportation.

Transportation Insecurity: As defined by the U.S. DOT, transportation insecurity "occurs when people are unable to get to where they need to go to meet the needs of their daily life regularly, reliably, affordably, and safely."

Housing Cost: Housing costs include rental or mortgage costs, as reported in the 2017-2021 U.S. Census Bureau American Community Survey (ACS) Public Use Microdata Sample (PUMS).

Transportation and Housing Cost Burden: The transportation and housing cost burden is the sum of the transportation cost and the housing cost divided by the household income.

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[3] For additional details regarding the specific elements included in the measure of household income, see the U.S. Census Bureau definition of income at https://www.census.gov/glossary/?term=Income, and the income-related questions (43 and 44) used on the 2021 American Community Survey (ACS) questionnaire at https://www2.census.gov/programs-surveys/acs/methodology/questionnaires/2021/quest21.pdf#page=18.

The Department considers a household to be transportation and housing cost-burdened if they spend more than 45 percent of their income on transportation and housing combined.

⚙️ Summary Overview of Model Framework

The TIAT and the modeling used to estimate transportation cost and cost burden rely on robust data sets and follow industry best practices. The Department began by reviewing existing models, methods, tools, and techniques for estimating transportation cost burden at the local level. Then, the Department developed a set of improved methods and data to advance transportation cost and cost burden estimation. The Department presented the resulting modeling approach at a two-day virtual workshop in May 2023, attended by nearly fifty subject matter experts and practitioners. Based on input from that workshop and feedback from third-party reviewers, the Department refined and improved the initial data and modeling approaches.

This section provides a high-level summary of the data and techniques used to develop the transportation cost and cost burden information included in the TIAT. Overall, the approach that is used consists of four overarching component elements, summarized in the sections below. More detailed information regarding the data sources, estimation methodologies, and other technical details can be found in the separate Transportation Insecurity Analysis Tool (TIAT) Technical Documentation report.

Disaggregate Household Model Estimation

The Department assembled a combined household travel survey (HTS) data set consisting of approximately 191,000 households, comprised of 25 separate existing HTS data collections that were obtained from 16 different agencies (see Table 2). This combined HTS data set formed the basis for estimating a disaggregate household travel model to predict the miles traveled by individual households for seven separate combinations of travel mode (e.g., personal auto, transit, taxi & ride-hailing) and trip purpose (e.g., work, non-work, long-distance) as a function of household, transportation, and land use/neighborhood attributes.

The seven separate models that were estimated include:

1. Household vehicle miles traveled (VMT) for work trips
2. Household vehicle miles traveled (VMT) for non-work trips
3. Household vehicle miles traveled (VMT) for long-distance trips over 100 miles
4. Miles traveled using public transportation for work trips
5. Miles traveled using public transportation for non-work trips
6. Miles traveled via taxi and ride-hailing services for work trips
7. Miles traveled via taxi and ride-hailing services for non-work trips

Table 2: HTS Data Used for Disaggregate Household Model Estimation

Sponsor Agency or Agencies	Geographical Region	Data Collection Year(s)	Sample Size (number of Households)
Puget Sound Regional Council (PSRC)	Seattle, WA	2017	3,311
		2019	3,076
		2021	2,790
		2023	3,000
Metropolitan Council (Met Council)	Twin Cities, MN	2018–2019	7,837
		2021-2022	7,950
Wasatch Front Regional Council (WFRC) and Utah DOT (UDOT)	Utah, and Salt Lake City, UT	2023	8,500
Ohio Department of Transportation (ODOT)	Columbus, OH	2016–2017	3,054
	Outer Columbus, OH	2017–2018	2,470
	Dayton, OH	2018–2019	1,743
	Toledo, OH	2019–2020	2,573
	Cincinnati, OH	2021-2022	4,193
Community Planning Association of Southwest Idaho (COMPASS)	Boise, ID	2021	4,012
Spokane Regional Transportation Council (SRTC)	Spokane, WA	2022	1,953
U.S. DOT, Federal Highway Administration	Nationwide	2022	7,893
	Nationwide	2016-2017	26,099
California Department of Transportation (Caltrans)	California	2016-2017	26,095
Georgia Department of Transportation (GDOT)	Georgia	2016-2017	8,631
New York Department of Transportation (NYSDOT)	New York	2016-2017	15,851
North Carolina Department of Transportation (NCDOT)	North Carolina	2016-2017	8,000
South Carolina Department of Transportation (SCDOT)	South Carolina	2016-2017	6,500
Texas Department of Transportation (TxDOT)	Texas	2016-2017	20,000
Wisconsin Department of Transportation (WisDOT)	Wisconsin	2016-2017	11,675
Iowa Northland Regional Council of Governments (INRCOG)	Waterloo, IA	2016-2017	1,293
North Central Texas Council of Governments (NCTCOG)	Dallas/Ft. Worth, TX	2016-2017	2,917
TOTALS			191,416

Population Synthesis

After the disaggregate household model estimation step described above, the Department used a modeling technique known as population synthesis to generate representative data of household-level demographic, transportation, and housing information for the entire U.S. based on data from the American Community Survey (ACS). To implement this population simulation technique, the Department utilized part of the ActivitySim transportation modeling platform, which is an open-source software platform for activity-based travel modeling.[4] Specifically, the Department used the PopulationSim population synthesizer tool, which is integrated into the ActivitySim platform.[5] A consortium of state DOTs and metropolitan planning organizations (MPOs), administered by the Association of Metropolitan Planning Organizations (AMPO), developed and maintains ActivitySim and PopulationSim. This group has successfully collaborated over the course of the past several years, with new members continuing to periodically join the consortium, and new applications of the ActivitySim platform continue to be implemented by both member and non-member transportation agencies, as well as in academia.[6]

> The PopulationSim tool uses a population sample (called a seed or reference sample) and marginal distributions (called controls or targets). For the modeling performed for the TIAT, the Department used the 2017-2021 5-year American Community Survey (ACS) Public Use Microdata Sample (PUMS) as the seed sample, with the targets also based on ACS data. The population synthesis occurs when the model runs to match the population sample to the marginal distributions, resulting in a data file of synthetic household-level demographic, transportation, and housing information for the entire U.S.

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[4] Freedman, Joel, and David Hensle, PhD. *ActivitySim: Activity-Based Travel Demand Modeling Built by and For Users*. 2021. Retrieved from https://rsginc.com/wp-content/uploads/2022/06/ActivitySim-White-Paper-2022.pdf.
[5] PopulationSim v0.5.1. Retrieved from https://github.com/ActivitySim/populationsim. The documentation for PopulationSim v0.5.1 is available at https://activitysim.github.io/populationsim/.
[6] For additional background information on *ActivitySim*, see https://research.ampo.org/activitysim/.

Application of the Disaggregate Household Model

The Department applied the disaggregate household travel model, developed earlier using the combined household travel survey (HTS) data, to the data file of the synthetic household-level demographic, transportation, and housing information for the entire U.S. produced from the population synthesis step above. This results in household-level estimates of the miles traveled for the seven separate combinations of travel mode (e.g., personal auto, transit, taxi & ride-hailing) and trip purpose (e.g., work, non-work, long-distance) as a function of household, transportation, and land use/neighborhood attributes.

Transportation Cost Estimation

The Department applied unit cost values drawn from sources such as the Consumer Expenditure Survey (CEX), the U.S. DOT FTA National Transit Database (NTD), the combined HTS data set noted earlier, the Department of Energy, the auto insurance industry, as well as various other sources. These values were applied to household-level estimates of the miles traveled by transportation mode and trip purpose that the application of the disaggregate household model noted above produced. This results in a set of household-level transportation cost estimates. These household-level cost estimates and other household attributes and outputs are then processed and aggregated to yield Census tract, county, state, and national values for transportation cost and cost burden.

🛠️ Using the Tool

The TIAT is the primary means of viewing and downloading the local-level cost burden estimates.

Accessing the Tool

The tool can be accessed through the U.S. DOT Transportation Community (TC) Explorer home page, TC Explorer interface, or through the direct link below:

Tool Overview

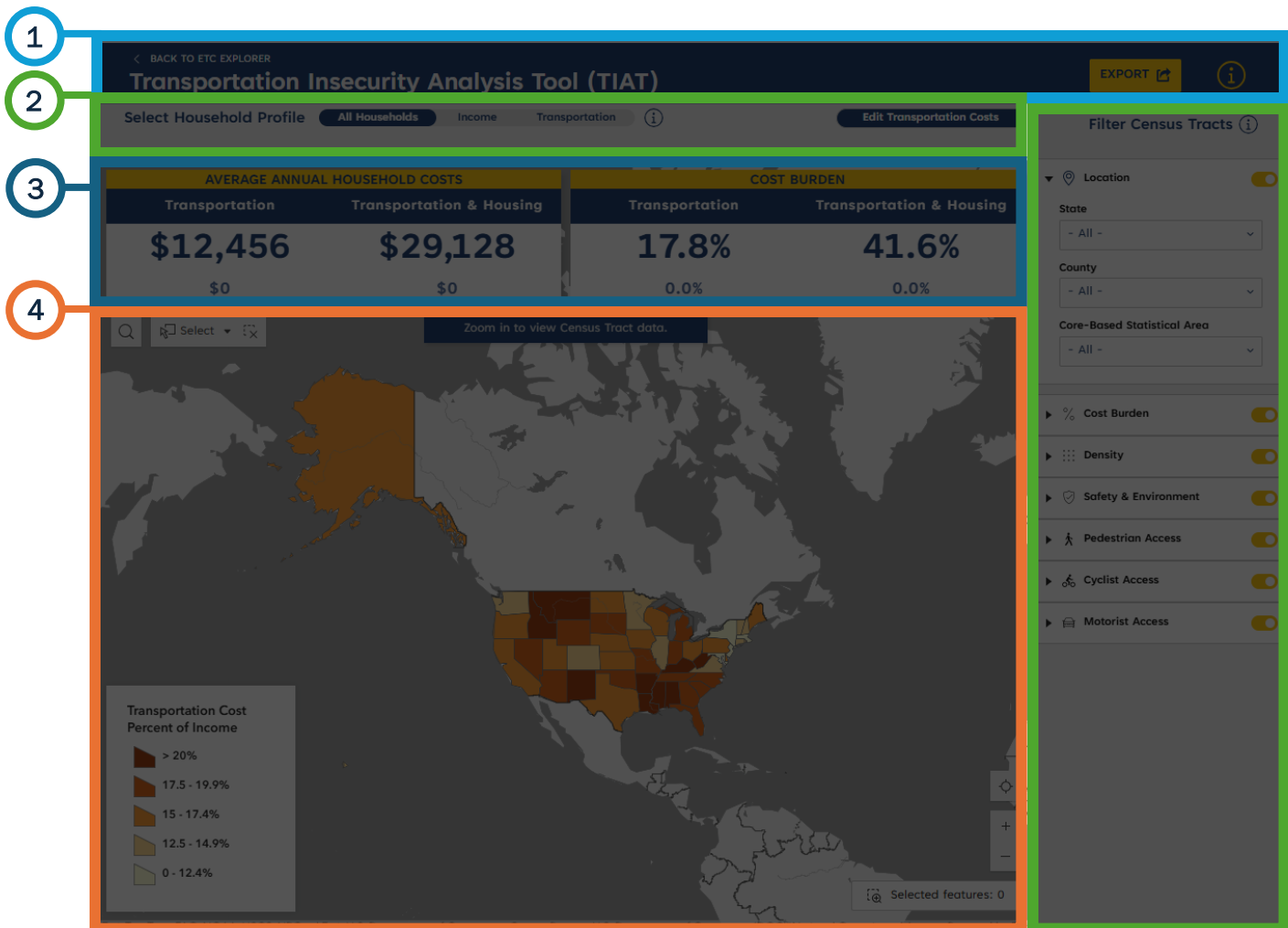Upon launching the tool, the main interface appears, which includes four primary sections (see Figure 1).

https://maps.dot.gov/ost-p/etc-explorer/tiat/

Figure 1: Tool Main Interface (with sections defined)

1 **Header** – the blue header at the top of the tool includes the title of the application and three buttons:

- TC Explorer button – directs users back to the TC Explorer tool.
- Export button – allows users to export data. More detail regarding exporting data is available in the Downloading Results (Export Data) section of this User Guide.
- Info button – launches the pop-up screen and allows users to get more information on how to use the tool.

2 **Customization Menu** – the customization menu is below the header and presents several ways to filter and customize the Census tracts to explore the data. To learn more about each, navigate to the corresponding section of this user guide.

- Household Profile: allows the user to view tract populations based on income thresholds or transportation variables within tracts.
- Edit Transportation Costs: allows the user to change the cost input for a select number of census tracts.
- Filter Tracts: allows the user to filter in and out different tracts based on several dimensions.

3 **Summary Statistics** – Along the top of the map area, three "cards" display summary statistics for the Census tracts currently shown or selected on the map. The statistics are based on the current zoom level, any filters applied, and any specific tract or group of tracts selected by the user. These cards also reflect adjustments made by the user, such as selecting a household profile or modifying transportation costs for a selected group of tracts using the Edit Transportation Costs tool. These summary statistics include:

INCOME
- Median Household Income

AVERAGE ANNUAL HOUSEHOLD COSTS
- Transportation
- Transportation & Housing

COST BURDEN
- Transportation
- Transportation & Housing

4 **Map** – the main portion of the tool is the map. Census tracts are symbolized based on their transportation cost burden. The map also contains the selection tool and map legend (see Figure 2). The map initially shows the contiguous United States and state-level transportation cost burden symbology.
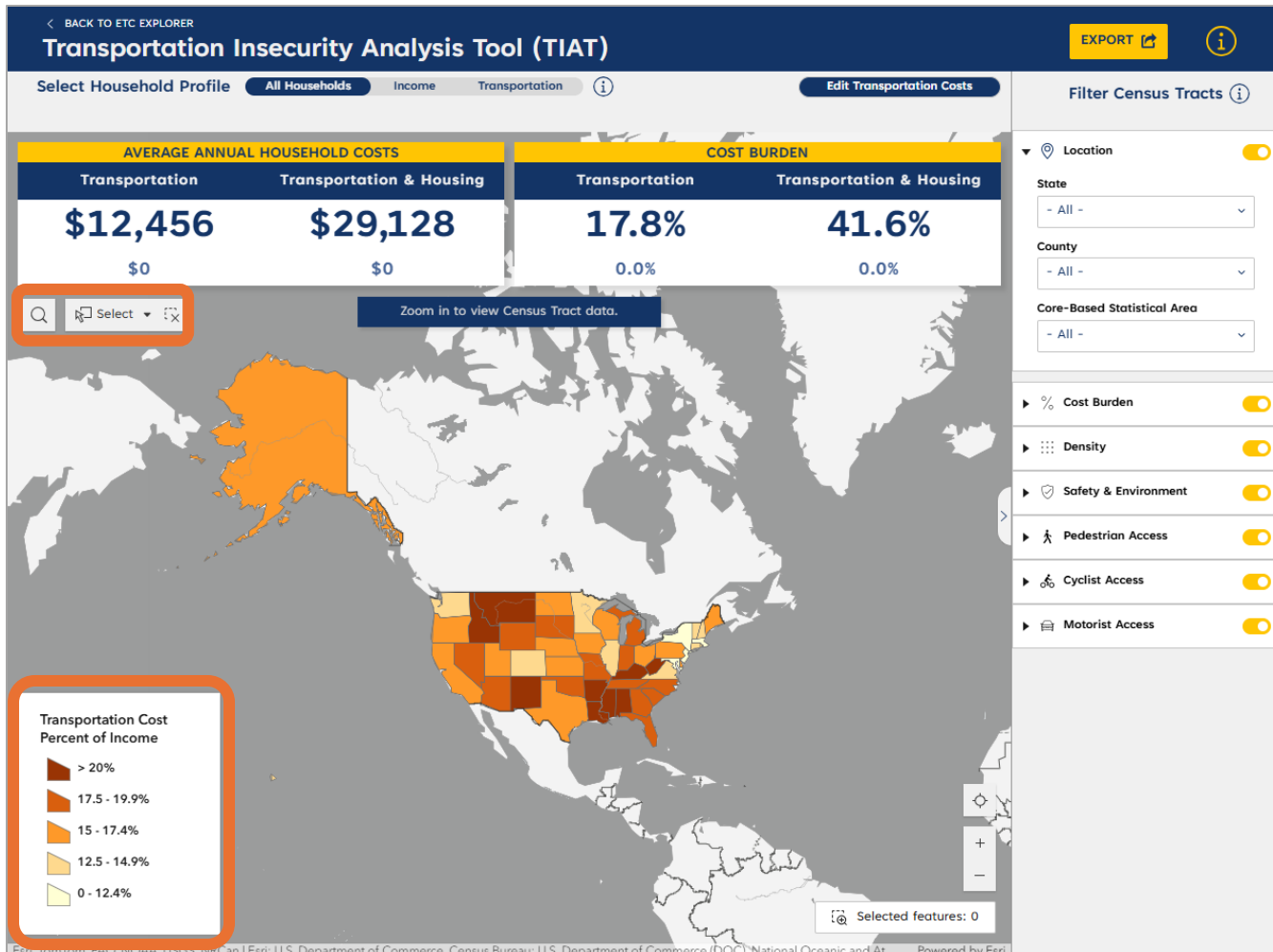

Figure 2: TIAT initial Map View with locations of the Selection Tool and Map Legend

Summary Statistics

As shown in Figure 3, there are three sections (Income, Average Annual Household Costs, and Cost Burden) along the top of the map containing weighted median averages of summary statistics for the displayed or selected Census tracts. The summary statistics presented are:

INCOME
- Median Household Income

AVERAGE ANNUAL HOUSEHOLD COSTS
- Transportation
- Transportation & Housing

COST BURDEN
- Transportation
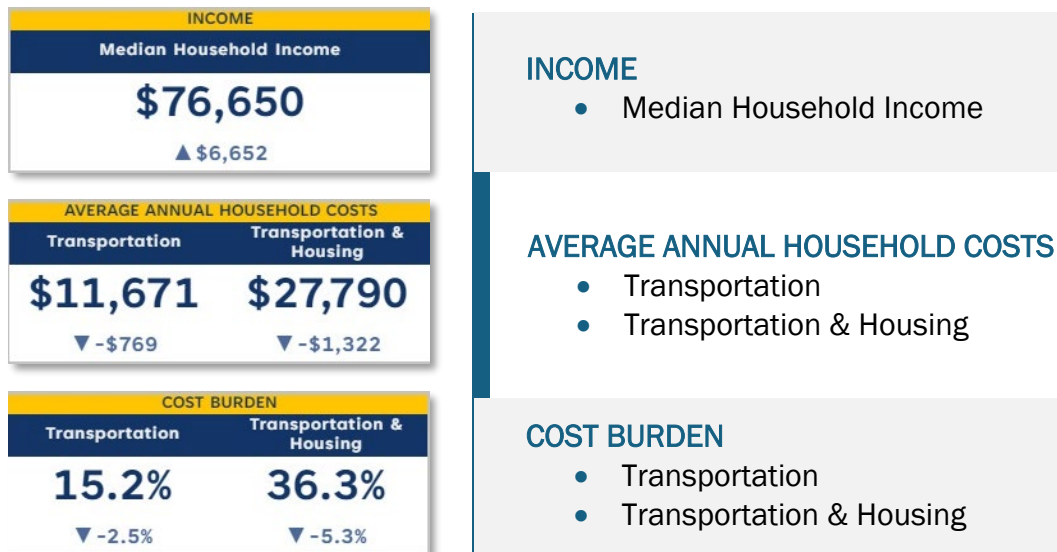- Transportation & Housing

Figure 3: Summary Statistics

The cards show an average for each item, weighted by the number of households in the selected household profile for the displayed or selected Census tracts. The summary statistics on the cards update in real-time based on six different actions by the user, including:

1. Zooming in or zooming out on the map.
2. Applying one or more filters using the Filter Census Tract sidebar panel (see Figure 4).
3. Selecting a Household Profile.
4. Selecting a single tract to display the tract information pop-up window.
5. Selecting multiple tracts using the selection tool.
6. Adjusting individual transportation cost elements for the selected tract(s) using the Edit Transportation Costs tool.
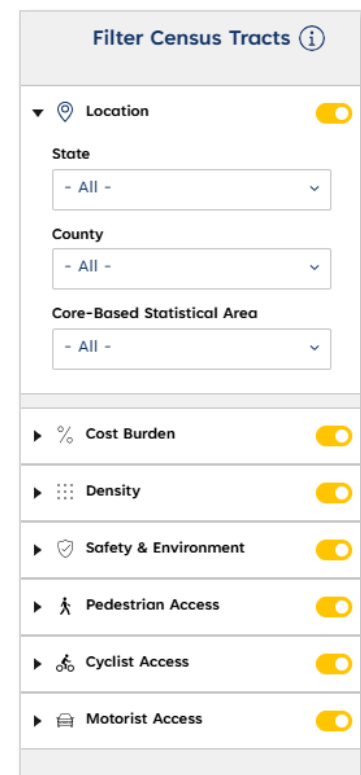

Figure 4: Filter Tracts Sidebar found on the right-hand side

At the bottom of each summary statistic below the large dark blue number, a smaller light blue number shows how the statistic compares to the national average, which is expressed in dollars for the INCOME and AVERAGE ANNUAL HOUSEHOLD COSTS statistics, and in percentage points for the COST BURDEN statistics. By clicking on these smaller light blue numbers, the user can display a tooltip (see Figure 5) that provides additional details and context regarding these comparisons to the nationwide statistics.[7]

Figure 5: Relation to National Average Tooltip

Similar summary statistics to those that are presented in the cards can also be displayed for just a single user-selected Census tract in a Census tract information pop-up window (see Figure 6). This pop-up window can be displayed simply by left-clicking on any individual Census tract on the map when zoomed in to see tracts. The pop-up window will not activate at the state-level zoom. These individual Census tract summary statistics provide somewhat more detailed information than the more limited number of summary statistics provided at the top of the map and can be displayed by scrolling down within the Census tract information pop-up window.

A somewhat larger version of this Census tract information pop-up window can also be viewed by clicking on the "dock" button at the top of the pop-up window (shown in the blue square in each pop-up window presented in Figure 6). This "dock" feature will also fix the position of this pop-up window into the top right of the map window. The standard, smaller, and "undocked" version of this pop-up window can be restored if desired by clicking again on the same "dock" button at the top of the pop-up window.

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[7] A "tooltip" is a text-based information pop-up that a user can access by clicking on certain elements in the TIAT and that provides additional context and information to the user that is related to that element.
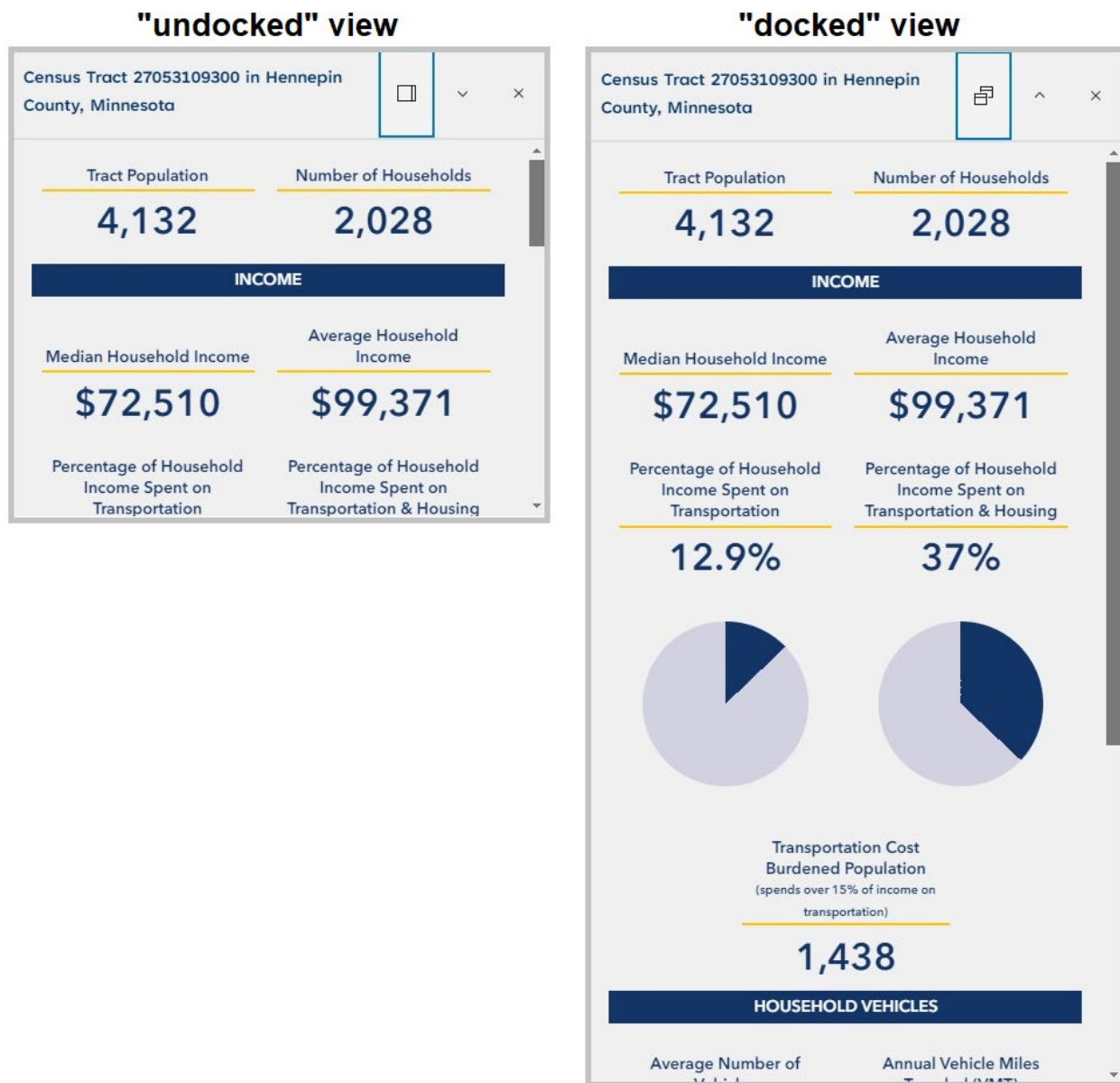
Figure 6: Census Tract Information Pop-Up Window

Selecting a Household Profile

The household profile menu (Figure 7) allows the user to select the household profile of interest which then updates the TIAT to display the cost burden estimates for that selected profile in the map and in the three summary cards. There are two categories of household profiles, income characteristics and transportation (see Table 3). Figure 8 shows an example of how both the income and the transportation household profiles appear in the TIAT. Only one household profile can be selected at a time.

Figure 7: Household Profile Selection

Changing the household profile changes the Census tract characteristics. The detailed household-level attribute data produced for all households in the U.S. from the modeling procedures described earlier have been pre-processed and used to develop separate Census-tract level data sets specific to each of the 25 different household profile types that are available to select. After having selected a given household profile, the household attribute data and transportation and housing cost and cost burden estimates displayed in the summary cards and in any Census tract information pop-up window is based on only the households within the selected profile. For example, if a user selects the 1st Quintile under the relative income quintiles, the map and summary cards will show every Census tract but provide summary statistics for each tract based on only the households in the 1st quintile of income. The household profiles allow tool users to customize the transportation cost burden information based on only certain types of households that may be of particular interest to the user. Using household types can lead to more precise estimates of the connection between household characteristics and transportation behavior and transportation costs and cost burden.

Table 3: All Available Household Profile Types and Descriptions

Household Profile Type		Household Profile Category Description
	All Households	Average Household
INCOME	**Relative Income Quintile**	1st quintile
		2nd quintile
		3rd quintile
		4th quintile
		5th quintile
	Fixed Income Ranges	Less than $24,999
		$25,000 to $49,999
		$50,000 to $99,999
		$100,000 to $149,999
		$150,000 or more
	Official Poverty Measure	Below 100 percent of the poverty level
		100 to less than 150 percent of the poverty level
		150 to less than 200 percent of the poverty level
		200 percent of the poverty level or greater
TRANSPORTATION	**Vehicle Availability**	No cars in HH
		Cars in HH, but fewer cars than # adults
		Cars in HH equal or greater than # adults
	Transit Availability	No transit service available
		Transit service likely available, but limited data
		Transit service available
	Walkability	Least walkable
		Below average walkable
		Above average walkable
		Most walkable

Users have the ability to select from two categories of Income or Transportation to drop down a selection box of the selectable Household Profiles as shown in Figure 8.
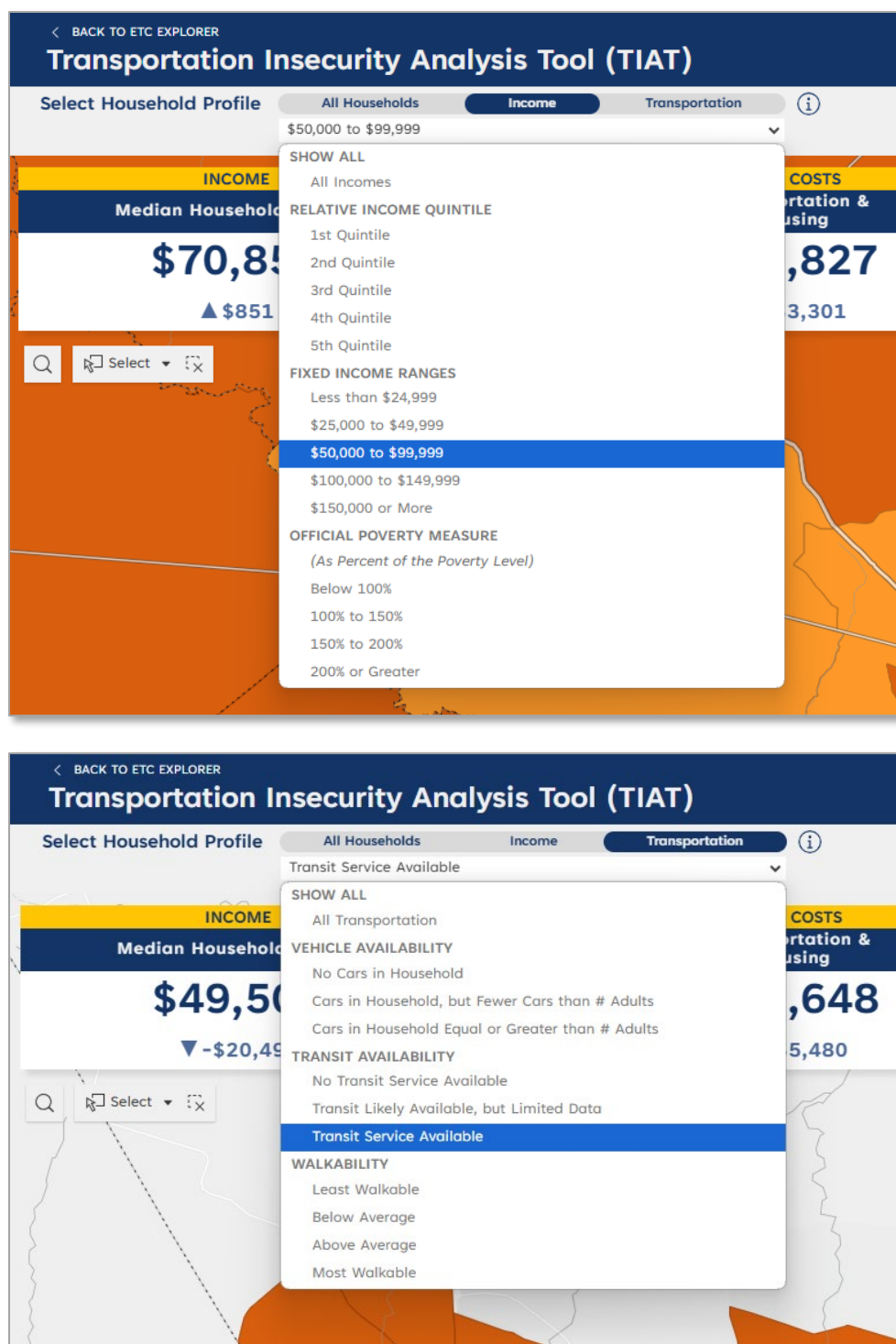

Figure 8: Example Income and Transportation Household Profile Selections

All Households:

All of the households in the displayed or selected tracts are used in calculating the summary statistics shown in the cards and in the data that can be downloaded. These summary statistics represent the median income, average household size, and average commuters per household for all of the households within a Census tract.

Income:

Relative Income Quintiles: Relative income quintile ranges vary across different Census tracts, based on the distribution of household incomes in each tract.

Fixed Income Ranges: Income is divided into five categories, starting from less than $25,000, with subsequent ranges increasing in $25,000 to $50,000 increments, up to $150,000 or more.

Official Poverty Measure: The federal poverty guidelines (FPG) as defined by the U.S. Department of Health and Human Services (HHS) are used as the basis of a set of four poverty level-focused income categories.[8] These four categories are defined as percentages of the FPG (below 100 percent, 100 percent to 150 percent, 150 percent to 200 percent, and over 200 percent). The FPG vary by the number of people in the household and also differ for the states of Alaska and Hawaii as compared to the rest of the U.S.

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[8] *U.S. Federal Poverty Guidelines*. U.S. Department of Health and Human Services (HHS), Office of the Assistant Secretary for Planning and Evaluation (ASPE). Retrieved from https://aspe.hhs.gov/topics/poverty-economic-mobility/poverty-guidelines, and from https://aspe.hhs.gov/sites/default/files/documents/e03cb39a940516a81d5537829bad9430/guidelines-1983-2024.xlsx

Transportation:

Vehicle Availability: Using ACS, TIAT presents households based on the average number of vehicles available in the household, ranging from no vehicles, to fewer vehicles than adults, to an equal or greater number of vehicles compared to adults.

Transit Availability: Transit availability has three categories based on the best available data from the U.S. DOT Bureau of Transportation Statistics (BTS) National Transit Map, the Environmental Protection Agency (EPA) Smart Location Database, transit agency headquarters locations from the U.S. DOT Federal Transit Administration National Transit Database, and mode of journey to work from the ACS. Based on a comprehensive review of all of these datasets, TIAT groups Census tracts into one of the following three categories:

1. No transit service available
2. Transit likely available, but limited data
3. Transit service available

Walkability: Walkability measures the probability of whether people walk as a mode of transportation. The measure comes from the National Walkability Index[9] from the EPA Smart Location Database, which estimates walkability based on the built environment: street intersection density, proximity to transit stops, and diversity of land uses.

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[9] U.S. Environmental Protection Agency. *Smart Location Database. Technical Documentation and User Guide.* Version 3.0. June 2021. Retrieved from https://www.epa.gov/system/files/documents/2023-10/epa_sld_3.0_technicaldocumentationuserguide_may2021_0.pdf

Filtering Census Tracts

The tool provides users with three options for querying Census tracts by Zoom Extent, Selection, or Filtering. Users may opt to *zoom* to or *select* areas they are familiar with or use the *filter* sidebar to query by neighborhood (i.e., Census tract) characteristics variables measuring the built environment's impact on transportation cost burden. The variables include metrics such as housing costs, walkability, housing density, and access to employment. The neighborhood characteristic variables are drawn from multiple sources and are detailed in the Data Dictionary.

1. Zoom Extent
   a. Users can use the search button or zoom into a specific location on the map. This will filter the Census tracts to those shown on the map and the income, costs, and cost burden summary statistics at the top of the map will update accordingly.

2. Selection Tool
   a. By clicking the "Select" button (see Figure 9) on the left side of the map, users can select Census tracts within a rectangle, by default, or by clicking and dragging. Only the selected Census tracts will then be displayed, outlined with a neon light blue border.

   b. Clicking the ▼ provides the user with different selection options beyond the default rectangle (see Figure 10).
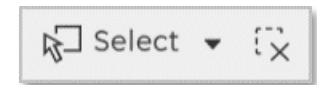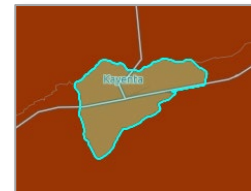

Figure 9: Selection Tool

- **Default - Rectangle (click & drag)** – Allows users to draw any size rectangle which selects the corresponding Census tracts.
- **Lasso (click)** – Allows users to draw a custom shape by placing vertices. Once the vertices have been placed, selecting the first vertex or pressing "Enter" on the keyboard selects the corresponding Census tracts.
- **Circle (click & drag)** – Allows users to draw a circle of any radius where the first point is the center of the circle, and users can drag to expand the radius as desired. Releasing the circle selects the corresponding Census tracts.
- **Line (click)** – Allows users to draw a multi-segment line where pressing "Enter" on the keyboard selects the corresponding Census tracts.
- **Point (click)** – Allows users to select an individual tract by clicking on an area.

c. Selection mode

    i. The user can select from two types of selection modes, "Partially or completely within" which will select all tracts if the selection shape intersects a tract, or "Completely contained by" which will only select a tract if the selection shape completely contains the tract.

d. Other

    i. Users can also select tracts within a current selection using any selection tool type.

    ii. To clear the selection, users can select the "x" to the right of "Select" or click anywhere outside the current selection.

    iii. To exit the selection tool, users can click the "Select" button so that it is grey (see Figure 9) instead of yellow (see Figure 11).

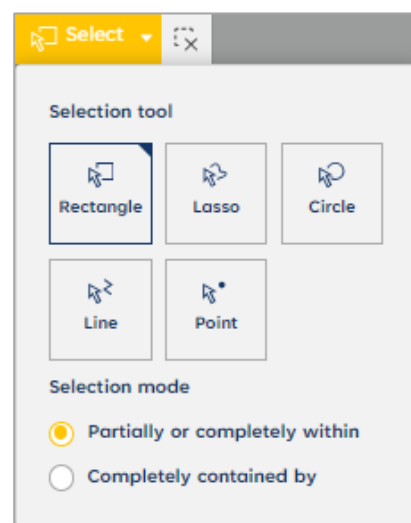   iv. To cancel a current selection process, users can click the stop icon that appears next to "Select."

Figure 10: Selection Tool Types

Figure 11: Selection in Progress Button

3. Filter Sidebar:

a. The "Filter Census Tracts" sidebar panel (see Figure 12) allows the user to narrow the selection of Census tracts by characteristics associated with the tract overall or with all households in the tract. This is in contrast to the Household Profile selector described earlier, which is based on data for subsets of particular households within each tract based on their income level or transportation availability. For more information on the details and sources of these variables, please access the Data Dictionary.
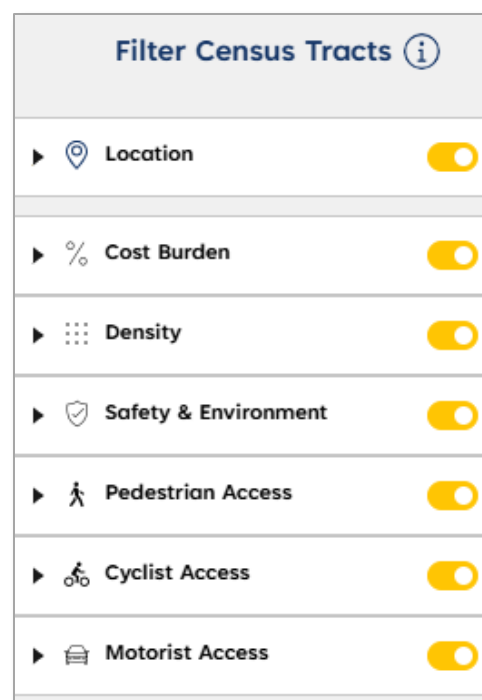

Figure 12: Filter Tracts Sidebar

The characteristics used for the Filter Census Tracts filters were developed outside of the model development and are not tied into the cost burden calculations. The filters presented here remove (i.e., hide the display of) tracts that do not meet the conditions of the filter or filters that have been specified by the user. To adjust cost and income model specific components, please use the Household Profile selector described earlier, or the Edit Transportation Costs tool described in the following section. A neighborhood characteristic can be turned off by selecting the toggle to change it to white from yellow. Refer to the data dictionary and to the separate Transportation Insecurity Analysis Tool (TIAT) Technical Documentation report for more detailed information on how each field was calculated.

Adjusting Transportation Costs

Edit Transportation Costs Inputs: Users can view and edit the components of transportation costs for the selected tracts

Figure 13: Edit Transportation Costs Button

on the map by selecting the "Edit Transportation Costs" button (see Figure 13) on the top toolbar. This will bring up the pop-up window shown in Figure 14.
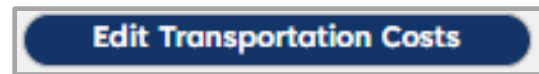

Figure 14: Edit Transportation Costs Pop-up

Tracts must be selected using the select tool shown in Figure 9 to edit the transportation costs. If no tracts are selected, the user will see the message shown in Figure 15 in the "Edit Transportation Costs" pop-up. A "select visible tracts" button can be selected at tract view zoom levels in which all tracts within the zoomed extent will be selected.
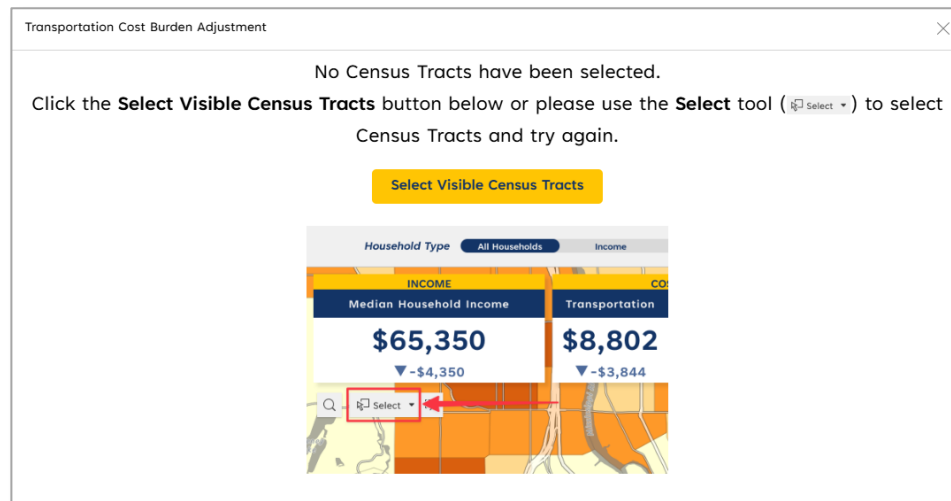
Figure 15: Edit Transportation Costs - No Census tracts selected

The inputs allow users to visualize how costs and cost burden change based on any inputs that the user provides to more precisely characterize a local area. The updated costs and cost burden resulting from changing these transportation costs are displayed in the summary cards and are also reflected in the data that a user can download as noted in the Downloading Results (Export Data) section presented later in this User Guide. The user inputs that have been made to the transportation costs shown in the Edit Transportation Costs pop-up window can be reset either by selecting the "Reset All" button at the bottom of the pop-up window as shown in Figure 17, and if the set of selected tracts changes. With the Edit Transportation Costs tool, the user can edit the following components:

1. Automotive Ownership Costs
   - Finance Charges
   - Fixed Ownership Costs
   - Vehicle Depreciation
   - Household Vehicles

2. Automotive Operating Costs
   - Maintenance Costs
   - Gasoline Price
   - Vehicles Miles Traveled (miles)
   - Fuel Efficiency (miles per gallon)

3. Other Transportation Costs
   1. Parking
   2. Tolls

4. Non-Automotive Transportation Costs
   3. Spending on Regional Transit
   4. Taxi & Ride-hailing

Except for Parking and Tolls, each component has a multiplier option that increases the original value. For example, a multiplier of 110 is 110 percent of the original value. The tool sets the Parking and Toll costs to $0 by default and can be adjusted to the annual average cost per household by typing in the value.
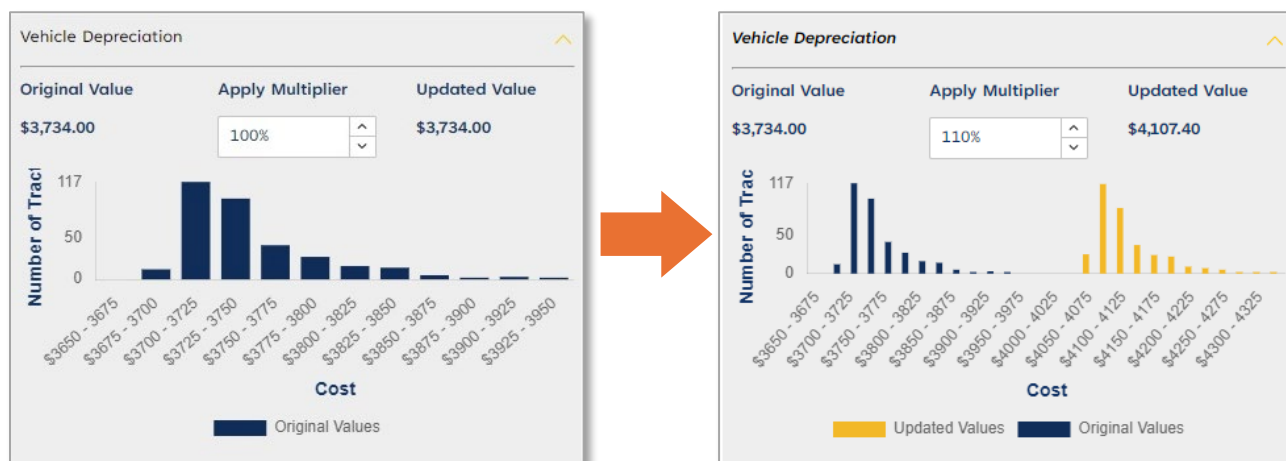

Figure 16: Edit Transportation Costs Example

Histogram: The blue bars on the histogram represent the original values, whereas the yellow bars represent the updated values. The Y-axis on the histogram represents the number of Census tracts, and the X-axis represents the respective component. For example, the left side of Figure 16 shows the original "Vehicle Depreciation" cost with the default multiplier of 100. The right side of Figure 16 shows the "Vehicle Depreciation" cost with a multiplier of 110, and the adjusted values are indicated by the yellow bars. In this case, the results show a shift to the right, indicating that more Census tracts now have a higher "Vehicle Depreciation" cost.

Adjustment for average cost of living: The cost of living varies among regions. In some regions, households spend more on housing, groceries, goods, medical care, and other goods and services than in others. These higher costs leave less money in a household budget for transportation. To account for these differences, refer to the button labeled "Adjust for Average Cost of Living," which scales costs by the regional price parity (RPP) produced by the Bureau of Economic Analysis.[10] This adjustment increases the adjusted

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[10] U.S. Department of Commerce, Bureau of Economic Analysis (BEA). *Regional Price Parities by State and Metro Area*. Retrieved from https://www.bea.gov/data/prices-inflation/regional-price-parities-state-and-metro-area.

transportation cost burden in higher-cost regions and reduces it in lower-cost regions. This adjustment only applies to the selected Census tracts.

Applying & Resetting: Edited transportation costs will automatically be supplied. Users can reset their changes by selecting the "Reset All" button at the bottom of the pop-up window shown in Figure 17.

Figure 17: Edit Transportation Costs Button

Clicking outside the window or selecting the "x" in the top right corner of the pop-up hides the "Edit Transportation Costs" window and shows the map. The map will outline the tracts with the modified transportation costs in a neon light blue border.

Downloading Results (Export Data)

Export: Users can access various data download options by selecting the "EXPORT" button at the top right of the screen, as shown in Figure 18.
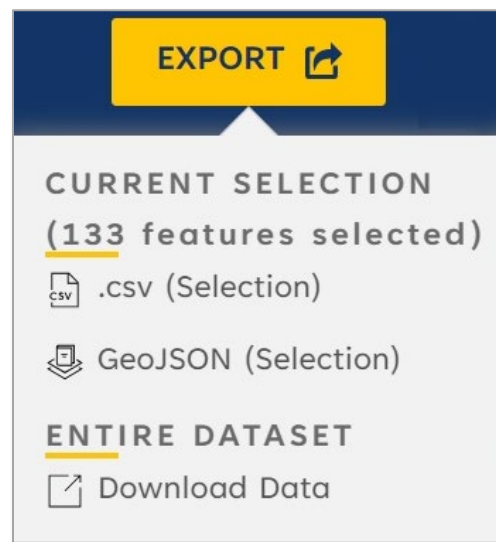

Figure 18: Export Menu

Using the two options under "CURRENT SELECTION" from the EXPORT menu, a set of transportation cost burden data can be downloaded.

If a user has selected a specific set of Census tracts by using the Selection Tool (see Figure 9), then data for those selected Census tracts can be exported to either a CSV file or to a geoJSON file for further analysis (e.g., using a spreadsheet, relational database, geographic information systems (GIS) application, etc.) by selecting the corresponding option under "CURRENT SELECTION." Note that this download option is limited to exporting data for a maximum of 7,500 Census tracts. The data that is exported will reflect any filters that have been selected, as well as any components of transportation costs that have been changed using the Edit Transportation Costs tool.

If a user has not selected any specific set of Census tracts, then data for all tracts that are currently displayed on the screen (and also reflecting any filters and/or cost adjustments that have been selected) can be exported to either a CSV file or to a geoJSON file in a similar manner by selecting the corresponding option under "CURRENT SELECTION." Note that this download option is also limited to exporting data for a maximum of 7,500 Census tracts.

If a user would like to download data for more than 7,500 tracts, it is recommended that the entire dataset be downloaded instead. This can be accomplished under "ENTIRE DATASET" from the EXPORT menu and by selecting the "Download Data" option. This option will direct the user to the Data Download and Resources section of the U.S. DOT TC Explorer website at the URL below:

https://experience.arcgis.com/experience/836cf87c91344bb991a1b149873 f27af/page/Data-and-Methodology-Download/

The data available for download at the URL shown above includes the full TIAT transportation cost burden datasets for both 2019 and 2021, and the 2020 Census tracts spatial file for joining via GEOIDs, as well as data from the related U.S. DOT TC Explorer tool.

Example Use Cases

This section provides several examples of use cases of the TIAT.

Identification of Projects to Reduce Cost Burden in a City:

- **Use Case:** A city government wants to address the high transportation cost burden faced by low-income households in certain neighborhoods. They utilize the tool to identify areas where households spend a significant portion of their income on transportation.

- **How it Works:** By analyzing household transportation costs and income at a granular level, the tool helps pinpoint neighborhoods with the highest transportation cost burden in comparison to the national average. City planners can then prioritize infrastructure projects such as improving public transit access, implementing bike lanes, or enhancing pedestrian infrastructure in these areas to reduce transportation costs for residents. City planners could also use the various access filters to understand what key resources (schools, grocery stores, medical facilities, parks, transit, and jobs) are accessible by which mode (walking, biking, driving) to target investment.

- **Action:** Select the "High" option in the Transportation Cost Burden filter within the "Filter Census Tracts" sidebar.

Identification of Projects to Reduce Cost Burden in a Region or Statewide:

- **Use Case:** A metropolitan planning organization (MPO) or state department of transportation (DOT) aims to allocate resources effectively to address transportation cost burden across its jurisdiction.

- **How it Works:** The agency uses the tool to identify Census tracts with high transportation cost burdens and low access to affordable transportation options. By overlaying this information with existing transit routes, employment centers, and housing affordability data, the agency can identify priority areas for targeted interventions, such as expanding public transit service, implementing fare subsidies for low-income riders, or promoting mixed-income housing developments near transit hubs.

- **Action:** Select the "High" option in the Transportation Cost Burden filter within the "Filter Census Tracts" sidebar and select the "Low" option in the Access filters.

Transit Agency Service Planning and Resource Allocation:

- **Use Case:** A transit agency aims to optimize its service offerings and allocate resources effectively to address the transportation cost burden for riders.

- **How it Works:** The transit agency uses the tool to identify corridors and neighborhoods with high transportation cost burdens for constrained-income households, using filters to identify Census tracts that currently have limited transportation options by non-automotive modes. By identifying corridors or neighborhoods with high transportation cost burdens and limited access to affordable transit options, the agency can tailor its service planning efforts to better serve these communities. This may involve adjusting bus schedules, expanding service coverage to underserved areas, implementing fare reduction programs for low-income riders, or partnering with local organizations to provide transportation assistance programs. The tool helps the transit agency make data-driven decisions to improve transit equity and accessibility for all passengers.

- **Action:** Select the "High" option in the Transportation Cost Burden filter within the "Filter Census Tracts" sidebar and select the "Low" option in the Pedestrian and Bicyclist Access filters.

Prioritizing Safety Improvements in High Transportation Cost Burden Areas:

- **Use Case:** A city or regional government seeks to understand the relationship between transportation cost burden and traffic safety in order to prioritize safety interventions in areas where residents are facing both high transportation costs and increased exposure to unsafe conditions.

- **How it Works:** The tool can be used to analyze Census tracts with high transportation cost burden and filter Census tracts with high fatalities. This allows planners to identify areas where both safety concerns and cost burden are high. This combination allows planners to address equity issues in transportation safety by focusing on communities most affected by both financial and safety-related transportation challenges.

- **Action:** Select the "High" option in the Transportation Cost Burden filter within the "Filter Census Tracts" sidebar and select the "6+" option in the Safety filter.

Targeting Emission Reductions in Communities with High Transportation Cost Burden:

- **Use Case:** A state department of transportation (DOT) or a regional planning organization wants to reduce both transportation cost burdens and transportation-related emissions in a specific area or region.

- **How it Works:** By using the tool, planners can identify Census tracts where households experience high transportation cost burden and where the transportation mode share is heavily reliant on personal vehicles. This can be cross-referenced with data on vehicle emissions, identifying high-emission areas. Planners can then prioritize interventions such as expanding public transit, incentivizing the adoption of electric vehicles (EVs), or creating carpooling programs to reduce the need for single-occupancy vehicle trips. These actions can reduce both the financial strain on households by providing more affordable transportation options and contribute to environmental goals by lowering emissions in areas where air quality is poor.

- **Action:** Select the "High" option in the Transportation Cost Burden filter within the "Filter Census Tracts" sidebar and select the ">7.0 metric tons / year" option in the Automotive CO_2 Emissions per Household filter within the Safety & Environment filters.

Assessing the Impact of Fuel Efficiency Improvements on Transportation Costs:

- **Use Case:** A city government aims to explore the potential impact of increasing fuel efficiency (measured by miles per gallon, MPG) for vehicles in a particular area while acknowledging that travel behavior, such as the number of trips or mode of transportation, does not change.

- **How it Works:** Using the tool, city planners can model the effect of increasing the average MPG for an area's vehicle fleet on transportation cost burden by adjusting the local "Fuel Efficiency (MPG)" value using the "Edit Transportation Costs" tool. While this intervention would not alter the travel behavior of residents (i.e., the number of trips, modes of transportation, and total miles traveled), it could still reduce fuel costs for households, thus lowering the transportation cost burden. The tool shows how incremental improvements in fuel economy and thus fuel costs reduce household transportation costs. This helps decision-makers understand that improving fuel efficiency alone has cost-saving benefits but may not address broader concerns such as traffic congestion or equity in access to different modes of transportation.

- **Action:** Select the desired census tracts and hit the "Edit Transportation Costs" button. Adjust the "Fuel Efficiency (MPG)" value and hit "Apply".

⚠ Limitations

TIAT should not be used, or should be used with caution, in the following cases due to the limitations of the underlying model and data. These include:

- **Evaluation of alternative future scenarios via the "Edit Transportation Costs" button in the tool:** This button allows the user to view the components of transportation cost burden. While it allows for customizing results, it is not intended for testing alternative future scenarios where there are significant changes in macro-scale conditions. The model does not factor in any change in travel behavior due to changes in transportation costs. For instance, changes in gasoline prices may over the long-term change household VMT, mode choice, or vehicle fuel efficiency in ways not captured by the tool. Thus, it should not be used for the evaluation of alternative future scenarios where a travel pattern change may be expected.

- **Households, neighborhoods, and other geographic areas that are not representative of those for which data were available:** The model captures many household types as defined by residential location, income, vehicle ownership, transit availability, and neighborhood walkability. However, there are many more potential types of households, as well as residents of group quarters, that are not explicitly accounted for in the model. Similarly, the model is calibrated based on data from a wide array of regions throughout the country but may not be fully representative of some types of areas or neighborhoods with limited or no HTS data or notably different travel behavior and patterns. Extra care should be used when examining areas or neighborhoods with unique socio-economic and travel contexts that may influence travel behavior and expenditures, such as military bases and university dorms (which are examples of group quarters that are not included as "households" in the analysis or the tool), Tribal Areas, and some states such as Alaska and Hawaii, for example.

🔍 Frequently Asked Questions (FAQ)

1. **What is the TIAT, and how was it developed?**

   The TIAT includes a cost burden model that estimates transportation cost burden at the local level using the best available data at the time. The estimates of the transportation cost burden that it produces can be accessed through the U.S. DOT Transportation Insecurity Analysis Tool (TIAT), which allows for both interacting with and downloading the cost burden estimates. As compared to the related Transportation Community (TC) Explorer tool that the U.S. DOT has developed and published, the TIAT is primarily focused on providing cost and cost burden information in terms of their absolute dollar values or percent values, whereas the TC Explorer is primarily focused on providing the same type of information but expressed in terms of percentiles and relative index values that better indicate how an area of interest compares to other areas of the U.S.

2. **What is transportation cost burden?**

   Transportation cost burden is the percent of a household's income that is spent on transportation.

3. **What transportation modes are included in the TIAT?**

   The transportation cost burden estimate accounts for costs associated with owning and driving an automobile, using transit, and using taxi or ride-hailing services. The TIAT also allows users to examine households' transportation cost burden based on different levels of household vehicle ownership, the availability of regional public transportation service, and the ability to reach destinations on foot (also called "walkability"), by bicycle, or by vehicle. Thus, tool users can see how transportation cost burden varies based on households' ability to use automobiles, availability of public transportation, walkability, bikeability, and drivability.

4. **What will the data be used for?**

   U.S. DOT developed the TIAT to assist applicants of its discretionary grant programs and to make data available to address the high transportation cost burden. Other potential users include State DOTs, MPOs, and other transportation planning organizations to inform transportation planning. The data is downloadable and is available for use by the general public, governmental organizations, businesses, non-profit organizations, researchers, and any other interested individual or organization.

5. **How are these estimates different from earlier efforts to estimate transportation cost burden?**

Existing transportation cost burden estimates produced by the U.S. DOT as part of the TC Explorer tool (and a previous version of the TIAT) were based primarily on aggregate Census tract-level data and other data sources at various levels of geographic granularity. For the new TIAT presented in this User Guide, large disaggregate household-level data sets and related modeling and simulation methods have been utilized, and additional improvements in the geographic granularity of certain other data (such as vehicle fuel economy, auto insurance costs, etc.) have also been incorporated in order to produce more granular cost burden estimates and cross-tabulations. There have also been several prior efforts to estimate transportation cost burden at the local level in the United States, including the Location Affordability Index (LAI) by the U.S. Department of Housing and Urban Development and the U.S. Department of Transportation, as well as the Center for Neighborhood Technology's Housing and Transportation (H+T) Affordability Index. The TIAT differs from these models in several ways. While they both also include costs associated with housing, the TIAT focuses on transportation costs. Additionally, the TIAT uses several previously unavailable data sources, including the use of regional, statewide, and national HTS to better understand how and how much Americans travel.

6. **At what geospatial scale are the results?**

The estimates of household transportation cost burden are at the level of Census tracts, as well as counties, states, and the country as a whole. Within the TIAT, users can select multiple Census tracts to produce a weighted average transportation cost burden for their selection.

7. **When will the model be updated in the future?**

U.S. DOT has built the model to allow it to be updated and to allow new transportation costs to be included as adequate data becomes available. An exact update schedule does not yet exist.

8. **Does the model account for costs associated with walking, biking, car subscription services, parking, or tolls?**

Adequate data does not yet exist to account for households' costs for walking, biking, car subscription services, parking, and tolls at the local level and for different household types.

9. **What household types are results available for?**

   Transportation cost burden estimates are available for a "typical" household in an area, as well as different household types defined by household income (income quintile, select income ranges, and poverty level) and by the household's transportation availability (vehicle ownership, transit availability, and walkability).

10. **Why might I see minor discrepancies when making transportation cost adjustments?**

    There are small amounts of expected variation in data due to rounding, approximations, or sampling. In cases where values are rounded to a certain number of decimal places, minor discrepancies can occur, but they typically fall within the range of $200. Data is stored with reduced decimal precision (e.g., two decimal places) to optimize storage and processing.

11. **Are there any plans for future enhancements or expansions of the model and its capabilities?**

    U.S. DOT has built the model to allow new transportation costs to be included as adequate data becomes available. Plans for these updates are under development.

Glossary

Developed Area: Land characterized by urban or built-up features.

Filters: Criteria applied to refine analysis of Census tracts within the tool, such as transit availability, walkability, household density, employment density, and urban/rural location. Selecting a filter removes Census tracts from the view.

Finance Charges: Costs associated with financing the purchase or lease of a vehicle, including interest payments and fees.

Fixed Ownership Costs: Expenses related to vehicle ownership that do not vary with the number of miles driven, such as insurance premiums and taxes.

Household Characteristics: Attributes and demographics of households, including income, household size, number of children, number of commuters, and vehicle ownership.

Household Profiles: Categories used to classify households based on income levels and transportation options, facilitating analysis of transportation cost burden.

Household Travel Surveys: Surveys collected by various transportation agencies such as MPOs and state DOTs on travel behavior and patterns of households, including modes of transportation, trip purpose, and frequency.

Income: Household income encompasses the total annual earnings, before deductions for taxes and other items, of all individuals residing within a specific household. This includes wages, salaries, government assistance, and other sources of revenue contributing to the household's financial resources.[11]

Income Quintiles: Divisions of the population into five equal groups based on income levels.

Maintenance Costs: Expenses associated with keeping a vehicle in drivable condition, including repairs, servicing, and replacement parts.

Neighborhood Characteristics: Features of a neighborhood or area, such as walkability, bike access, transit availability, housing density, and employment opportunities.

Official Poverty Measure: The federal poverty guidelines (FPG) as defined by the U.S. Department of Health and Human Services (HHS) are used as the official poverty

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[11] For additional details regarding the specific elements included in the measure of household income, see the U.S. Census Bureau definition of income at https://www.census.gov/glossary/?term=Income, and the income-related questions (43 and 44) used on the 2021 American Community Survey (ACS) questionnaire at https://www2.census.gov/programs-surveys/acs/methodology/questionnaires/2021/quest21.pdf#page=18.

measure.[12] The FPG vary by the number of people in the household, and also differ for the states of Alaska and Hawaii as compared to the rest of the U.S.[13]

Population Synthesis: The process of creating a synthetic population representative of real-world demographics and characteristics.

Taxi and Ride-hailing: Services providing transportation for hire, typically on-demand and utilizing vehicles such as taxis or privately owned cars.

Transit Availability: The ease with which individuals can access and utilize public transit services within their community or region.

Transportation & Housing Cost Burden: The ratio of a household's combined transportation-related expenses and housing-related expenses to its gross household income. It indicates the proportion of income spent on both transportation and housing combined. A household is considered transportation and housing cost-burdened if it spends 45 percent or more of its gross income on both transportation and housing combined.

Transportation Cost Burden: The ratio of a household's transportation-related expenses to its household income. It indicates the proportion of income spent on transportation. A household is considered transportation cost-burdened if it spends 15 percent or more of its gross income on transportation.

Transportation Cost: Expenses associated with various modes of transportation, including automobile ownership and operation, taxi, ride-hailing, and regional public transit.

Vehicle Depreciation: The decrease in the value of a vehicle over time, typically due to age, wear and tear, and market factors.

Vehicle Fuel Efficiency: The distance in miles that a vehicle can travel per gallon of fuel consumed, measured as miles per gallon.

VMT (Vehicle Miles Traveled): The total distance traveled in owned or leased automobiles by a household within a specified time period.

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[12] *U.S. Federal Poverty Guidelines*. U.S. Department of Health and Human Services (HHS), Office of the Assistant Secretary for Planning and Evaluation (ASPE). Retrieved from https://aspe.hhs.gov/topics/poverty-economic-mobility/poverty-guidelines, and from https://aspe.hhs.gov/sites/default/files/documents/e03cb39a940516a81d5537829bad9430/guidelines-1983-2024.xlsx

[13] There are two versions of the "federal poverty measure." The first version is the "poverty thresholds" defined by the U.S. Census Bureau, which are used primarily for statistical purposes. The second version is the "federal poverty guidelines" defined by the U.S. Department of Health and Human Services (HHS). The federal poverty guidelines (FPG) are a simplification of the poverty thresholds and are used primarily for administrative purposes such as determining financial eligibility for various federal programs.