

DRAFT User's Manual

NJDOT 2012-13: *Integration of Bus Stop Count Data with Census data for Improving Bus Service and Efficiency*

Prepared for New Jersey Department of Transportation and NJ Transit

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2 OVERVIEW

2.1 TRANSIT DEMAND MODELING

This collection of tools and methodologies are intended to allow planners to assess changing transit demand in customizable market areas defined simply by GTFS routes and census geographies. The web-tool designed by AVAIL aggregates a number of data sets which are universally available in the US, such as the American Community Survey (ACS), Census Transportation Planning Products (CTPP) and The Longitudinal Employment and Household Dynamics (LEHD) survey, with data generated by transit agencies like GTFS and ridership surveys. These data sets are then run through an algorithm to approximate bus ridership. Custom developed software combined with Open Trip Planner is then used to microsimulate bus ridership in a given market area. The collection of tools and methodologies together, illuminate dynamics of bus ridership in a given area.

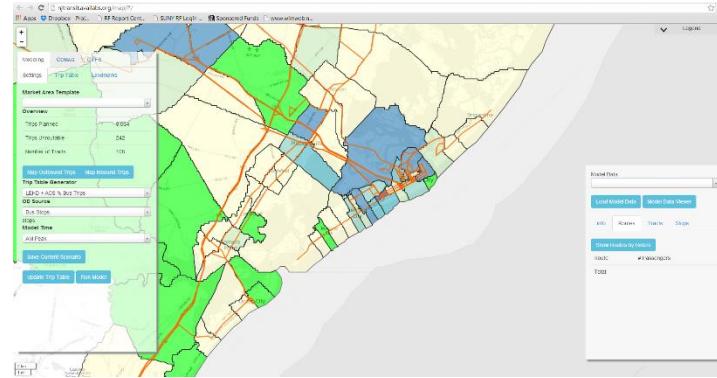


Figure 1 Map Viewer

2.2 USER'S GUIDE

This User's Guide is broken into two sections:

1. Admin Tool: This section discusses every functionality of the web tool guiding a user through the process of uploading data, creating market areas, running models, and reviewing model outputs.

2. Modeling: This section contains a summary of data elements and the regression model specifications used in the microsimulation process, including the sources of data, descriptive statistics, the correlations coefficients, regression model development and latest regression models for the three market areas; Atlantic City, Princeton/Trenton, and Paterson.



Figure 2 Admin Tool

	Atlantic City			
	Atlantic City1	Atlantic City2	Atlantic City3	Atlantic City4
Dependent Variable	bus_to_wor	bus_to_wor	bus_to_wor	bus_to_wor
Constant	6.14	-23.95	-12.39	-17.40
car_0	0.77*	0.69**	.63**	.54**
car_1		0.1**	.14**	.14**
informatio			-.82**	-.76**
emp_den				.01*
R Sq.	0.56	0.59	0.61	0.63
N	110	110	110	110

Table 1 Regression Modelling

3 ADMIN TOOL

The Admin Tool contains three sections: a navigation panel on the left; a content section in the center; and a user's guide at right. As a user navigates throughout the website, the User's Guide at right changes to reflect the functionalities located in the center pane. The right panel User's Guide provides information about how to use each of the tools located in the center panel.

The Admin Tool (see Figure 1, below) is the landing page or “**Dashboard**” which users will see when they first sign in. This figure illustrates the Left Navigation Pane, the Center Pane, and the User’s Guide at Right. A user can access a PDF of the entire User’s Guide by clicking on the “**User’s Guide**” link in the Left Navigation Pane.

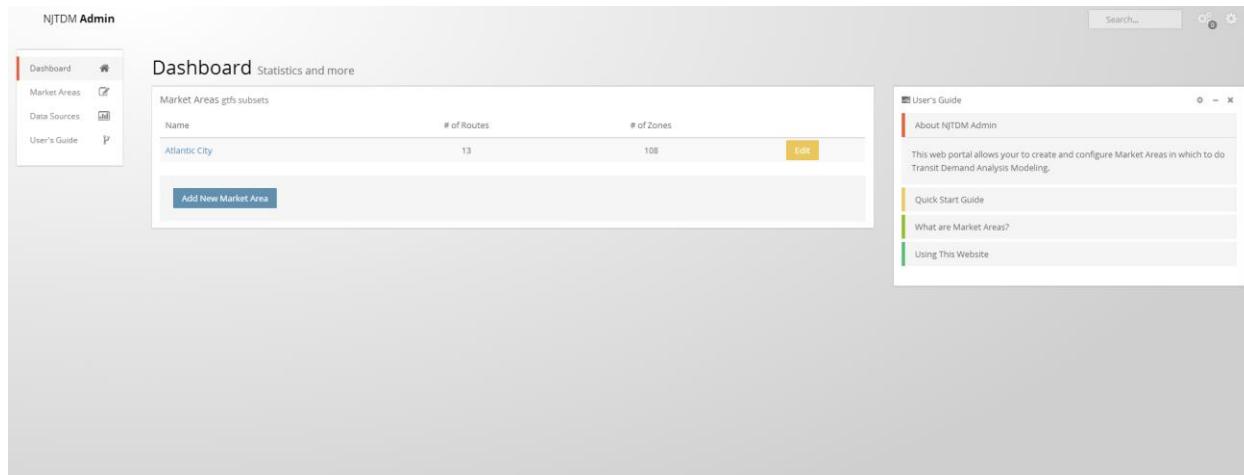


Figure 3 Admin Tool: Dashboard

3.1 USER’S GUIDE - RIGHT PANE

The Admin Tool contains a User’s Guide in the Right Side Panel (see Figure 4 at right). This User’s Guide contains information and instructions related to the functionalities of the Admin Tool’s Center Pane.

The category titles are named for each of the functionalities and columns located in the Center Pane.

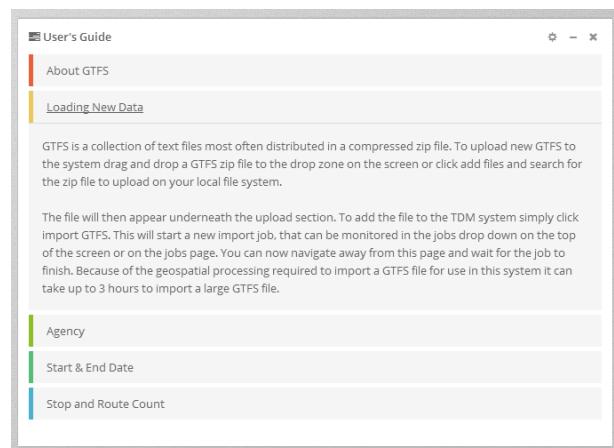


Figure 4 Admin Tool: Right Pane User's Guide

3.2 LEFT NAVIGATION PANE

Before discussing the Center Pane functionality tools or their corresponding Right Pane User's Guide sections, the following section describes the full suite of functions in the Left Navigation Pane.

3.2.1 Left Navigation - Market Areas

Selecting Market Areas opens a list of each of the models in your web tool. Below each model is an Overview, Model Runs, and access to the Map Tool.

3.2.2 Left Navigation - Data Sources

By Clicking on **Data Sources**, you open a list of each of the data sources used in building the web tool and it allows you to upload new data.

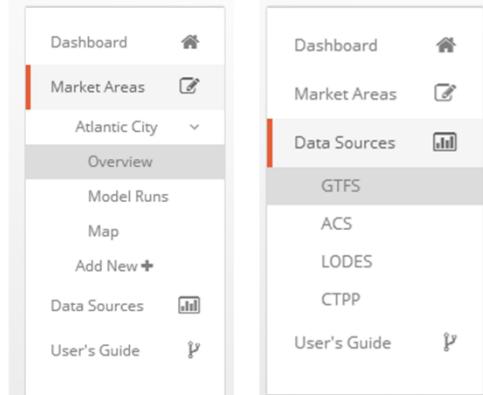
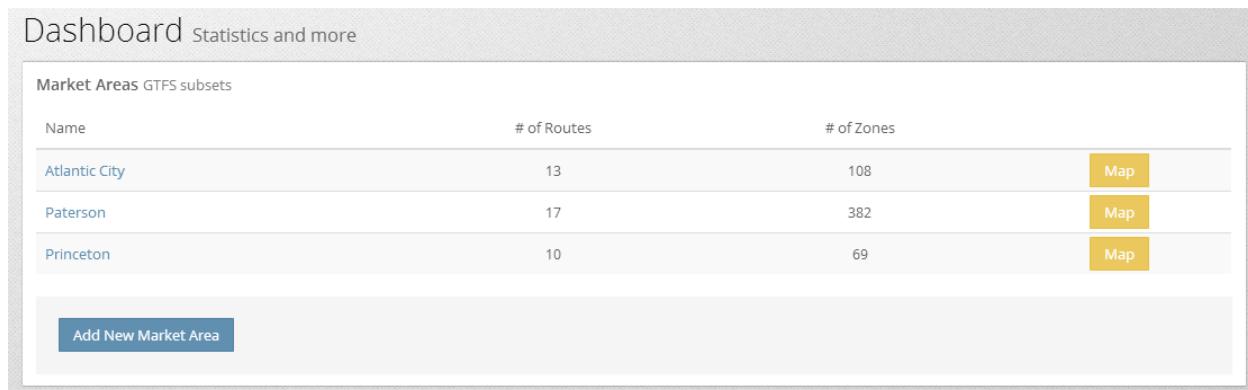


Figure 5 Admin Tool: Left Navigation Pane

3.3 DASHBOARD

Upon opening the Admin Tool, users will find the Dashboard page with the three navigation panes discussed above. The Center Pane is currently set to land on “**Market Areas.**” At this time, the only market area in the web tool is Atlantic City.

3.3.1 Dashboard - Center Pane



Market Areas GTFS subsets			
Name	# of Routes	# of Zones	
Atlantic City	13	108	Map
Paterson	17	382	Map
Princeton	10	69	Map

Add New Market Area

Figure 6 Admin Tool: Dashboard Center Pane

The Center Pane has three functionalities:

1. By Clicking on the name of a city, a user can access the Overview for that city
2. The “**Add New Market Area**” Button is for creating a new Market area
3. The “**Map**” Button navigates to the Map View Tool

3.4 MARKET AREAS

When you click on “Market Areas” in the Left Navigation Panel you’ll get a dropdown list of all of the Market Areas listed in your tool and an “Add New” option. At this time, the only city in this tool is Atlantic City.

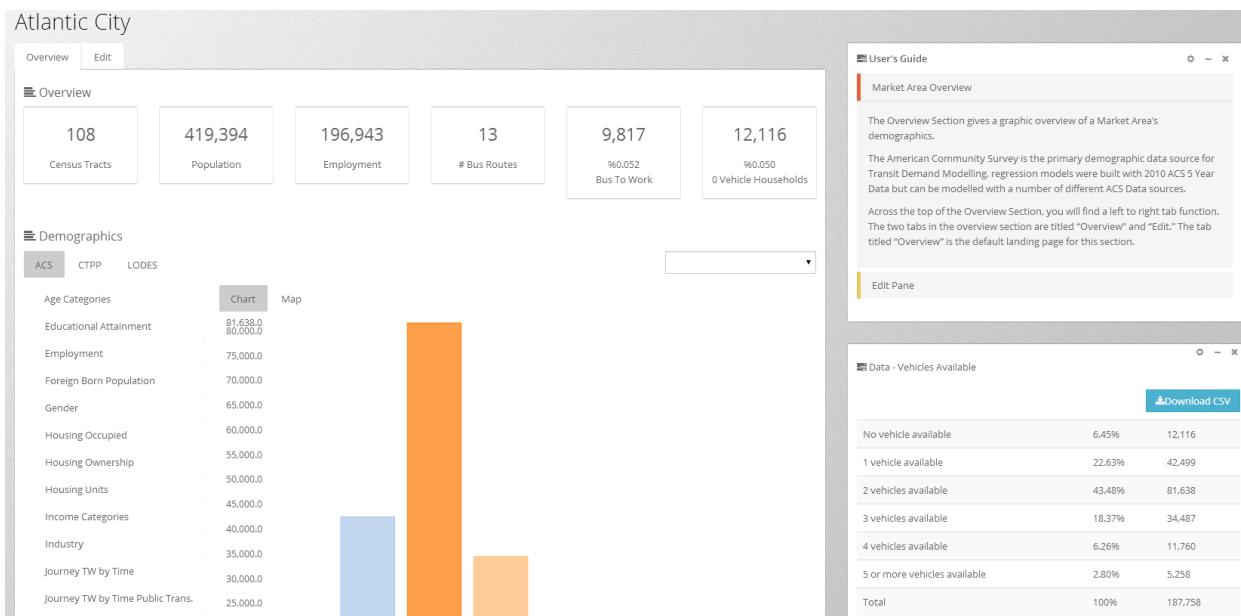
By clicking on Atlantic City, the user opens a dropdown menu that includes three sections:

1. Overview
2. Market Runs
3. Map View

3.4.1 Overview (Market Areas>Atlantic City)

The Overview Section gives a graphic overview of a Market Area’s demographics.

Figure 7 Admin Tool: Market Area Overview



Category	ACS	CTPP	LODES
Educational Attainment	81,638.0	80,000.0	
Employment	75,000.0		
Foreign Born Population	70,000.0		
Gender	65,000.0		
Housing Occupied	60,000.0		
Housing Ownership	55,000.0		
Housing Units	50,000.0		
Income Categories	45,000.0		
Industry	40,000.0		
Journey TW by Time	35,000.0		
Journey TW by Time Public Trans.	30,000.0		
	25,000.0		

Category	Percentage	Count
No vehicle available	6.45%	12,116
1 vehicle available	22.63%	42,499
2 vehicles available	43.48%	81,638
3 vehicles available	18.37%	34,487
4 vehicles available	6.26%	11,760
5 or more vehicles available	2.80%	5,258
Total	100%	187,758

The Overview Section is split into three distinct areas:

- The **Center Pane** allows you to view charts and maps and to edit market area routes and census tracts.
- The **User’s Guide** in the top right corner of the page will contain much of the text from this user’s manual that pertains to navigating the functionalities of this section.
- The **Data Section** on the lower right section of the page allows you to see exact category numbers and percent by category. contains the **Download CSV button**, and is the control mechanism for the center pane.

Across the top of the Overview Section, you will find a left to right tab function. The two tabs in the overview section are titled “Overview” and “Edit.” The tab titled “Overview” is the default landing page for this section.

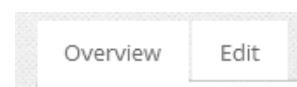


Figure 8 Admin Tool: Market Area Overview Tabs

3.4.1.1 Overview Tab (Market Areas>Atlantic City>Overview)

In the Center Pane of the Overview Section, there is a left to right feature across the top of the page. This feature provides broad market area statistics relevant to transit modeling.

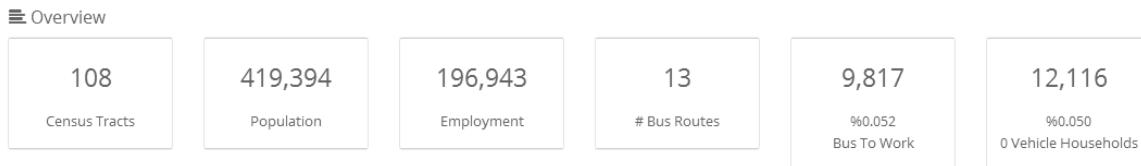


Figure 9 Admin Tool: Market Area Overview Census Data Table

The data listed left to right above the graph includes: Census Tracts, Population, Number of Households, Number of Bus Routes, Number of people indicating “Bus to Work” on the Census, and Number of Zero Car Households.

On the left side of the Overview Center Pane, there is a column of data. The categories listed here can be clicked on and they will change the graph in the center. The data in this column includes:

- Age Categories,
- Education Attainment,
- Employment, Foreign
- Born Population,
- Gender, Housing Units,
- Income Categories,
- Industry, Journey to Work, Journey to Work by Time, Language Spoken at Home,
- Population, Race, School Enrollment and Vehicles Available.

3.4.1.1.1 Charts and Maps

The center pane of the Overview Tab allows a user to choose between viewing market area statistics in chart form or on a census tract level map. To navigate between charts

and map simply click on the labels in the top left corner of the chart.

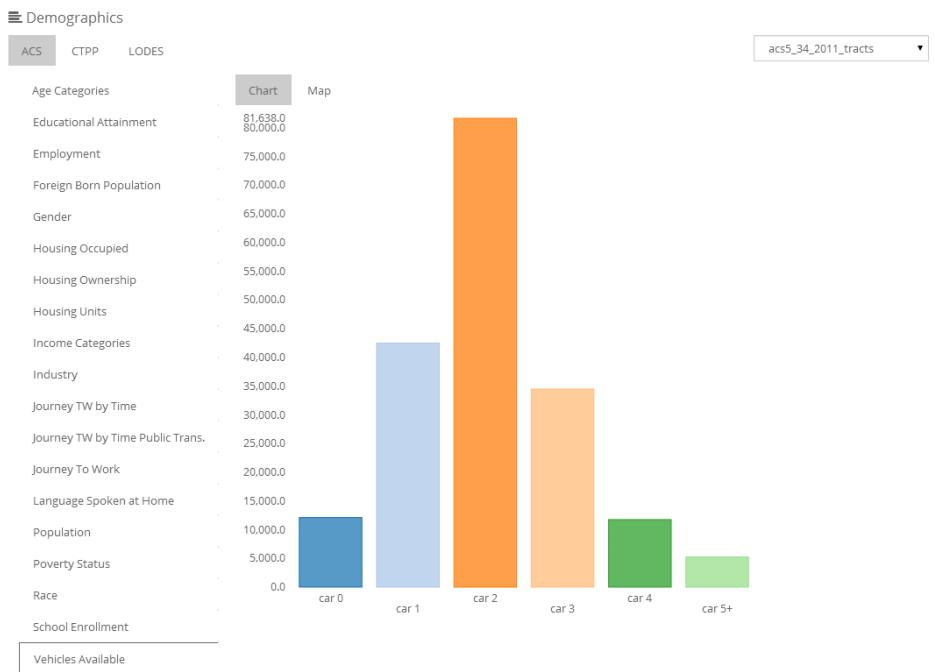


Figure 10 Admin Tool: Market Area Overview Census Data Graph Section

3.4.1.1.1 Maps

The Map Section of the Overview Tab is controlled by the Data Box located in the lower right section. To see distribution of census statistics across the market area simply click on the statistic you're interested in and the map will show distribution.

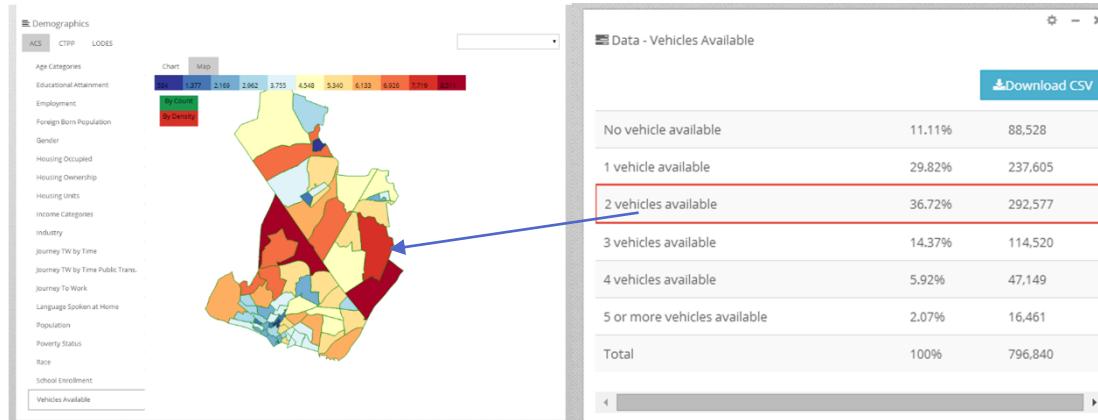
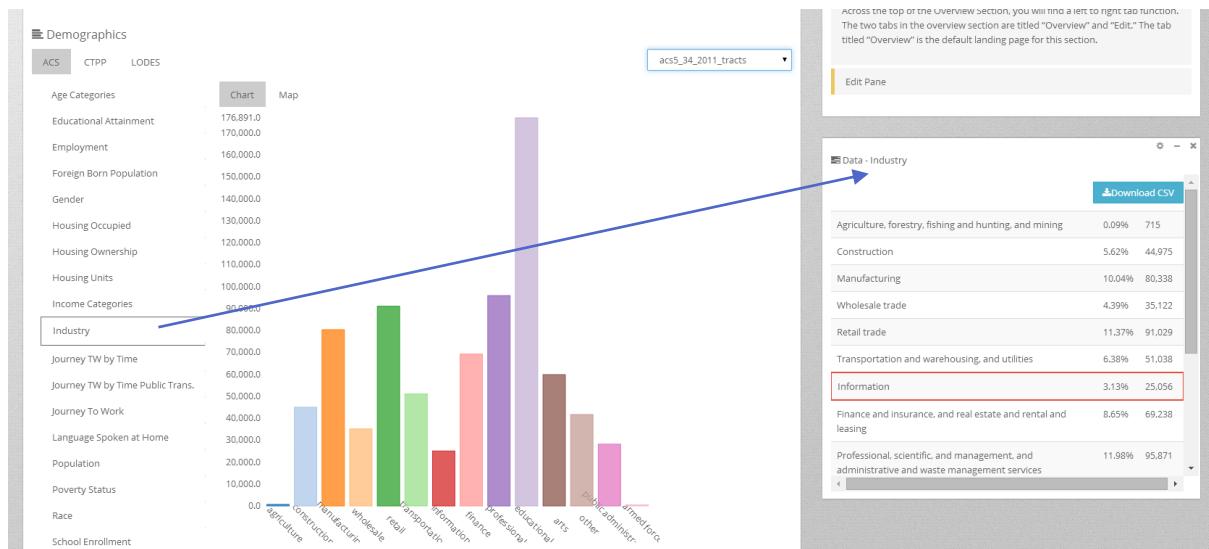


Figure 11 Overview Section, Map and Right Side Data Box

3.4.1.1.2 Data Box

The Data Box in the lower right interacts with other areas of the Overview page. The Data Box is controlled by the Demographics column and the Data Type Tabs. To change the data displayed in the Data Box at right, click on a demographic category in the column on the left side of the center pane.



3.4.1.1.3 Data Sets

- Data Sets:** To change data type in the center pane of the overview section click on one of the data types located in the top left.
- Data Sources:** There is also a drop down menu to change the source of the data type. ACS 5 year, 10 year, etc.

ACS CTPP LODES

Figure 12 Data Set Tabs



Figure 13 Data Source Dropdown

3.4.1.1.4 CTPP

The CTPP map allows a user to view home-to-work ridership data to and from census tracts. The first map that appears when you click on the CTPP tab shows the number of bus-to- work riders in each census tract. This section contains a toggle that allows the user to view outbound data and inbound.

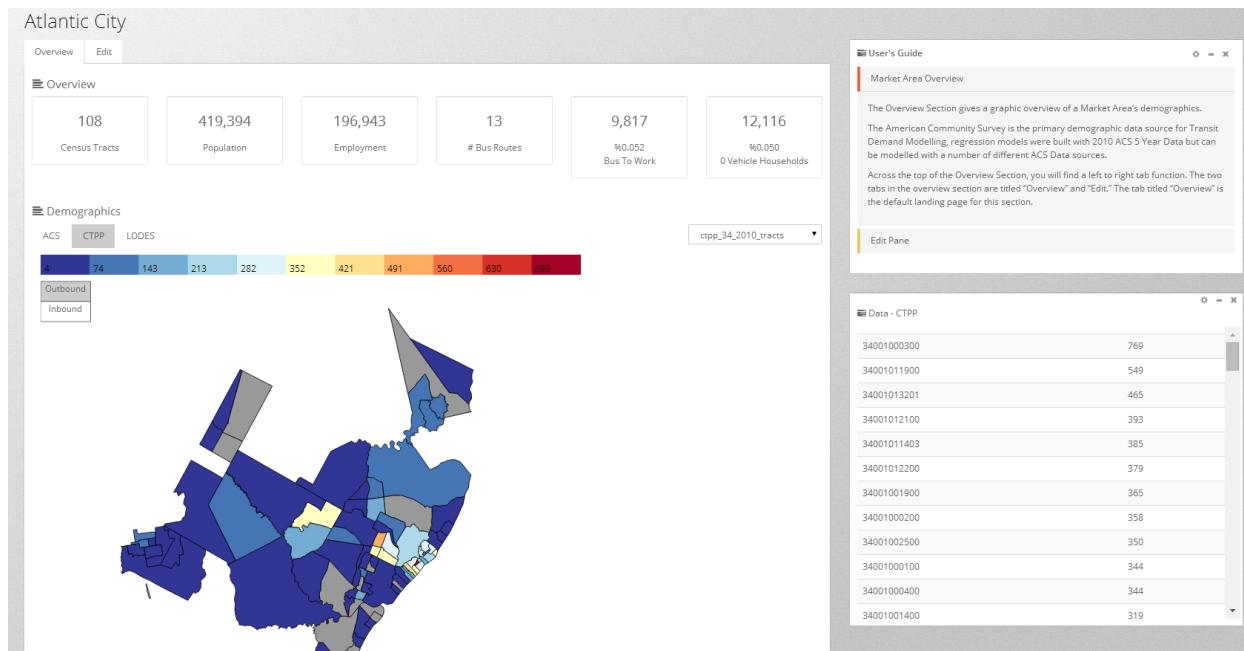


Figure 14 Market Area Overview CTPP Map

Mousing over each census tract in the right side data table magnifies the census tract in the map.

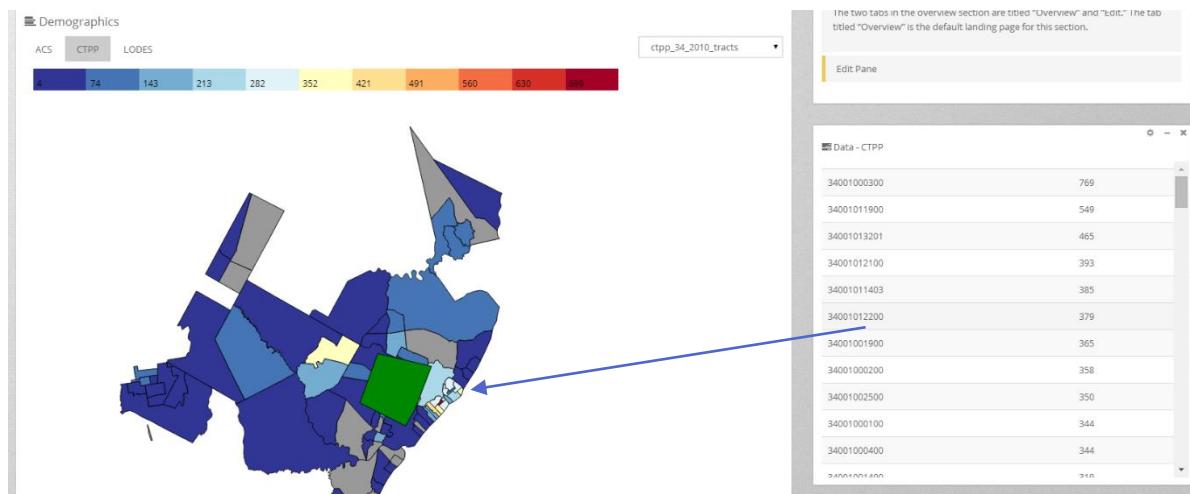


Figure 15 Illustration of Mouse-over Highlighting Census Tract

By selecting a census tract in either the map or the data table the user can view information about home-to-work trips outbound from that census tract.

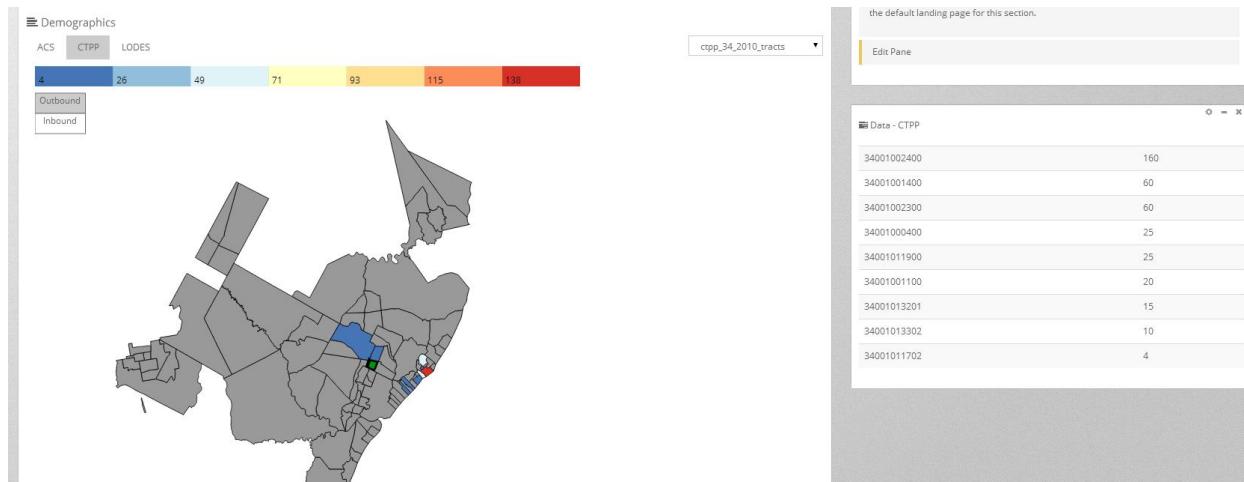


Figure 16 CTPP Bus-to-Work Outbound Trips from Chosen Census Tract

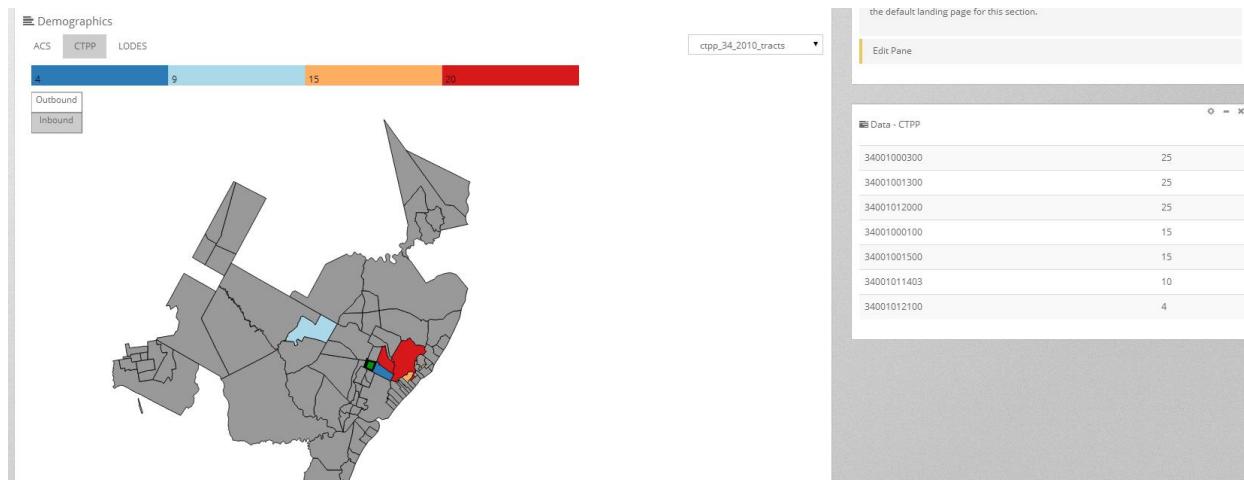


Figure 17 CTPP Inbound Trips to the Chosen Census Tract

3.4.1.1.5 LODES

The LODES tab allows the user to view LEHD Origin Destination Employment Statistics. These maps work in exactly the same way as the CTPP maps.



Figure 18 Market Area Overview LODES Map: Illustration of Mouseover Function

When a user selects a census tract, either on the map or in the data table, the map and table change to show travel to work data outbound from the selected census tract.

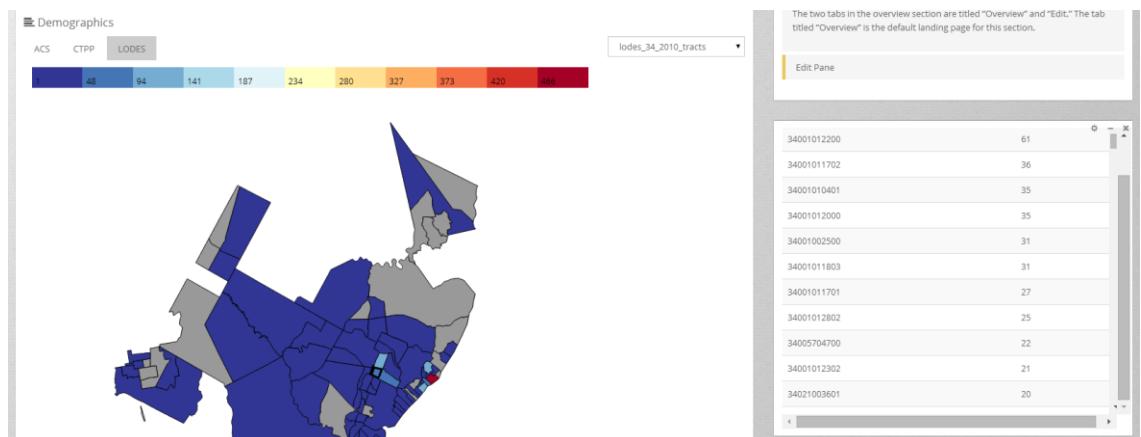


Figure 19 LODES All Modes Travel-to-Work Outbound from Chosen Census Tract

3.4.1.2 The Edit Tab (Market Areas>Atlantic City>Overview>Edit)

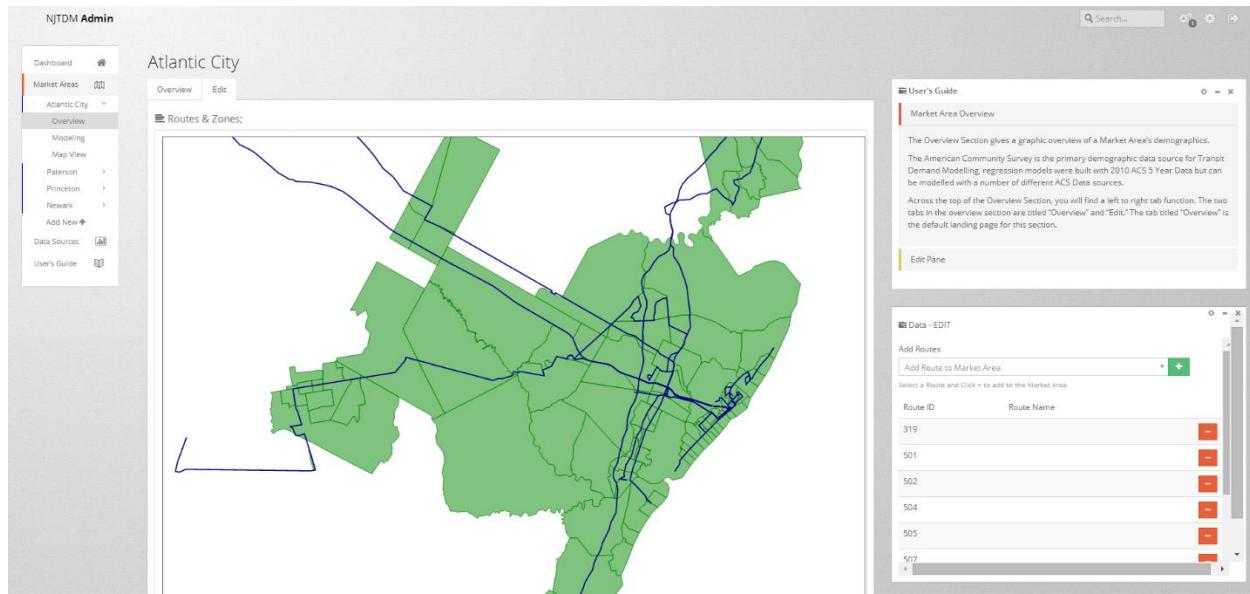


Figure 20 Admin Tool: Edit Market Area Tab

The Edit section allows you to add (Green + Button) or remove (Red – Button) a bus route in the right side box.

The map in the center of the screen shows you which census tracts are in your market area as well as which routes you've chosen for your market area.

The right side Routes Box (Figure 21) allows you to search all of the bus routes in a given Market Area in a smart dropdown menu. You can either search all bus routes or narrow your search by typing one of the numbers in the bus route you would like to use.

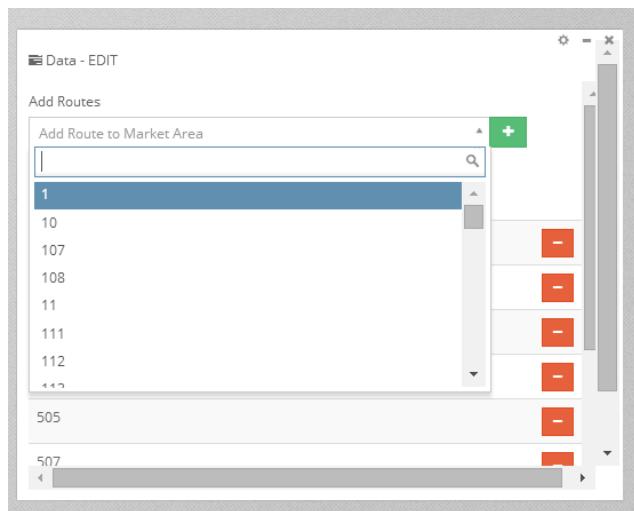
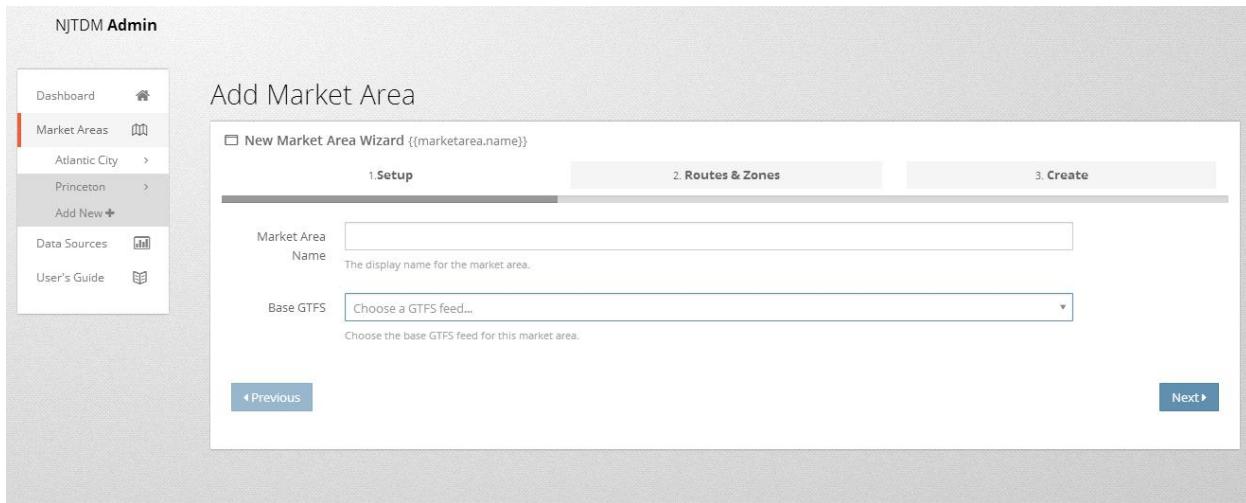


Figure 21 Admin Tool: Edit Bus Routes Dropdown Menu

3.4.2 Add Market Area

You can add new market areas by following the step-by-step process of the **Add Market Area Wizard**.

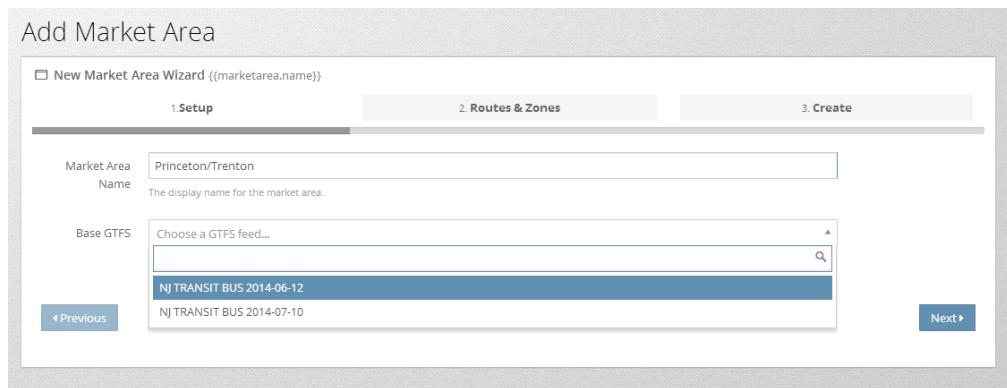


The screenshot shows the 'Add Market Area' wizard in the NJTDM Admin tool. The left sidebar has 'Market Areas' selected. The main area is titled 'Add Market Area' and shows 'Step 1: Setup'. It has fields for 'Market Area Name' (Princeton) and 'Base GTFS' (Choose a GTFS feed... dropdown with options: NJ TRANSIT BUS 2014-06-12 and NJ TRANSIT BUS 2014-07-10). Navigation buttons 'Previous' and 'Next' are at the bottom.

Figure 22 Admin Tool: Add Market Area

3.4.2.1 Step 1 - Name the Market Area

The first step is to give your market area a name and choose a base GTFS feed. Then click next.



This screenshot shows the 'Add Market Area Wizard' in Step 1: Setup. The 'Market Area Name' field is filled with 'Princeton/Trenton'. The 'Base GTFS' dropdown shows 'Choose a GTFS feed...' and lists two options: 'NJ TRANSIT BUS 2014-06-12' (selected) and 'NJ TRANSIT BUS 2014-07-10'. Navigation buttons 'Previous' and 'Next' are visible.

Figure 23 Admin Tool: Add Market Area Wizard

3.4.2.2 Step 2 - Routes & Zones.

Here you'll need some knowledge of your market area's bus routes. You'll need to type in the route numbers then click on the green plus symbol to add it to your market area.

Each Route you add to the Market Area will be included as a red line in the map below. Each route you add will include its corresponding census tracts illustrated in Figure 25 as black tract outlines. After viewing the map of census tracts and bus routes click **Next** to go to step 3.

Add Market Area

New Market Area Wizard {{marketarea.name}}

1. Setup 2. Routes & Zones 3. Create

Add Routes		
655	<input type="text" value="65"/>	
65		
165		
65		
153	655	
165	612	
166	613	
167	619	
156	603	
158	605	
159	606	
162	609	

Figure 24 Admin Tool: Add Market Area Wizard Step 2

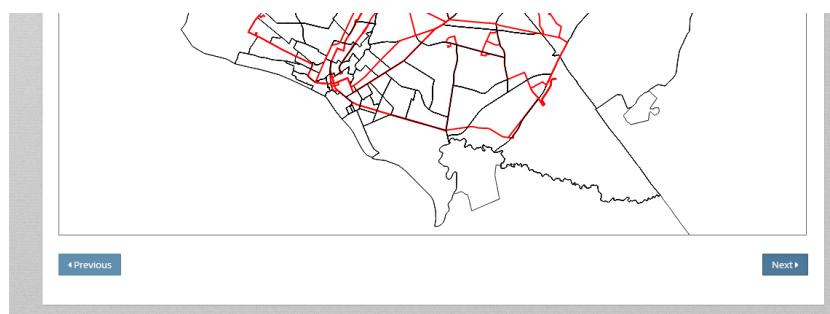


Figure 25 Admin Tool: Add Market Area Wizard Step 2 Routes and Zones Map

3.4.2.3 Step 3 - Review Market Area and Create

Here you'll view the number of routes and census tracts in your new Market Area. When you click **Finish** you will be brought to the Market Area > Overview page for your new Market Area.

Add Market Area

New Market Area Wizard Princeton

1. Setup 2. Routes & Zones 3. Create

Princeton

Overview

Routes	9
Census Tracks	86
Center Point	[-74.689873,40.275383500000004]

Click Finish to create this MarketArea

Figure 26 Admin Tool: Add Market Area Wizard Step 3 Finish

3.4.3 Modelling

The Modelling section of the Admin Tool allows you to run models and analyze their outputs.



Figure 27 Admin Tool Modelling Section

This section contains two tabs: “**Model Analysis**” and “**New Model**.”

The landing page for this section is the “**New Model**” Tab.

Model Analysis

New Model

Figure 28 Admin Tool Modelling Section Tabs

3.4.3.1 New Model

The New Model tab allows you to run a model in the Admin Tool without navigating to the Map View. This feature is controlled by the right side workspace as seen in Figure 29. These boxes control settings for your new model. The Settings are as follows:

New Model Options

- Model Time
 - AM Peak
 - Full Day
 - PM Peak
- Model Type
 - CTPP
 - LODES+ACS
 - Regression
 - Survey
- Model OD Source
 - Bus Stops
 - Parcels
 - Survey Data
- Model Forecast
 - Five Year Future Forecast
 - Current

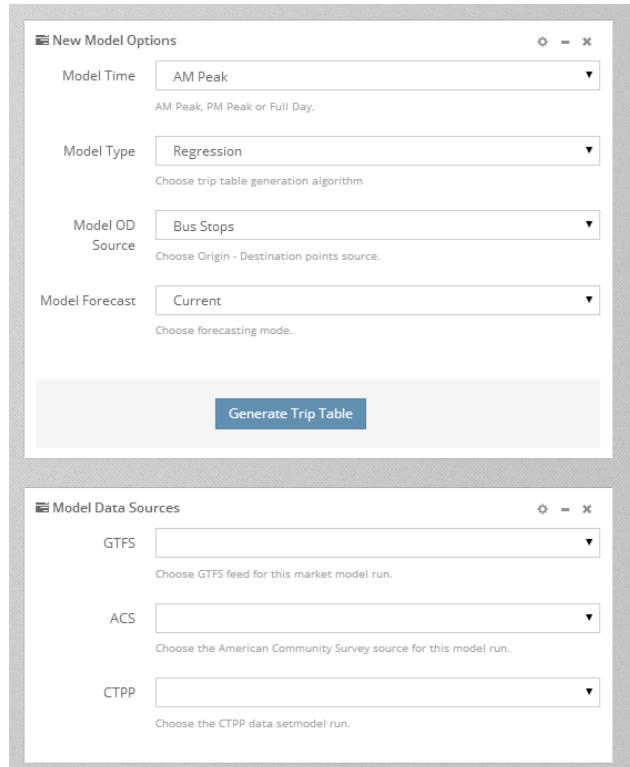


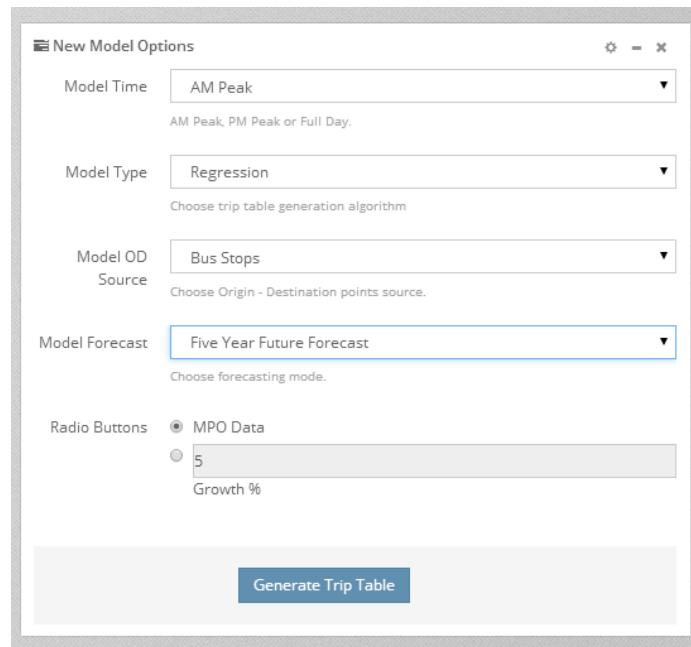
Figure 29 Admin Tool Modelling Section Model Settings Boxes

3.4.3.1.1 Running a Model in the Admin Tool: New Model Tab

The Process for running a model in the Admin Tool is exactly the same as running a model in the Map View (**See Section: 3.6 Map View** for a run through on the process). The Difference here is that each setting you need for running a model is organized for you in the two boxes in the right. The two boxes are New Model Options and Model Data Sources.

New Model Options box has all of your basic model settings that are available to you on the Map View page. The Model Data Sources Box allows you change between data sources.

In the New Model Options Box, each setting option is set to a default as illustrated in Figure 29. To run a model, simply set each box to your desired setting and click **Generate Trip Table**.



The 'New Model Options' dialog box contains the following settings:

- Model Time:** AM Peak (selected)
- Model Type:** Regression
- Model OD Source:** Bus Stops
- Model Forecast:** Five Year Future Forecast (selected)
- Radio Buttons:** MPO Data (selected)

A 'Generate Trip Table' button is located at the bottom of the dialog.

3.4.3.1.2 Model Forecasting

Five Year Future Forecast allows the user to run a model that forecasts future ridership. When you click on the model forecasting dropdown menu and select Five Year Future Forecast a new box will open below that allows you to choose the % Growth as set by the MPO models or to choose to set your own % Growth (including negative growth).

3.4.3.1.3 Trip Tables

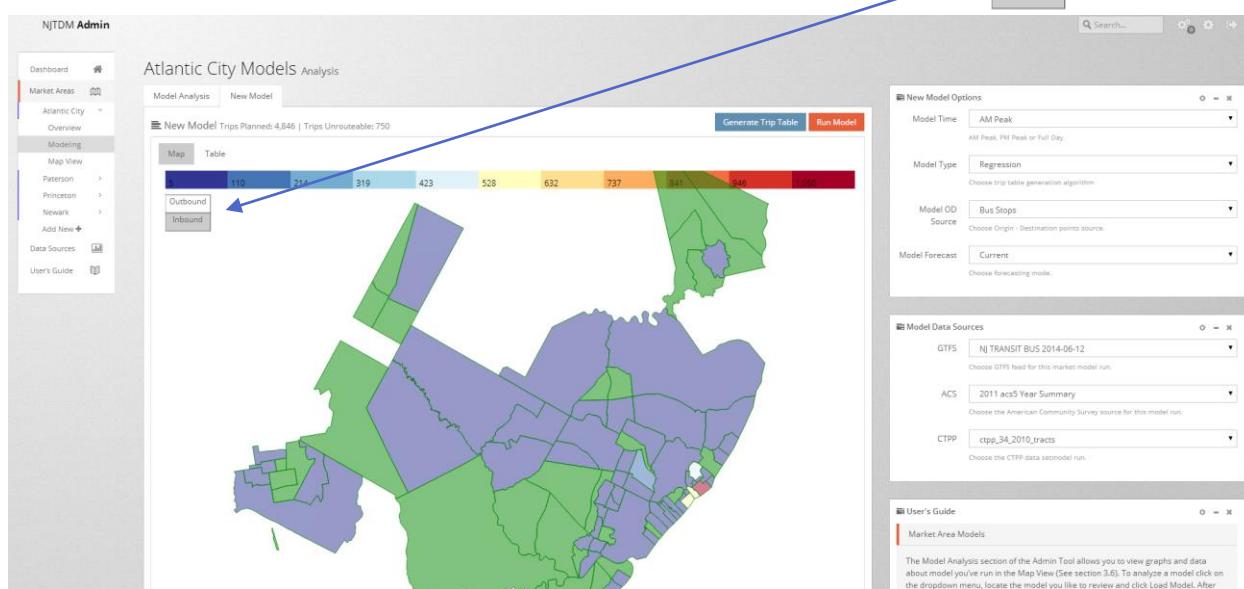
The New Model tab allows you to view information about the inbound and outbound trips generated by the new model options. The information can be viewed in both map and chart form.

3.4.3.1.4 New Model: Map Tab

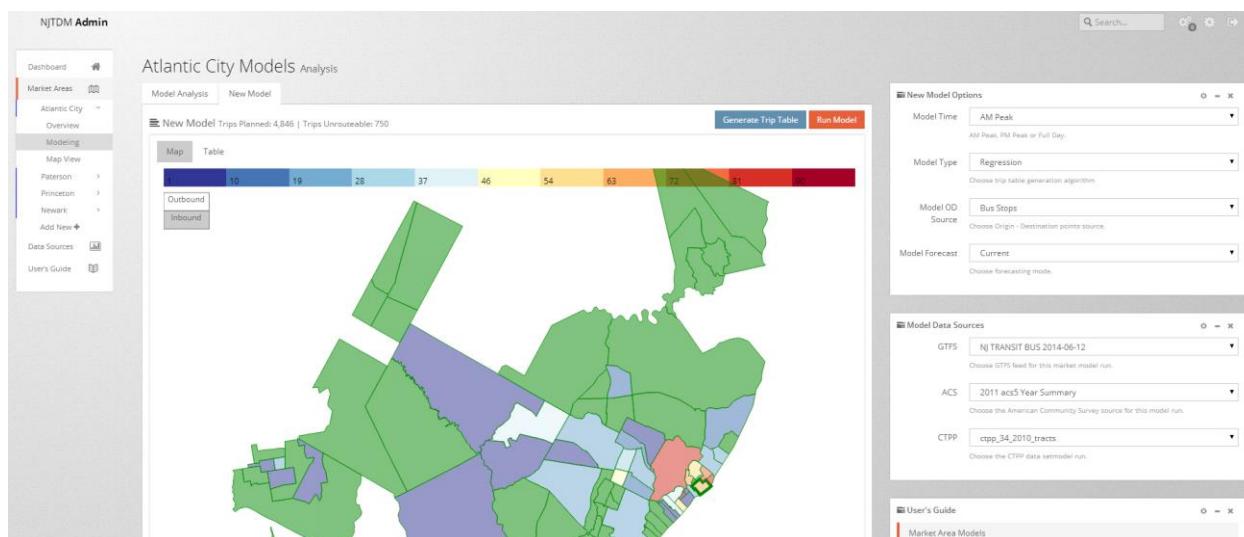
The **Trip Table Map** allows you view trips generated by census tract.



To toggle between inbound and outbound trips click on the box in the top left.



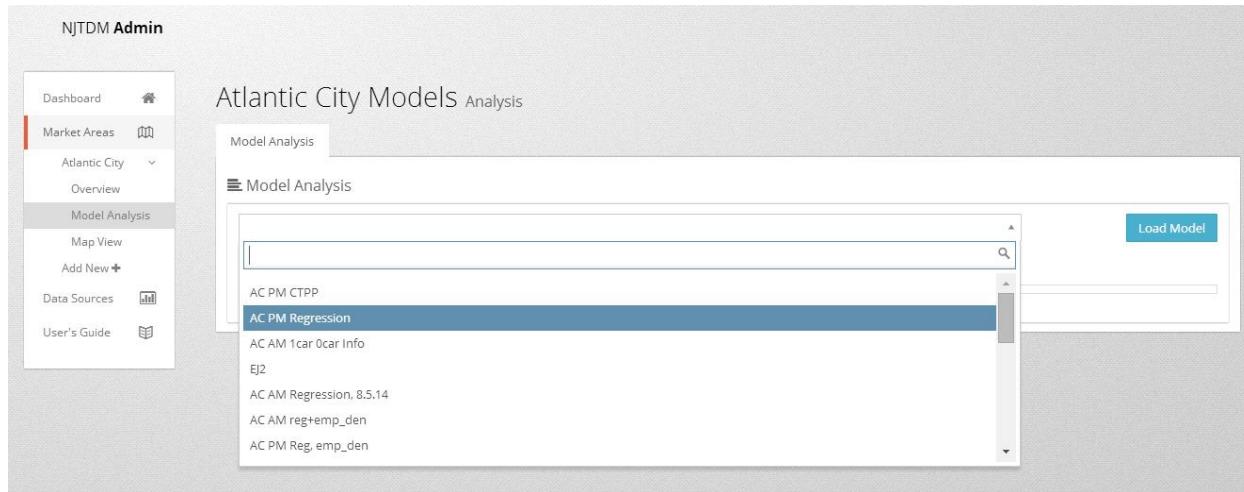
When you click on a census tract the map will reorganize to show inbound and outbound trips for that tract. The chosen census tract will be highlighted in the map.



3.4.3.1.5 New Model: Table Tab

3.4.3.2 Model Analysis Tab

The Model Analysis section of the Admin Tool allows you to view graphs and data about model you've run in the Map View (See section 3.6). To analyze a model click on the dropdown menu, locate the model you would like to review and click **Load Model**. After loading your model a graph will appear.



The screenshot shows the 'Model Analysis' tab selected in the left sidebar. A dropdown menu is open, listing several model names: 'AC PM CTPP', 'AC PM Regression', 'AC AM 1car 0car Info', 'EJ2', 'AC AM Regression. 8.5.14', 'AC AM reg+emp_den', and 'AC PM Reg, emp_den'. The 'AC PM Regression' option is highlighted. A large blue button labeled 'Load Model' is located to the right of the dropdown menu.

Figure 30 Admin Tool: Model Analysis

Figure 31 shows a second dataset (AC PM Farebox). This was added to the Model Analysis view in order to compare the regression model to the measured Farebox totals.

Below the graph are a series of tables and charts for analyzing the accuracy of the model run.

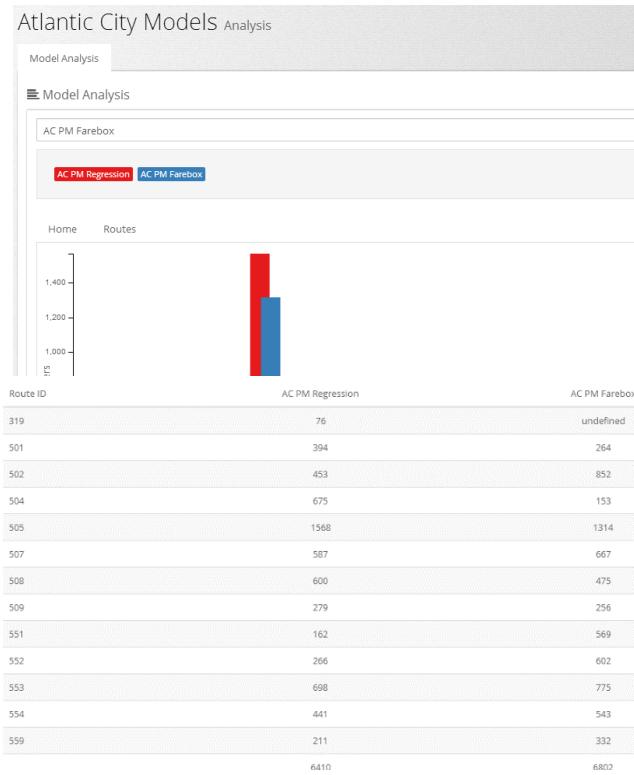


Figure 31 Admin Tool: Model Analysis Graphs and Tables

3.5 DATA SOURCES

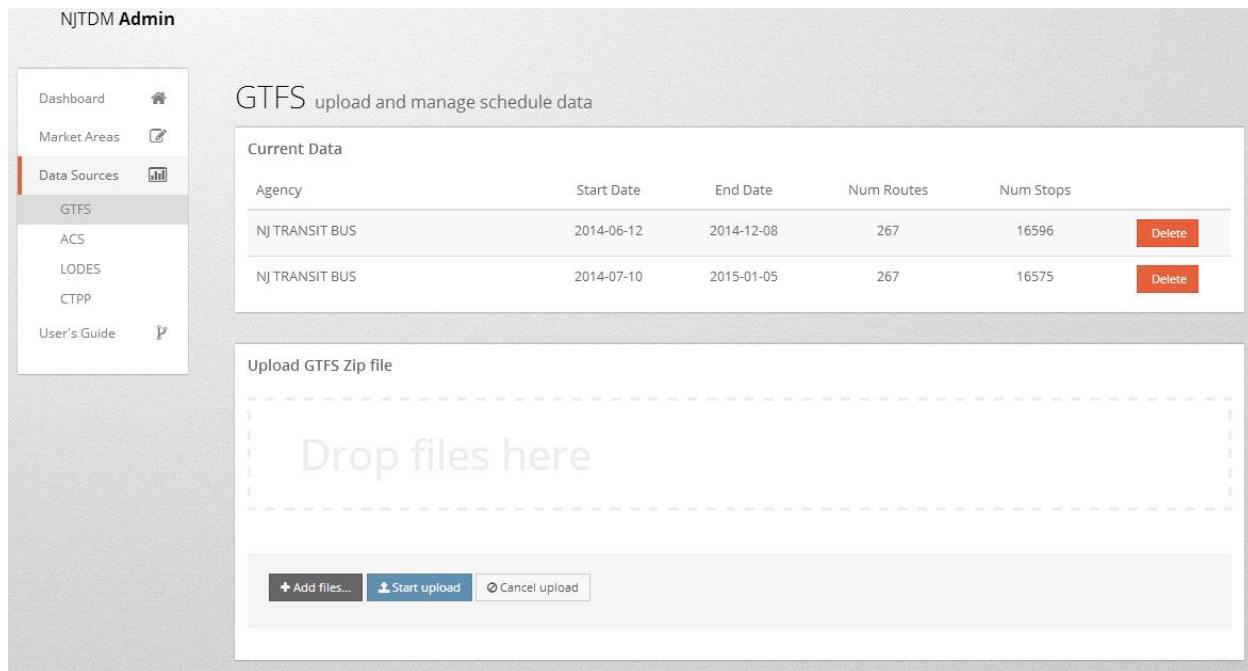
The Data Sources section serves two functions:

1. Data Upload and Management: This functionality is located in the Admin Tool Center Pane.
2. Information about Data Sources and User's Guide: This functionality is located in the Right Pane.

3.5.1 GTFS

3.5.1.1 About GTFS

The **General Transit Feed Specification (GTFS)** is a data standard for encoding transit schedule and operations information. GTFS is a collection of text files most often distributed in a compressed zip file.



Agency	Start Date	End Date	Num Routes	Num Stops
NJ TRANSIT BUS	2014-06-12	2014-12-08	267	16596
NJ TRANSIT BUS	2014-07-10	2015-01-05	267	16575

Figure 32 Admin Tool: Data Sources Section GTFS Upload and Manage

3.5.1.2 Loading New Data

To upload new GTFS to the system drag and drop a GTFS zip file to the drop zone on the screen or click **add files** and search for the zip file to upload on your local file system.

The file will then appear underneath the upload section. To add the file to the TDM system simply click **Start upload** to import GTFS. This will start a new import job that can be monitored in the jobs dropdown on the top of the screen or on the jobs page. You can now navigate away from this page and wait for the job to finish. Because of the geospatial processing required to import a GTFS file for use in this system it can take up to 3 hours to import a large GTFS file.

3.5.1.3 Agency

Every GTFS file is required to have an agency file that lists the agency that created the GTFS file. This column lists the agency of loaded GTFS Data.

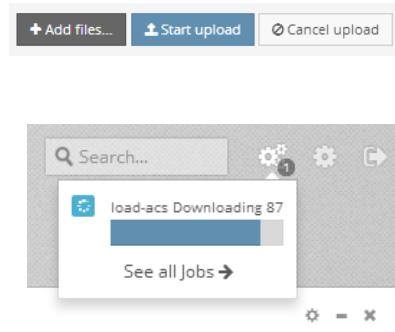


Figure 33 Loading New Data Jobs
Dropdown Top Right Corner of Page

3.5.1.4 Start and End Date

A GTFS file is only valid for a specific amount of time as specified by the Calendar and/or Calendar dates files of the GTFS feed. These listings let you know when the file starts and ends its valid use.

3.5.1.5 Stop and Route Count

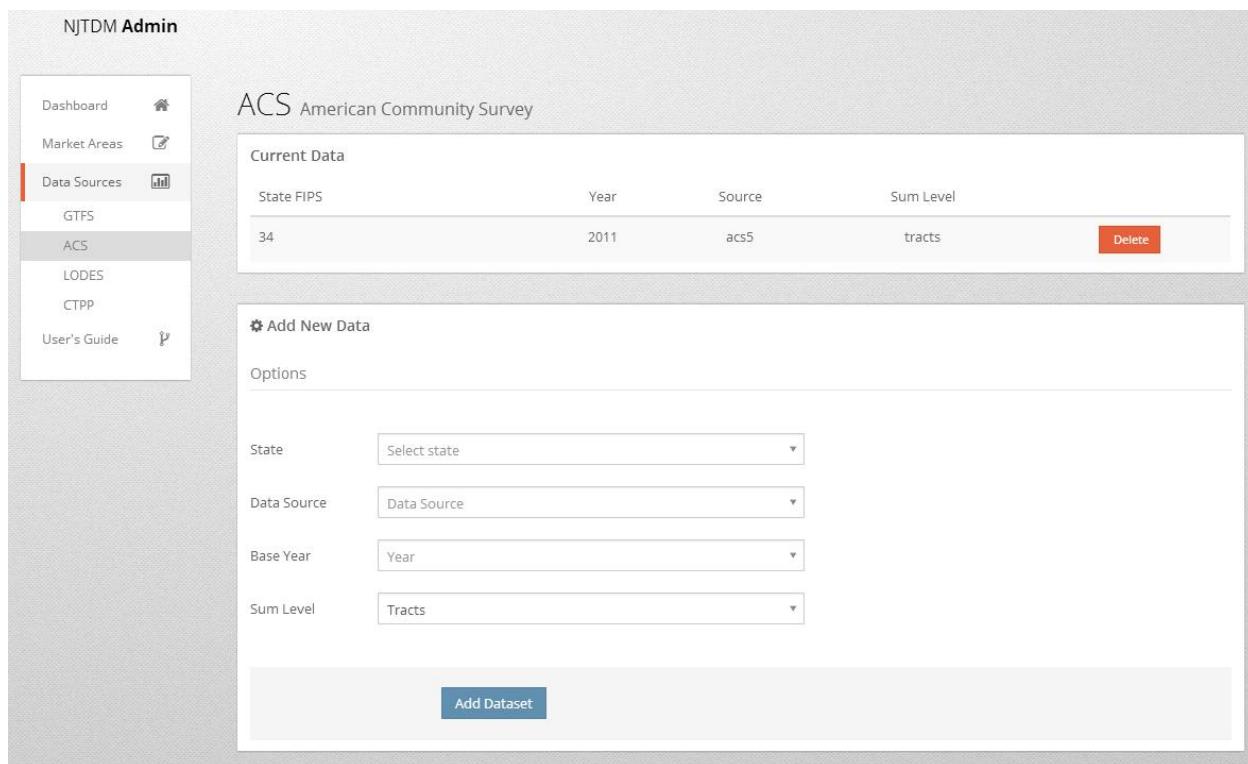
Lists the number of stops and routes present in each GTFS file.

3.5.2 ACS

The American Community Survey is the primary demographic data source for Transit Demand Modelling, regression models were built with 2010 ACS 5 Year Data but can be modelled with a number of different ACS Data sources.

3.5.2.1 Add New Data

ACS Data is loaded directly from the census ACS Application Programming Interface (API) into our Transit Demand Modeling database. To add data from neighboring states use the state dropdown menu to locate the desired state, enter Data Source, Base Year and Sum Level then click **Add Dataset**.



State FIPS	Year	Source	Sum Level
34	2011	acs5	tracts

Figure 35 Admin Tool: Data Sources Section ACS Upload and Manage

State	New Jersey
Data Source	ACS 5 Year
Base Year	2012
Sum Level	Tracts

Add Dataset

Figure 34 Admin Tool: Data Sources with Chosen Settings

3.5.2.1.1 Monitoring your Data Source Upload

After Choosing your settings, click **Add Dataset**. This will start a new import job that can be monitored in the jobs drop down on the top of the screen or on the jobs page. You can now navigate away from this page. Because of the processing required to import a census API file for use in this system it can take significant time to import file.

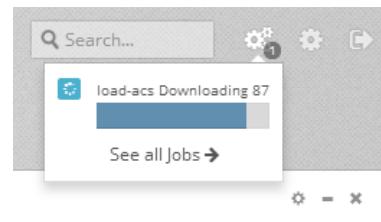
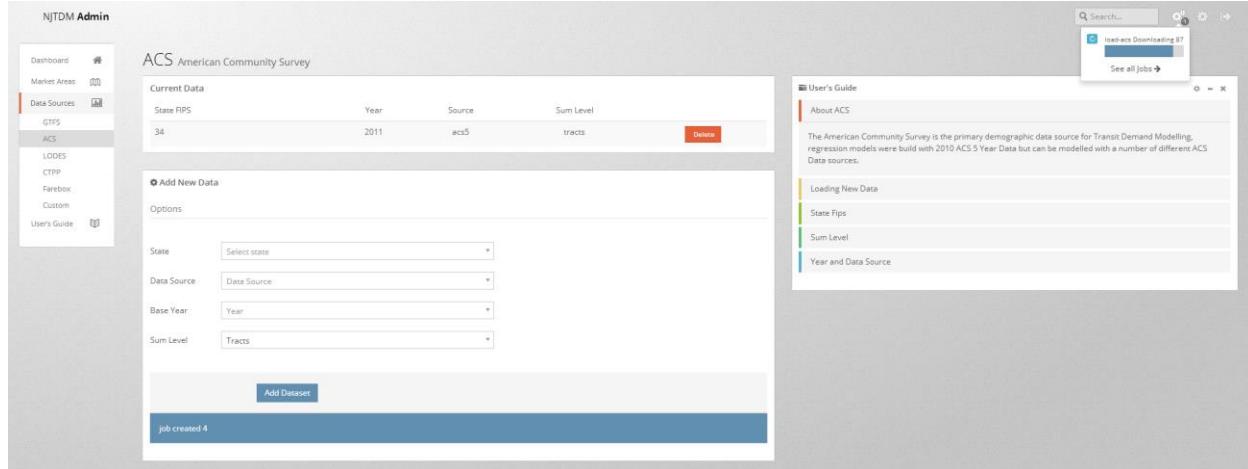


Figure 36 Jobs Dropdown



The screenshot shows two windows. The main window is titled 'ACS American Community Survey' and contains a table with one row: State FIPS (34), Year (2011), Source (ecss5), and Sum Level (tracts). Below this is a form for 'Add New Data' with fields for State, Data Source, Base Year, and Sum Level, each with dropdown menus. A blue button labeled 'Add Dataset' is at the bottom. A message at the bottom says 'job created 4'. The second window is titled 'User's Guide' and shows a section titled 'Loading New Data' with three items: 'State Fips', 'Sum Level', and 'Year and Data Source'.

Figure 37 ACS Data Source Upload: New Job Created, Monitoring Process in Jobs Dropdown

3.5.2.2 Current Data Bar

3.5.2.2.1 State FIPS

State FIPS is the code used by the census to identify a state. New Jersey State FIPS Code is 34.

3.5.2.2.2 Sum Level

In this case, sum level is the geographic level to which the data is summed. For this tool we can use either census tracts or block groups.

3.5.2.2.3 Year and Data Source

ACS Data is available in 1, 3 & 5 year summary groups, the data source denotes which of these groups is being used. The year always denotes the last year of the summary group.

3.5.3 LODES

LEHD Origin-Destination Employment Statistics is an annual data set provided by the US Census Bureau. This data set provides mode-less commuting data at the census tract level.

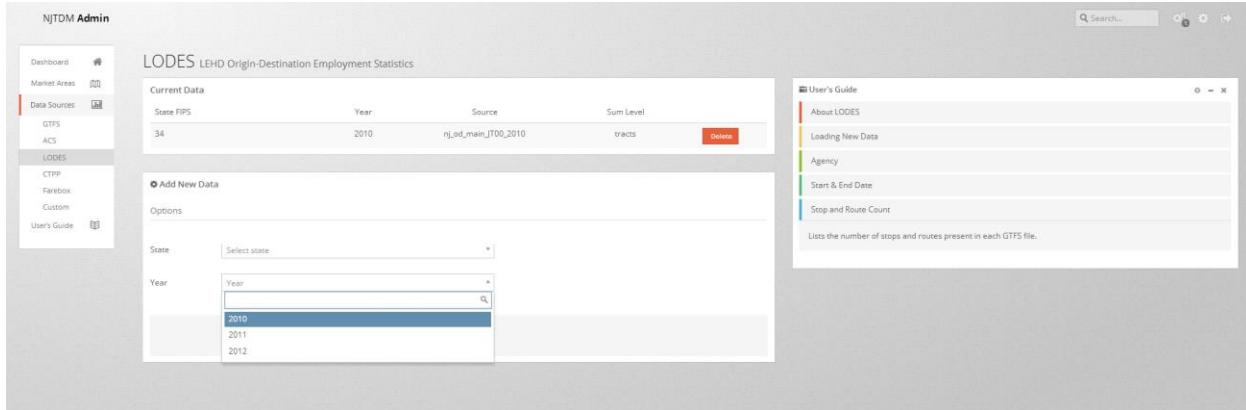


Figure 38 Admin Tool: Data Sources LODES Section

3.5.4 CTPP

The CTPP Section runs exactly the same way as the LODES Section.

3.5.5 Farebox

Future implementation.

3.5.6 Custom Data

Future implementation.

3.6 MAP VIEW

The Map View is accessed through the Left Navigation Panel (Market Areas>City>Map View). The Map View will open in another tab.

There are four Map View Tools to help in building and analyzing your model runs. Three of them are located on the left navigation panel. The fourth is the Model Data Viewer button on the right side of the page. The three tabs in the left navigation panel are as follows:

1. The Modeling Tab – This is the default tab where models are run.
2. The Census Tab – For viewing data about a given Market Area.
3. The GTFS Tab – For viewing routes and adding or removing routes.

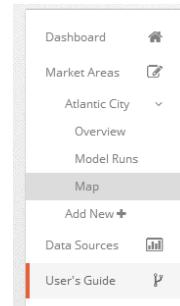


Figure 39 Admin Tool:
Left Navigation Panel
Access to Map View

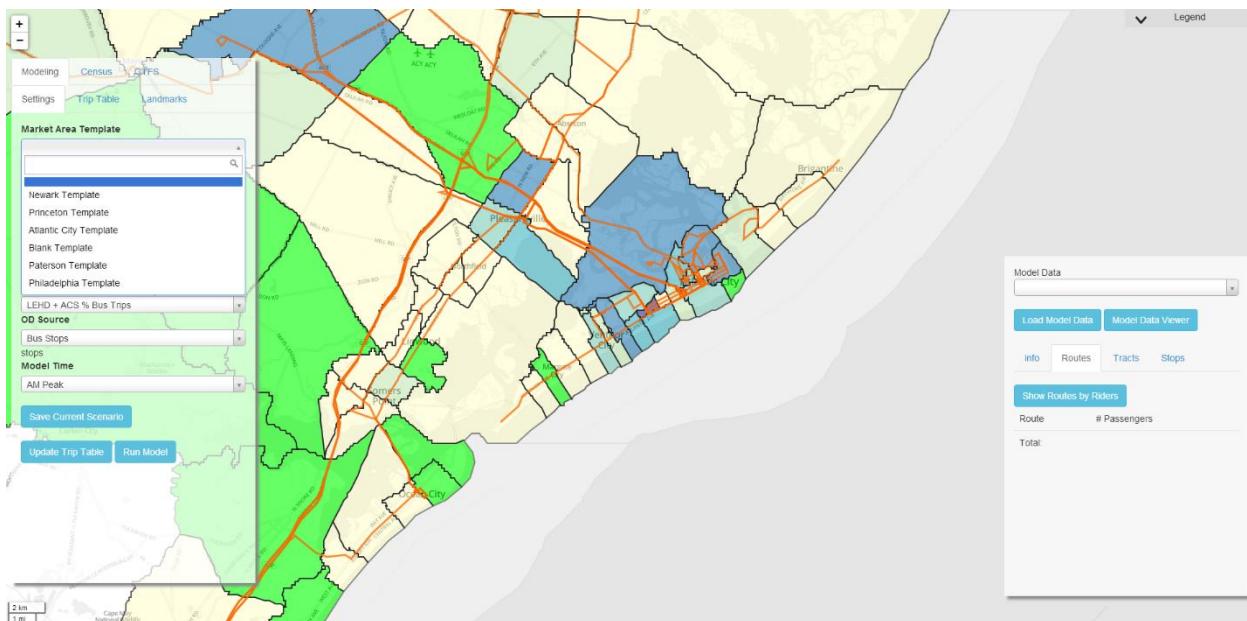


Figure 40 Map View

3.6.1 Modeling View – How to use Map View to Run Models

3.6.1.1 Step 1 - Load a Template

The first step in running a model involves loading your template.

Atlantic City is the default template. To choose another template, click on the dropdown menu titled “Market Area Template” located on the left side of the page.

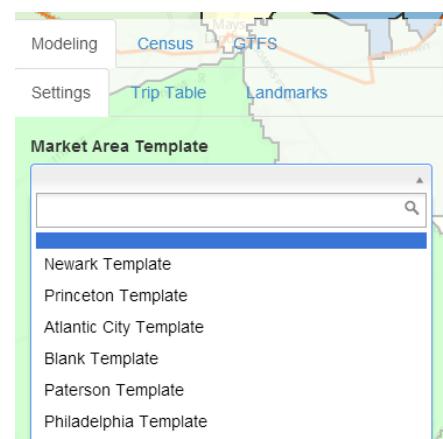


Figure 41 Map View: Load Market Area Template

3.6.1.2 Step 1.2 Editing the Scenario

You can add or remove census tracts from your market area simply by holding the CTRL button and clicking on the census tract you want to add or remove. When a census tract is changed the census data and trip table for the market area are automatically recalculated. When you remove a census tract, it is dimmed as can be seen on the right side of Figure 42. The deselected tract will be removed from the

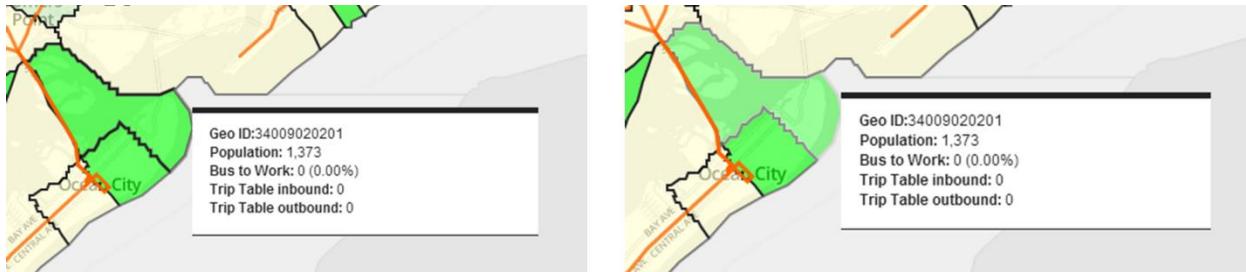


Figure 42 Map View: Illustration of Census Tract Removal

scenario map the next time the scenario is loaded.

3.6.1.3 Step 2 - Choose Your Trip Table Generation Algorithm (Model)

We have designed a number of algorithms to generate trip tables for a market area, they are based on different data sources and methodologies. These different algorithms perform differently in each market area and respond to different factors. Specific regression models calibrated with ACS 5 Year 2010 data have been designed for Atlantic City, Princeton Trenton and Paterson.

Choose your algorithm by clicking on the dropdown menu titled **Trip Table Generator** located on the left navigation panel.

3.6.1.4 Step 3 - Update Trip Tables

Once you have selected the trip table algorithm you want to use, click on the button below titled “**Update Trip Table**.” This will update the number of trips planned by the model you’ve chosen. You’ll notice a change in the number of **Trips Planned**, **Trips Unroutable** and **Number of Tracts**. These numbers are generated by a set of algorithms based on the model you’ve chosen combined with the census tracts and bus routes chosen and the time of day.

3.6.1.5 Step 4 - Choose Your OD Points Source

Trip table generation algorithms work at the level of a geographic zone, like a census tract. To create a trip table that can be simulated by Open Trip Planner, we need specific points of latitude and longitude inside each census tract to map those individual trips. **Bus Stops** - Uses bus stops from GTFS as origin destination points. **Parcel Data (experimental)** - Uses centroids of

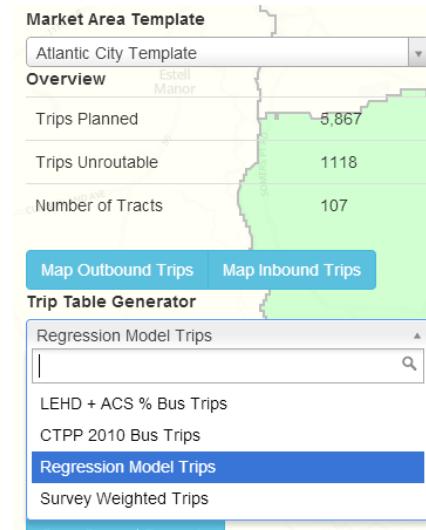


Figure 44 Map View: Trip Table Generation Algorithm Selection

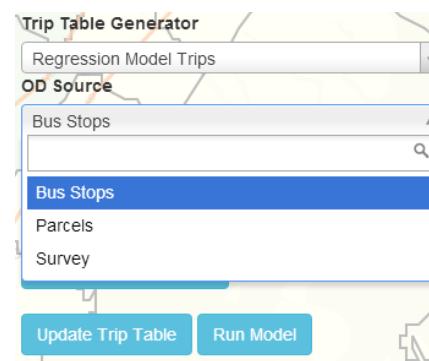


Figure 43 Map View: OD Source Selection

random parcels within 1/2 mile of bus stops. **Survey Data (where available)** - Uses survey origins and destinations as origin and destination points.

3.6.1.6 Step 4 - Choose Your Model Time Period

Data in CTPP, LODES and Regression Models use time of travel to work to understand and schedule ridership in the trip table during peak times. Survey data is available for AM only, PM is generated by reversing the direction of AM work traffic.

AM Peak - AM peak includes work trips from 6am to 10am.

PM Peak - PM Peak includes trips from 3pm to 7pm.

Full Day - (Coming soon) All work trips from peaks, plus non work trip estimate.

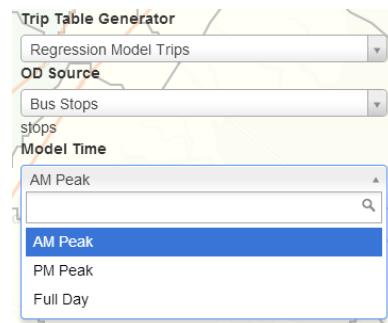


Figure 45 Map View: Model Time Selection

3.6.1.7 Run Model

Once you have chosen all your settings you are ready to run your model. It's worth noting that within the Trip Table tab of the model pane you can hide or show your trip table origins and destinations, you may want to investigate your trip table closely before running your model.

Running a model takes all of the Trips Planned and runs those trips through Open Trip Planner to simulate each rider. To initiate this final step, click the button titled "**Run Model**." You'll be asked to name the model. AVAIL has been naming the models based on city name, followed by time of day, followed by algorithm. For instance, AVAIL has chosen titles like AC AM Regression or AC PM Regression.

Once you've named the model click **OK**. Check the bottom of the left navigation panel to see model status. A bar will appear at the bottom of the left navigation pane as illustrated in Figure 47. It will contain a set of numbers, in Figure 47 you see 1/3064. This means that Open Trip Planner has simulated 1 out of a total of 3064 trips. It may take anywhere from 10 minutes to over an hour to complete the model run depending on the number of planned trips. However even if you navigate away from the page the model will continue to run on the server.

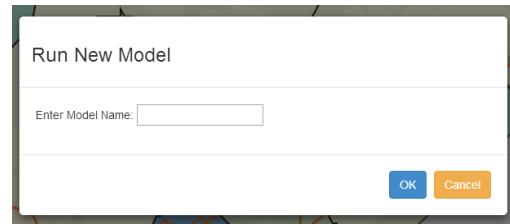


Figure 46 Map View, Model Name Window

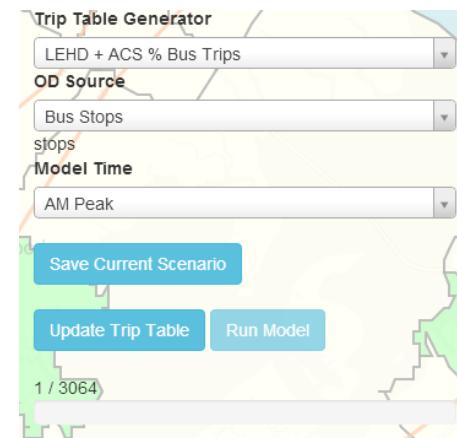


Figure 47 Map View: Run Model Button, Trips Run Bar with ratio of trips run to total trips planned

3.6.2 Model Analysis

The Model Analysis button on the Left Navigation Pane of the Map Viewer will take you back to the Admin Tool>Market Area>Model Analysis (see section 3.4.3 of this document).

3.6.3 GTFS View

The GTFS tab allows you to turn Routes and Stops on and off. This can help in analyzing model runs.

To filter down to a single bus stop, start by clicking on the Show/Hide Stops button. Routes are shown by default, Stops are hidden. Next, mouse over the map to find the “Stop Code” for the bus stop you want. In the example at right we chose Arctic Ave at Christopher Columbus. We then entered the Stop Code for this bus stop, 10054, into the filter bar. You’ll notice on the second map that Arctic Ave at Christopher Columbus is now the only bus stop showing.

This very same process can be used to turn Routes on or off.

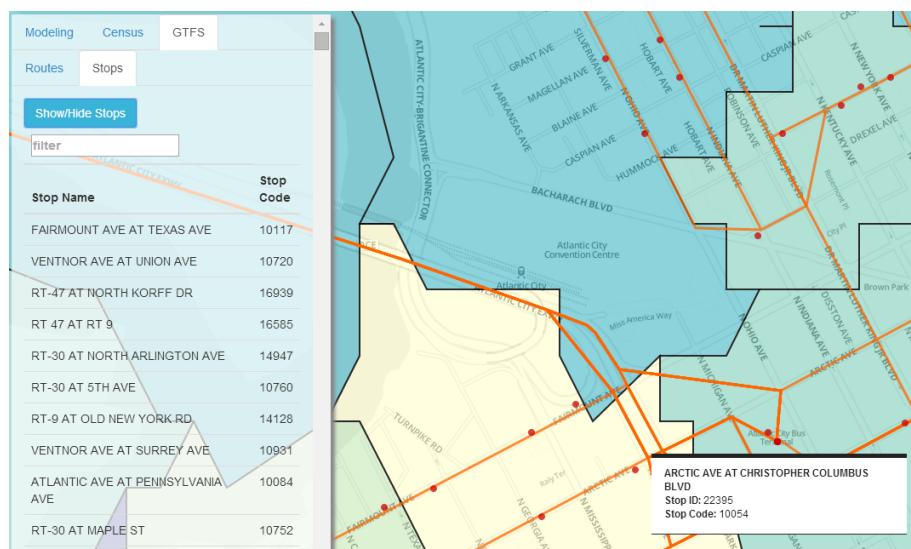


Figure 48 Map View: with Stops and Routes Shown

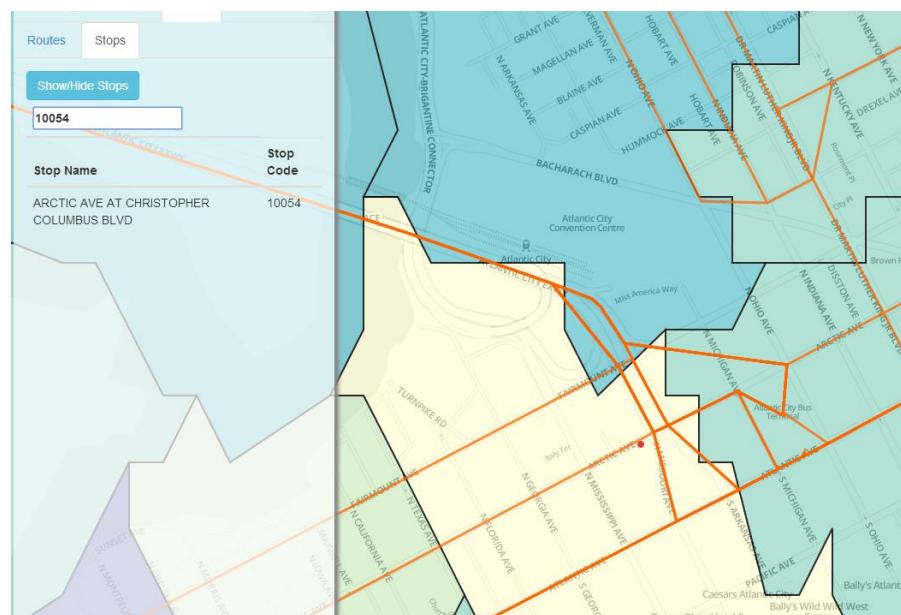


Figure 49 Map View: Filtered to show only one stop

3.6.4 Census View

The Census Tab allows you to view census data in choropleth shading on the map. To view census data, click on the box below the population number that looks like this: 

To see what values each shadings indicates, click on the “Legend” tab at the top right:

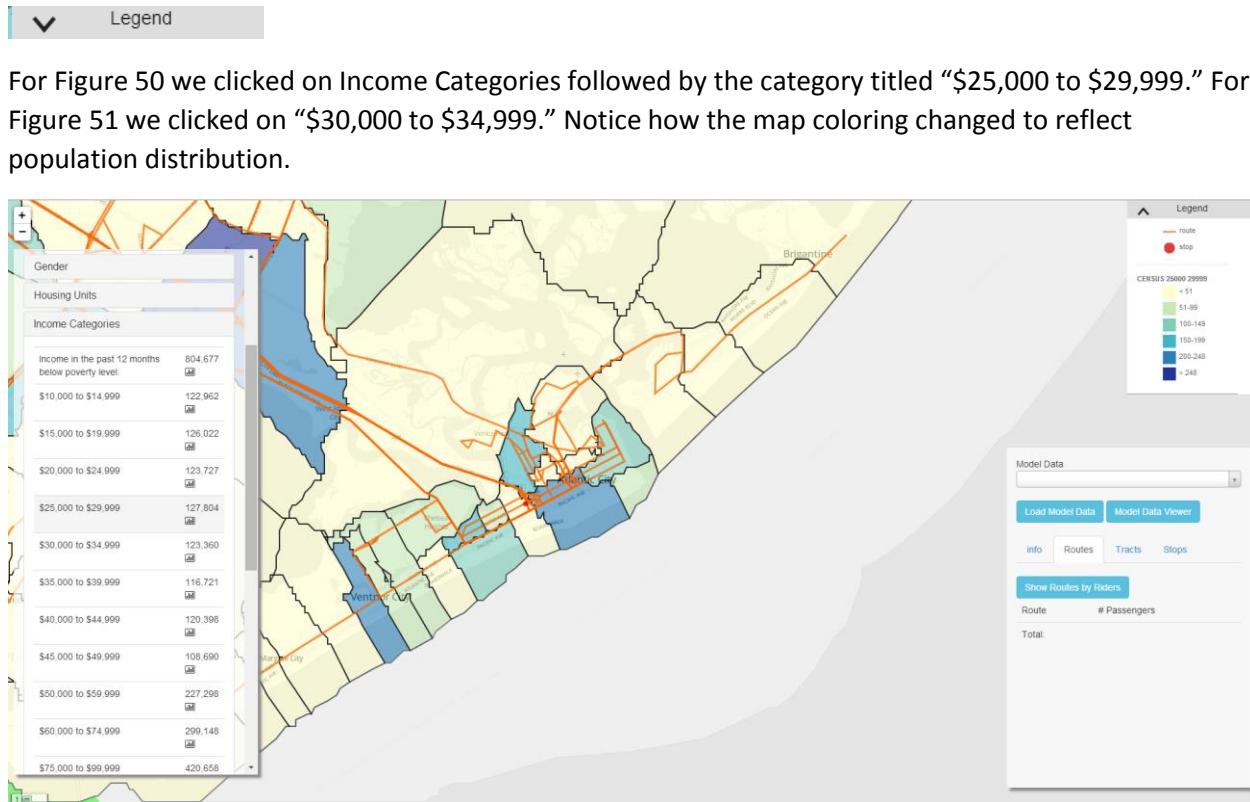


Figure 50 Map View: With census data shown in chloropleth, income \$25,000 to \$29,999

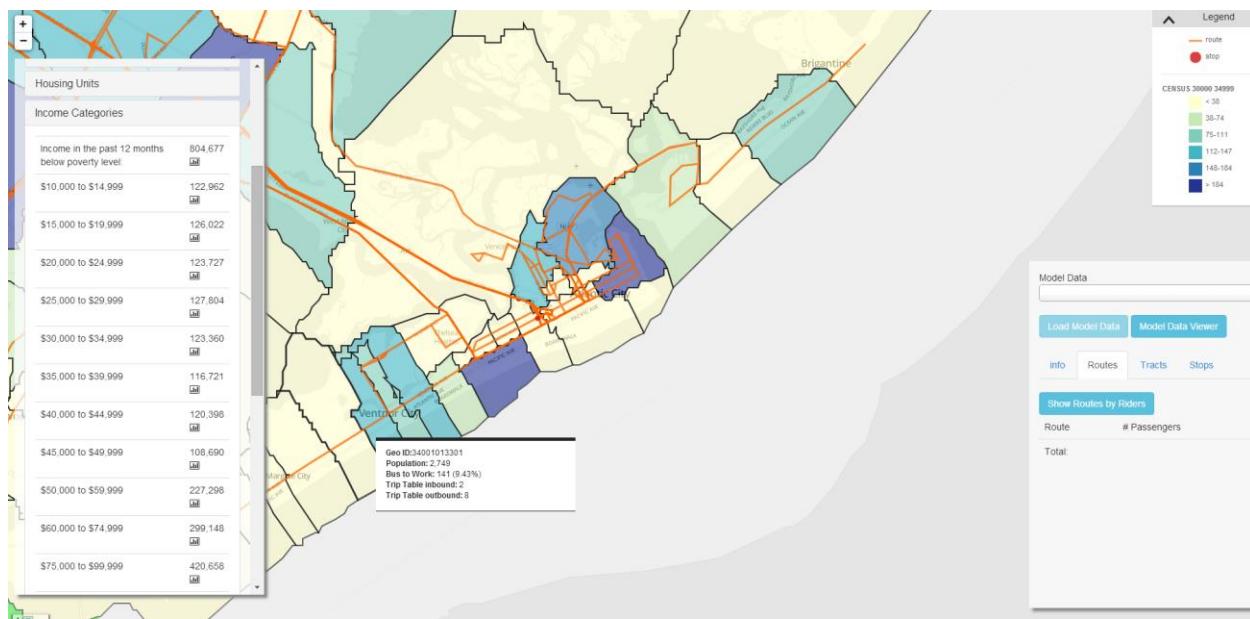


Figure 51 Map View: With census data shown in chloropleth, income \$30,000 to \$34,999

4 ATLANTIC CITY

4.1 INTRODUCTION

This report contains a summary of data elements and regression model methodology including the source of the data, descriptive statistics, the correlations coefficients, regression model development, and model outputs.

4.2 META DATA

The data used in this study was obtained from the US Census Application Programming Interface (API). The data set is called the American Community Survey Five-Year Data 2006-2010 (ACS). The ACS is an ongoing survey that provides data every year -- giving communities the current information they need to plan investments and services. The ACS covers a broad range of topics about social, economic, demographic, and housing characteristics of the U.S. population.¹ Employment Density (EMP_DEN) and Population Density (POP_DEN) were derived by dividing the employment at tract level by polygon tract area and population at tract level by polygon tract area.

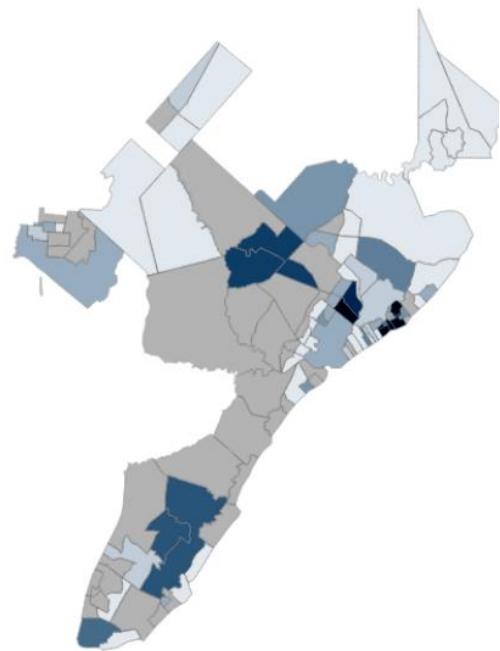


Figure 52 Map of Atlantic City by Census Tract

¹United States Census Bureau, American Community Survey, <http://www.census.gov/data/developers/data-sets/acs-survey-5-year-data.html>

4.3 DESCRIPTIVE STATISTICS

Descriptive Statistics will give mean median and standard deviation of each of the variables. The Mean and Median are measures of central tendency. The Mean is the numerical value found by summing the values and dividing by the number of cases. The Median is the numerical value separating the higher half of a data sample from the lower half. The Median can be found by arranging all observations from lowest value to highest value and picking the middle. The Standard Deviation measures the amount of variation or dispersion from the average and is equal to the square root of the sample variance.

Table 2 Atlantic City, Descriptive Census Statistics

	Description	N	Frequency	Percent	Minimum	Maximum	Median	Mean	Std. Deviation
unemployme	Unemployed Population	110			15	772	393.5	210.98	142.595
public_tra	Journey to Work by Public Transportation Total	110			0	687	343.5	98.68	135.252
bus_to_wor	Journey to Work by Public Transportation by Bus or Trolley Bus	110			0	681	340.5	91.92	133.127
informatio	Employment in Information	110			0	155	77.5	23.32	28.639
arts	Employment in Arts	110			35	1977	1006	411.53	355.460
under__100	Annual Income Under \$10,000	110			0	465	232.5	97.05	85.500
10000_1499	Annual Income \$10,000-\$14,999	110			0	365	182.5	77.16	67.555
15000_1999	Annual Income \$15,000-\$19,999	110			0	258	129	73.82	50.954
20000_2499	Annual Income \$20,000-\$24,999	110			0	215	107.5	68.92	46.450
25000_2999	Annual Income \$25,000-\$29,999	110			0	298	149	79.80	59.398
30000_3499	Annual Income \$30,000-\$34,999	110			0	221	110.5	78.30	56.202
35000_3999	Annual Income \$35,000-\$39,999	110			0	310	155	74.40	62.852
125000_149	Annual Income \$125,000-\$149,999	110			0	469	234.5	76.63	74.587
150000_199	Annual Income \$150,000-\$199,999	110			0	287	143.5	71.75	58.056
200000+	Annual Income Greater than \$200,000	110			0	291	145.5	57.57	56.298
poverty_st	Poverty Status	110			2	2168	1085	454.21	408.911
no_high_sc	No High School Education	110			0	1309	654.5	258.78	246.246
foreign_bo	Foreign Born	110			0	2178	1089	485.78	516.462
spanish_sp	Spanish Speaking	110			0	2224	1112	220.68	321.584
other_lang	Other Language Speaking	110			0	867	433.5	135.05	192.075
age25_29	Age 22 to 24 Total	110			0	758	379	218.13	159.650

age30_34	Age 25 to 29 Total	110			0	745	372.5	215.85	177.709
race_white	Race White	110			205	10974	5589.5	2831.38	1752.575
race_black	Race Black	110			0	4005	2002.5	506.35	705.171
race_asian	Race Asian	110			0	1710	855	203.12	348.793
race_other	Race Other	110			0	1972	986	248.59	356.403
race_two	Bi-racial	110			0	806	403	101.20	144.053
1_unit_det	Housing 1 Unit	110			4	4953	2478.5	1263.95	821.716
5_9units	Housing 5-9 Units	110			0	795	397.5	111.29	156.096
10_19units	Housing 10-19 Units	110			0	565	282.5	76.73	107.689
20_49units	Housing 20-49 Units	110			0	728	364	58.00	98.116
50+_units	Housing 50+ Units	110			0	1365	682.5	135.48	244.931
occ_renter	Tenure, Occupancy Status, Renter Occupied	110			0	1487	743.5	434.72	314.301
car_0	Households, Zero Vehicles Available	110			0	638	319	111.57	129.770
car_1	Households, One Car Available	110			0	1565	782.5	394.65	244.678
car_3	Households, Three Cars Available	110			0	2273	1136.5	322.12	325.706
car_4	Households, Four Cars Available	110			0	541	270.5	109.95	117.316
emp_den	Employment/Area	110			25.78	11146.82	5586.301	1059.42	1677.16
pop_den	Population/Area	110			64.27	25452.69	12758.48	2391.52	3940.31

Table 3 This Table will be included in the Descriptive Statistics Table Above

Variable	Description	Category	Frequency	Percent of Category
Population	Total Population		419,394	100%
bus_to_wor	Journey to Work by Public Transportation by Bus or Trolley Bus	Journey To Work	9817	5.32%
unemployme	Unemployed Population	Employment	22,463	10.24%
public_tra	Journey to Work by Public Transportation Total	Journey To Work	10,471	5.68%
constructi	Employment in Constuction Sector	Employment	11,975	6.29%
informatio	Employment in Information Sector	Employment	2,555	1.34%
arts	Employment in Arts	Employment	44,276	23.25%
poverty_st	Poverty Status	Total Population	48,560	11.58%
no_high_sc	No High School Education	Total Population	27,612	6.58%
foreign_bo	Foreign Born	Total Population	52,806	12.59%
spanish_sp	Spanish Speaking	Total Population	23,533	5.61%
other_lang	Other Language Speaking	Total Population	14,595	3.48%
age25_29	Age 25 to 29 Total	Age Categories	23,344	5.91%
age30_34	Age 30 to 34 Total	Age Categories	22,941	5.81%
race_white	White alone	Total Population	304,073	72.50%
race_black	Black or African American alone	Total Population	54,243	12.93%
race_asian	Race Asian	Total Population	22,264	5.31%
race_other	Some other race alone	Total Population	26,193	6.25%
race_two	Two or more races:	Total Population	10,735	2.56%
occupancy_	Tenure, Occupancy Status, Owner Occupied	Housing Ownership	116,710	71.30%
occupanc_1	Tenure, Occupancy Status, Renter Occupied	Housing Ownership	46,989	28.70%
car_0	Households, Zero Vehicles Available	Vehicles Available	12,116	6.45%
car_1	Households, One Car Available	Vehicles Available	42,499	22.63%
car_3	Households, Three Cars Available	Vehicles Available	34,487	18.37%
car_4	Households, Four Cars Available	Vehicles Available	11,760	6.26%
emp_den	Employment/Area	Total Employment/ Total Area	N/A	N/A
pop_den	Population/Area	Total Population/ Total Area	N/A	N/A

4.4 CORRELATIONS

A correlation coefficient is the measure of strength of the linear association between two variables (-1 to +1). This table contains only variables that have a statistically significant correlation with the bus_to_wor variable.

Table 4 Atlantic City Correlations

	Description	Pearson Correlation
unemployme	Unemployed Population	.285**
public_tra	Journey to Work by Public Transportation Total	.996**
bus_to_wor	Journey to Work by Public Transportation by Bus or Trolley Bus	1
informatio	Employment in Information	-.229*
arts	Employment in Arts	.504**
under_100	Annual Income Under \$10,000	.416**
10000_1499	Annual Income \$10,000-\$14,999	.223*
15000_1999	Annual Income \$15,000-\$19,999	.261**
25000_2999	Annual Income \$25,000-\$29,999	.349**
30000_3499	Annual Income \$30,000-\$34,999	.250**
35000_3999	Annual Income \$35,000-\$39,999	.238*
125000_149	Annual Income \$125,000-\$149,999	-.265**
150000_199	Annual Income \$150,000-\$199,999	-.330**
200000+	Annual Income Greater than \$200,000	-.256**
poverty_st	Poverty Status	.448**
no_high_sc	No High School Education	.503**
foreign_bo	Foreign Born	.561**
spanish_sp	Spanish Speaking	.406**
other_lang	Other Language Speaking	.416**
age25_29	Age 22 to 24 Total	.336**
age30_34	Age 25 to 29 Total	.225*
race_white	Race White	-.281**
race_black	Race Black	.500**
race_asian	Race Asian	.338**
race_other	Race Other	.394**
race_two	Bi-racial	.209*
1_unit_det	Housing 1 Unit	-.370**
5_9units	Housing 5-9 Units	.221*
20_49units	Housing 20-49 Units	.239*
50+_units	Housing 50+ Units	.392**
occ_renter	Tenure, Occupancy Status, Renter Occupied	.527**
car_0	Households, Zero Vehicles Available	.749**
car_1	Households, One Car Available	.467**
car_3	Households, Three Cars Available	-.224*
car_4	Households, Four Cars Available	-.225*
emp_den	Employment/Area	.524**
pop_den	Population/Area	.507**

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4.5 REGRESSION METHODOLOGY

The model used in this analysis is a linear regression model that assumes a linear relationship between the dependent variable (`bus_to_wor`) and a set of independent variables. A regression model fits a straight line to a set of observed data and provides sufficient statistically significance to ²

The regression model will produce a number of parameters and model fitting indicators such as the coefficient of determination (R Squared). The R Squared is defined as the percent of the variation of the dependent variable (`bus_to_wor`) explained by the set of independent variables. The percent of bus riders from each census tract will be explained by the regression model's set of independent variables. Therefore the higher the R Squared the more explanatory power the model provides.

The regression model output also provides a constant (intercept) which is the average value of the dependent variable when the independent variables equal zero.³

Slope coefficient indicate the average change in the dependent variable with a one unit change in the independent variable.

For the purposes of this modelling effort statistical significance is defined as a p-value of <.05 or a t-value >2.5.

4.6 ATLANTIC CITY MODEL DEVELOPMENT

AVAIL developed a regression model for Atlantic City that has an R-Squared of .629. The model uses the dependent variable of bus-to-work in the initial regression model and keeps only the independent variables which are statistically significant and contribute to increases in R-Squared and Adjusted R-Squared. When the coefficient for a variable is not statistically significant we must accept the null hypothesis that the coefficient equals zero. In the Atlantic City Regression Model the Constant is not statistically significant in any of the specifications.

Table 5 Atlantic City Regression Model Development

Atlantic City				
Dependent Variable	Atlantic City1	Atlantic City2	Atlantic City3	Atlantic City4
Constant	6.14	-23.95	-12.39	-17.40
car_0	0.77*	0.69**	.63**	.54**
car_1		0.1**	.14**	.14**
informatio			-.82**	-.76**
emp_den				.01*
R Sq.	0.56	0.59	0.61	0.63
N	110	110	110	110

** T-value >2.5 and P-value <.05. * T-value >2.5 or P-value <.05.

² Rogerson, Peter A., 2006, *Statistical Methods for Geography 2nd Edition*, London: Sage Publications

³ Lewis-Beck, Michael S., 1980, *Applied Regression, An Introduction*, Newbury Park: Sage Publications

4.7 ATLANTIC CITY REGRESSION EQUATION

This equation uses the following five variables:

- bus_to_wor = Journey to Work by Public Transportation by Bus or Trolley Bus CAR_0 = Zero Car Households
- car_0 = Households, Zero Vehicles Available
- car_1 = Households, One Vehicle Available
- informatio = Employment in Information Sector
- emp_den = Employment/Area

The regression equation with an R Squared of 63% is specified as follows:

bus_to_wor = 0.5438445*(car_0)+ 0.135101*(car_1)-0.7550878*(information)+ 0.01220453*(emp_den)

4.8 IMPLEMENTING REGRESSION MODELS FOR MICROSIMULATION

To predict ridership in our microsimulation, we use the following process for each tract in the market area. To show this process on a smaller scale, we will show a Regression Model example using a single census tract, 34001012200 and the Atlantic City Regression Equation. This census tract has 379 individuals indicating bus-to-work as their mode of transportation. On the map below, the tract has been enlarged in green for viewing:

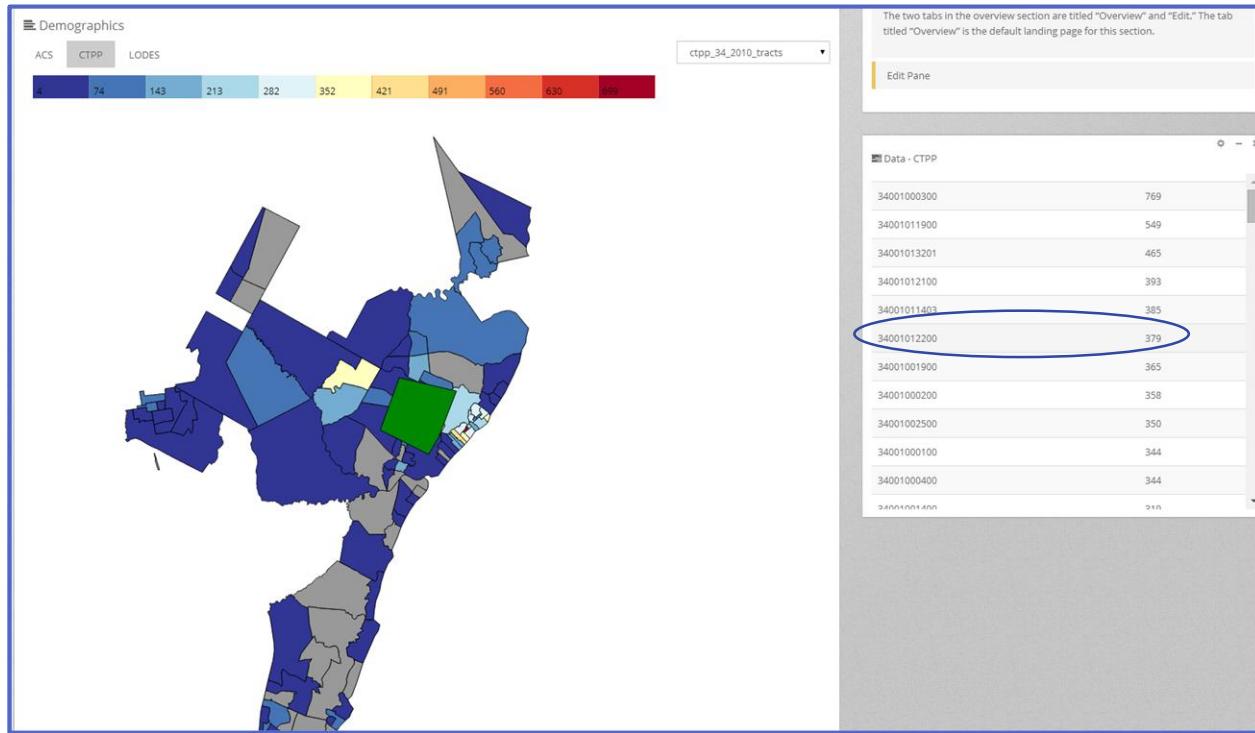


Figure 53 Admin Tool Overview Map

4.8.1 Find the number of riders predicted by the regression model for the tract.

To find the number of riders AVAIL has developed an algorithm that pulls specific census data for each census tract into the regression model. In this example, we will collect the variables for the Atlantic City Regression Equation and the corresponding data for census tract 34001012200. One can access this information using the Admin Tool by accessing the overview map and scrolling over the desired census tract.

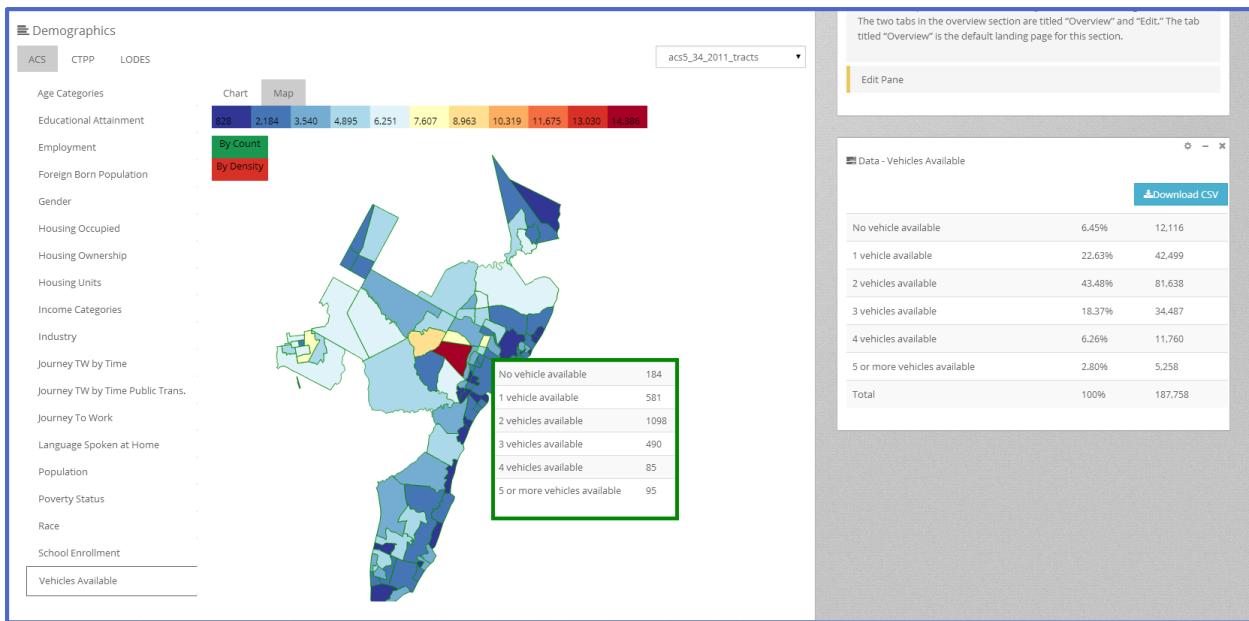


Figure 54 Admin Tool Overview Map with Mouseover

The trip table generating algorithm gathers the census tract data for each regression model variable.

Equation Variable	Description	Census Category	Amount in Census Tract 34001012200
bus_to_wor	Journey to Work by Public Transportation by Bus or Trolley Bus	Journey To Work	382
car_0	Households, Zero Vehicles Available	Vehicles Available	184
car_1	Households, One Car Available	Vehicles Available	581
informatio	Employment in Information Sector	Employment	15
emp_den	Employment/Area	Total Employment/Total Area	2248

4.8.2 The Regression Model Equation

In Atlantic City census tract 34001012200, the Atlantic City Regression Model is run as follows

$$\text{bus_to_wor} = 0.5438445 * (\text{car}_0) + 0.135101 * (\text{car}_1) - 0.7550878 * (\text{information}) + 0.01220453 * (\text{emp_den})$$

When filled with census data for the tract:

$$\text{bus_to_wor} = 0.5438445 * (184) + 0.135101 * (581) - 0.7550878 * (15) + 0.01220453 * (2248) = 194.6705354$$

The number of riders in census tract 34001012200 predicted by the Atlantic City Regression Model is 195.

4.8.3 ACS Regression Ratio

We take the number of riders predicted by the regression, and divide that by ACS variable Journey To Work: Public Transportation –Bus for the tract, giving us the ratio of predicted riders to census counted riders.

$$\text{Regression Model Riders / ACS Riders} = \text{ACS Regression Ratio}$$

$$195/382=0.51$$

4.8.4 CTPP Home Tract to Work Tract Counts

Then for each home tract to work tract bus travel count in the CTPP, we multiply the count by the ACS Regression Ratio to find the ridership numbers for input into the trip table.

$$\text{Trip Table Input} = \text{CTPP} * \text{Regression Ratio}$$

Riders from Home Tract 34001012200		
Work Tract	Riders	Trip Table Output = CTPP*Regression Ratio (0.51)
34001002400	160	82
34001001400	60	31
34001002300	60	31
34001000400	25	13
34001011900	25	13
34001001100	20	10
34001013201	15	8
34001013302	10	5
34001011702	4	2
Total	379	193

4.8.5 All resulting trips are added to our trip table to be simulated by the modeling software.

The resulting trip table shows the number of bus trips from the origin point (census tract 3400101220) to each corresponding work census tract.

4.8.6 The trip is microsimulated using Open Trip Planner.

The trip table output is then run through Open Trip Planner, an open source transportation planning software. Open Trip Planner returns the three fastest-by-travel-time routes from the origin point to the destination point by departure time.



4.8.7 Model Analysis

The Admin Tool has a number of charts, tables and maps designed to allow the user to analyze the microsimulation. These include:

- Inbound and outbound trips for the zone

- Number of riders per route
- Number of unroutable trips which occur when there is not both a valid origin and destination point between two zones.
- Trips are listed by most likely bus route taken
- Wait times are estimated for each person's trip.

4.8.8 Implementing Regression Models Flow Chart

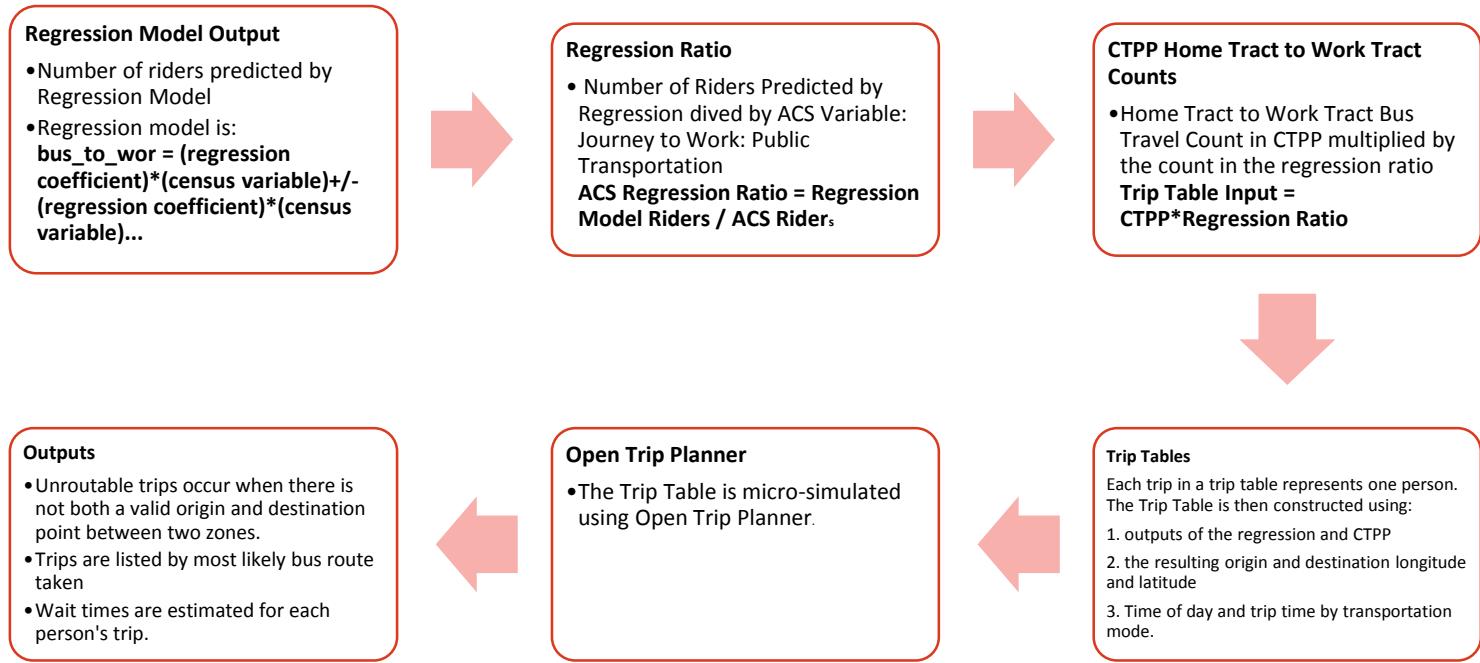


Figure 55 Flow Chart: Implementing Regression Models for Microsimulation

4.9 MODEL VALIDATION (INCLUDES: MODEL OUTPUTS, OBSERVATIONS ON MODEL OUTPUT)

4.9.1 Model Outputs

4.9.1.1 Atlantic City AM Regression Model

Figure 56 Atlantic City4 Regression Model vs. Farebox and Atlantic City3 model. Distribution Graph of Riders by Route ID

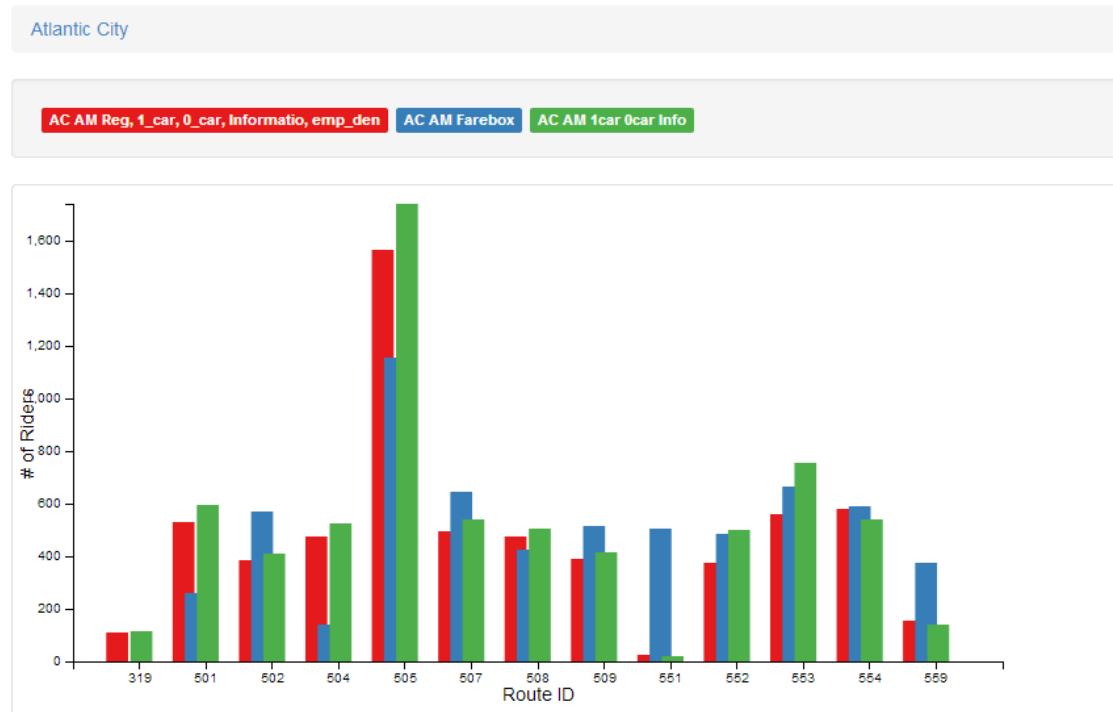


Table 6 Atlantic City4 Regression Model vs. Farebox and Atlantic City3 model. Distribution Graph of Riders by Route ID.

Route ID	AC AM Reg, 1_car, 0_car, Informatio, emp_den	AC AM Farebox	AC AM 1car 0car Info
319	108	undefined	114
501	529	258	595
502	386	569	410
504	475	138	527
505	1562	1154	1739
507	495	647	541
508	476	423	506
509	392	513	417
551	24	505	18
552	373	483	501
553	559	666	755
554	578	592	538
559	155	375	139
	6112	6323	6800

4.9.2 Observations on Model Outputs

4.9.2.1 AC AM Findings

- Using the Atlantic City4 Regression Model to test AM bus ridership, the microsimulation accuracy has improved to within 3.4% of Farebox. Previously, Atlantic City3 Regression Model resulted in a microsimulation over-estimate of 7.5%. The Atlantic City4 Model has a higher R Square and it provides a more accurate AM bus ridership microsimulation.
- Microsimulation over estimates Routes 504, 505, and to a lesser-degree 501. These are downtown on island routes that compete directly with Jitney service and as a result Farebox numbers are below microsimulation estimates. AVAIL suspects that these are real bus riders that are not utilizing NJTransit.
- The microsimulation underestimates AM ridership on Route 551 which is a long distance low-service bus route that caters to non-work related patrons. This is likely related to entertainment downtown.
- The possible explanation for the negative correlation and subsequent negative coefficient for the Employment in the Information sector is the spatial distribution of their home locations. They're predominantly located in the census tract X which is not served by transit.

4.9.2.2 Atlantic City PM Regression Model

Figure 57 Atlantic City4 Regression Model vs. Farebox and Atlantic City3 model. Distribution Graph of Riders by Route ID

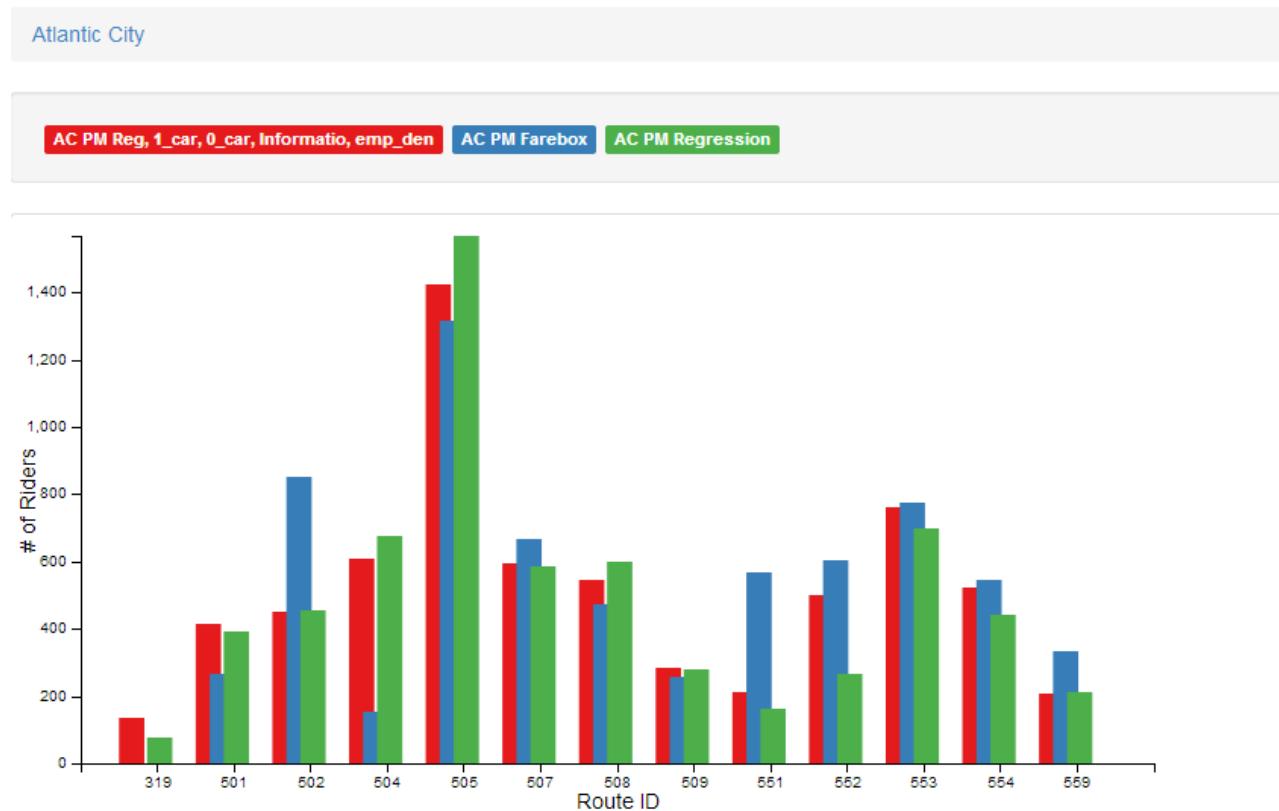


Table 7 Atlantic City4 Regression Model vs. Farebox and Atlantic City3 model. Distribution Graph of Riders by Route ID

Route ID	AC PM Reg, 1_car, 0_car, Informatio, emp_den	AC PM Farebox	AC PM Regression
319	134	undefined	76
501	416	264	394
502	450	852	453
504	608	153	675
505	1425	1314	1568
507	597	667	587
508	543	475	600
509	283	256	279
551	211	569	162
552	502	602	266
553	763	775	698
554	522	543	441
559	207	332	211
	6661	6802	6410

4.9.2.3 AC PM Findings

- Using the Atlantic City4 Regression Model to test PM bus ridership, the microsimulation accuracy has improved to within 2% of Farebox. Previously, Atlantic City3 Regression Model resulted in a microsimulation over-estimate of 6.1%. Again, the Atlantic City4 Model has a higher R Square and it provides a more accurate PM ridership microsimulation.
- Microsimulation over estimates Routes 504 and to a lesser-degree 501. These are downtown on island routes that compete directly with Jitney service and as a result Farebox numbers are below microsimulation estimates. AVAIL suspects that these are real bus riders that are not utilizing NJTransit.
- The Microsimulation is over estimating route 502 ridership most likely because riders are delaying their return trip to outside of the PM peak timeframe.
- The microsimulation once again under-estimates ridership on Route 551 which is a long distance low-service bus route that caters to non-work related patrons. This is likely related to entertainment downtown.

5 APPENDIX A: OVERVIEW ON BUILDING REGRESSION MODELS

The following is an overview of processes followed in building the regression models derived from the census data. At this time, the regression models show high sensitivity to changes in geographies.

5.1 EXTRACT CENSUS TRACTS FROM WEB TOOL

Our first step is to extract the GeOID's of the Census Tracts for a given market area from the database of our web-tool. For Atlantic City, the GeOID's are shown below:

```
"34001010102","34001010104","34001010105","34001001400","34001002500","34001002400","34001001900","34001001200","34001001500","34001001100","34001000300","34001002300","34001000500","34001000400","3400100100","34001000200","34001013201","34001013202","34001013302","34001013301","34001013000","34001013100","34001013102","34001001300","34001010101","34001010505","34001010200","34001011900","34001010300","34001012000","34001012100","34001012200","34001012401","34001012302","34001012402","34001012501","34001013500","34001012602","34001012701","34001012801","34001011803","34001012502","34001011702","34001011701","34001010506","34001010503","34001983400","34001010403","34001011802","34001011804","34001011404","34001012702","34001011805","34001011403","34009020201","34009020201","34009020101","34009020102","34009020203","34001012802","34001011600","34001011500","34001011401","34011030100","34009020301","34009020205","34009020800","34009020206","34001010401","34001010501","34009021001","34009020902","34009020901","34009021100","34009022102","34009022101","34009021804","34009021803","34009021701","34009021702","34009021805","34009021806","34009021900","34009022000","34009021600","34009021500","34009021400","34009021300","34009021002","34009020302","34009020700","34011041000","34011040800","34011040700","34011040600","34011040500","34011041100","34011040300","34011040400","34001011202","34001011100","34001011000","34001010900","34001010800","34029736101","34029736102","34029737000","34029736002","34029736001"
```

5.2 CREATING A DATA RICH GIS FILE

Now that we have a subset of Census Tracts, we slice this group out of our database that contains New Jersey Census Tracts, and query the Census API to acquire a selection of ACS data for these tracts. Once completed, this data is exported from our database as a JavaScript Object Notation (JSON) object that contains the census geographies and with the ACS data as attributes, this JSON object is then converted to a shapefile for use in GIS applications.

geoid	total_popu	employment	unemployme	travel_to_	car_to_wor	public_tra	bus_to_wor
34009020901	828	318	27	308	244	0	0
34009021002	3623	1930	141	1897	1735	16	16
34009022102	5533	2367	356	2299	2140	37	37
34009021001	2600	848	89	835	738	20	20
34009022101	1887	649	57	649	545	0	0
34009020301	4202	2136	185	2070	1969	10	0
34009021500	2150	1116	206	1084	944	43	24
34009020102	2413	1220	47	1210	867	19	9
34009021400	3650	1687	202	1657	791	104	101
34009020101	3307	1703	172	1703	1190	48	38
34009021804	5603	2789	343	2633	2448	79	79
34009021300	4111	1670	196	1580	1411	25	12

5.3 GEODA

Next, we take advantage of the Open Source program GeoDA⁴, a statistical tool for analyzing sets of spatial data. Using GeoDA, we developed a regression model for Atlantic City that provides significant ridership determination values using ACS variables.

Figure 58 GeoDA Regression Model Output for Atlantic City, 08.04.2014

```

SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES ESTIMATION
Data set : atlantic_city
Dependent Variable : bus_to_wor Number of Observations: 108
Mean dependent var : 90.8981 Number of Variables : 5
S.D. dependent var : 133.269 Degrees of Freedom : 103

R-squared : 0.635076 F-statistic : 44.8126
Adjusted R-squared : 0.620904 Prob(F-statistic) : 9.5755e-022
Sum squared residual: 699980 Log likelihood : -627.186
Sigma-square : 6795.93 Akaike info criterion : 1264.37
S.E. of regression : 82.4374 Schwarz criterion : 1277.78
Sigma-square ML : 6481.3
S.E of regression ML: 80.5065

-----
      Variable   Coefficient     Std.Error    t-Statistic   Probability
----- 
      CONSTANT   -19.35818     15.86841    -1.219919    0.22528
informatio  -0.7130557     0.3039812   -2.345723    0.02091
      car_0      0.5432931     0.08102835   6.704975    0.00000
      car_1      0.1331132     0.03839082   3.467318    0.00077
      emp_den   8.155064e-010   3.607904e-010   2.260333    0.02590
----- 

REGRESSION DIAGNOSTICS
MULTICOLLINEARITY CONDITION NUMBER 5.011276
TEST ON NORMALITY OF ERRORS
TEST          DF          VALUE        PROB
Jarque-Bera   2           27.4101    0.00000

DIAGNOSTICS FOR HETROSKEDEASTICITY
RANDOM COEFFICIENTS
TEST          DF          VALUE        PROB
Breusch-Pagan test 4           87.5447    0.00000
Koenker-Bassett test 4           39.3484    0.00000
===== END OF REPORT =====

```

⁴ <http://geodacenter.asu.edu/software/downloads>

6 APPENDIX B: REGRESSION MODELS FOR PRINCETON/TRENTON AND PATERSON

6.1 PRINCETON/TRENTON REGRESSION MODEL, 8.5.14

Table 8 Princeton/Trenton Regression Model

```

SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES ESTIMATION
Data set : princeton
Dependent Variable : bus_to_wor Number of Observations: 69
Mean dependent var : 70.4638 Number of Variables : 5
S.D. dependent var : 75.2699 Degrees of Freedom : 64

R-squared : 0.697629 F-statistic : 36.9152
Adjusted R-squared : 0.678731 Prob(F-statistic) : 5.55997e-016
Sum squared residual: 118204 Log likelihood : -354.796
Sigma-square : 1846.93 Akaike info criterion : 719.592
S.E. of regression : 42.976 Schwarz criterion : 730.762
Sigma-square ML : 1713.1
S.E of regression ML: 41.3896

-----
Variable Coefficient Std.Error t-Statistic Probability
-----
CONSTANT 1.612588 10.39041 0.1551996 0.87715
car_0 0.3400127 0.04336295 7.841088 0.00000
race_black 0.02379176 0.008090476 2.940712 0.00455
age25_29 0.07151607 0.02770711 2.581145 0.01215
poverty_st -0.0409672 0.02478712 -1.652762 0.10328

-----
REGRESSION DIAGNOSTICS
MULTICOLLINEARITY CONDITION NUMBER 7.302327
TEST ON NORMALITY OF ERRORS
TEST DF VALUE PROB
Jarque-Bera 2 2.2319 0.32760

DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS
TEST DF VALUE PROB
Breusch-Pagan test 4 8.8273 0.06557
Koenker-Bassett test 4 6.7490 0.14976
===== END OF REPORT =====

```

6.2 PATERSON REGRESSION MODEL, 8.5.14

Table 9 Paterson Regression Model

```

SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES ESTIMATION
Data set          : paterson
Dependent Variable : bus_to_wor Number of Observations: 128
Mean dependent var : 192.938 Number of Variables      : 6
S.D. dependent var : 136.32  Degrees of Freedom       : 122

R-squared          : 0.561941 F-statistic            : 31.3003
Adjusted R-squared : 0.543988 Prob(F-statistic)     : 2.15646e-020
Sum squared residual: 1.04198e+006 Log likelihood        : -757.919
Sigma-square       : 8540.82 Akaike info criterion : 1527.84
S.E. of regression  : 92.4165 Schwarz criterion   : 1544.95
Sigma-square ML    : 8140.47
S.E of regression ML: 90.2245

```

Variable	Coefficient	Std.Error	t-Statistic	Probability
CONSTANT	44.0737	18.68106	2.359271	0.01990
car_0	0.2265559	0.04817075	4.703183	0.00001
car_1	0.09415446	0.03179322	2.961463	0.00368
empoloymen	7.776514e-010	2.019496e-010	3.850719	0.00019
50+_units	0.131551	0.03525934	3.730957	0.00029
poverty_st	-0.05523987	0.01947491	-2.836464	0.00534

```

REGRESSION DIAGNOSTICS
MULTICOLLINEARITY CONDITION NUMBER 6.706108
TEST ON NORMALITY OF ERRORS
TEST           DF      VALUE      PROB
Jarque-Bera    2       2.3264    0.31249

DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS
TEST           DF      VALUE      PROB
Breusch-Pagan test 5       7.7766    0.16898
Koenker-Bassett test 5       11.4090   0.04385
===== END OF REPORT =====

```