Ver 2.5 TRAVEL MODEL DEVELOPMENT AND EVALUATION

Status Report

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TPB Travel Forecasting Subcommittee
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Overview

- Background
- Ver 2.5 Travel Model performance
- Ver 2.5 Travel Model sensitivity testing
- Conclusions

Gen 2/Ver 2.5 development status

- Model remains in evaluation/testing mode
- Progress has been made
- Development is behind schedule
- Staff is plowing ahead

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Gen2/Ver. 2.5 model: Background

- Reflects incremental refinements to the existing Ver 2.3 model
- Ver 2.5 developed/implemented by Cambridge Systematics, Inc. during FY 2017
- 2014 validation year
- Under evaluation by TPB staff during FY 2018/19

Ver 2.5 refinements

1. Updated transit network/path-building software
   - Public Transport (PT)
2. Refined non-motorized model sub-model
3. Refined transit modeling
   - Simplified/generalized mode choice model (11 to 3 modes)
   - Transit assignment process sensitive to sub-modes
4. Highway assignment enhancements
   - Highway assignment: VOT stratification
   - Modified volume-delay function

Checklist for Ver 2.5 adoption

1. Validation
2. Sensitivity testing
3. Running time optimization
4. Documentation

Recent activities

1. "Batch process" developed to produced Ver 2.5 land activity inputs by year
   - Reads pre-existing V2.3 land use files
   - Calculates density and mix variables
   - Appends pre-existing GIS/urban form variables

2. Performance summaries prepared

3. Sensitivity tests undertaken

Model reference names

Ver 2.3.66SIP:	Existing Version 2.3 travel model
Ver 2.5_CS:	The application Ver 2.5 model delivered by CS at the end of FY 2017
	TPB staff-modified adaption of **Ver 2.5_CS**
Ver 2.5_Base:	- Streamlined features: "Final " model executed instead of "Base/Final" construct used in previous V2.3; "PP" iteration removed
	- Scripts are refined or added for reporting purposes
Ver 2.5.76:	Same as **Ver 2.5_Base,** but treatment of external trip distribution updated

The V2.5 land use input format

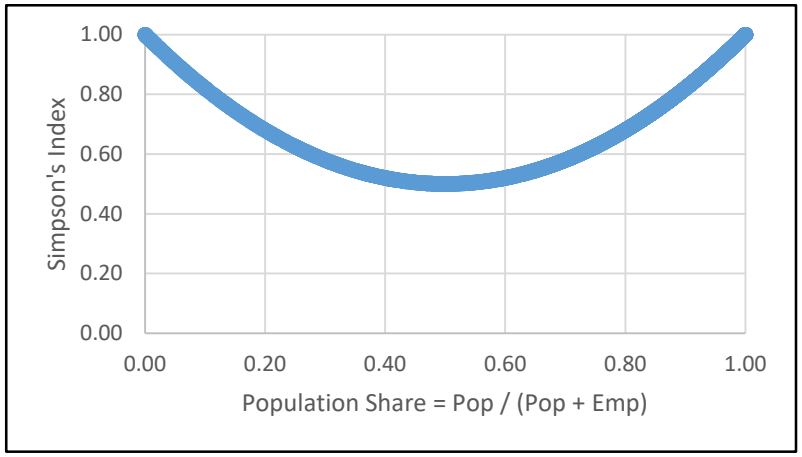
Standard V2.3 Variables

TAZ	TAZ (1-3,722)
HH	Households
HHPOP	Household Population
GQPOP	Group Quarters Population
TOTPOP	Total Population
TOTEMP	Total Employment
INDEMP	Industrial Employment
RETEMP	Retail Employment
OFFEMP	Office Employment
OTHEMP	Other Employment
JURCODE	Jurisdiction Code (0-23)
LANDAREA	Gross Land Area (in sq. miles)
HHINCIDX	Median HH income index
ADISTTOX	Airline distance to the nearest external sta.
TAZXCRD	TAZ X-Coord.
TAZYCRD	TAZ Y-Coord.

Added Variables supporting Ver 2.5

POPDEN	Population Floating Density One-mile "floating" population density
EMPDEN	Employment Floating Density One-mile "floating" employment density
SIMPSONIDX	Simpson's diversity index (an index of the "mix" of activity in a zone, in this case, population and employment, with 0.5 representing equal distribution and 1 indicating homogeneous land use in a zone)
ENTROPYIDX	Entropy (measuring homogeneity of land use in a given area, with a value of 0 representing homogeneous land use and 1 indicating evenly distributed land uses)
ITZFD_34Q	Intersection TAZ floating density: 3- or 4-leg intersections within 1/4 mile
ITZFD_34O	Intersection TAZ floating density: 3- or 4-leg intersections within 1 mile
ITZFD_CSQ	Intersection TAZ floating density: cul-de-sac intersections within 1/4 mile
ITZFD_CSO	Intersection TAZ floating density: cul-de-sac intersections within 1 mile
STZFD_Q	Stop floating density within a quarter mile
STZFD_O	Stop floating density within a quarter mile
NT	No transit access indicator
TAZCDS	TAZ Cul-de-Sacs

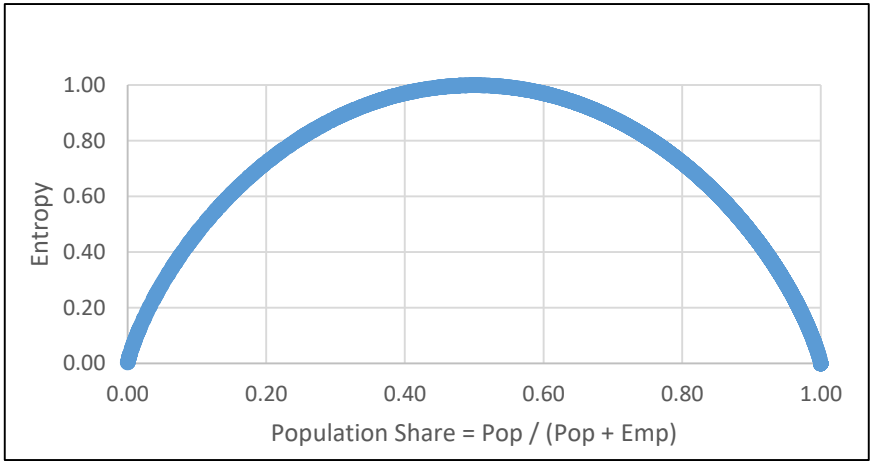
The Simpson & Entropy indices



Simpson's index as a function of pop. share

Entropy as a function of pop. share

- Both activity "mix" variables are used in the refined non-motorized sub-model and mode choice model



Performance Summaries

- All summaries correspond to the year 2014
- Summaries compiled:
  - Daily areawide VMT
  - Daily VMT on facilities (where link counts exist)
  - Daily screenline crossings (where link counts exist)
  - Daily transit boardings

VMT Performance (est./obs. ratio) by jurisdiction

- VMT reflects on-network facilities
- We note excessive VMT in Alexandria and, to a lesser degree, DC and Frederick

		E/O Ratio			
	Jurisdiction	**V2.3.66_SIP**	**V2.5_CS**	**V2.5_Base**	**V2.5.76**
TPB Member Area	District of Columbia	1.03	1.16	1.14	1.10
	Montgomery County	1.10	1.17	1.17	1.06
	Prince George's County	0.98	1.07	1.07	0.96
	Arlington County	0.96	1.12	1.10	1.09
	City of Alexandria	1.22	1.44	1.44	1.42
	Fairfax County	0.98	1.08	1.07	1.04
	Loudoun County	1.12	1.17	1.17	1.02
	Prince William County	1.00	1.06	1.05	1.00
	Frederick County	1.12	1.23	1.23	1.16
	Charles County	0.92	0.96	0.95	0.92
	Total	1.03	1.12	1.11	1.04
Non-TPB Member Area		1.01	1.06	1.06	1.02
	Grand Total	1.02	1.10	1.10	1.03

VMT Performance (est./obs. ratio) by facility type

	E/O Ratio			
FTYPE	**V2.3.66_SIP**	**V2.5_CS**	**V2.5_Base**	**V2.5.76**
Freeway	1.07	1.19	1.17	1.12
Major Arterial	1.07	1.11	1.10	1.06
Minor Arterial	1.13	1.18	1.17	1.08
Collector	0.73	0.78	0.77	0.73
Expwy	0.96	1.06	1.06	0.98
Ramp	0.87	0.88	0.86	1.13
Total	**1.06**	**1.14**	**1.13**	**1.07**

- E/O ratio based on 6,692 directional links with daily traffic counts
- Total E/O ratios appear excessive

% RMSE Performance by facility type

	Percent RMSE			
FTYPE	**V2.3.66_SIP**	**V2.5_CS**	**V2.5_Base**	**V2.5.76**
Freeway	21	30	30	26
Major Arterial	39	41	41	39
Minor Arterial	52	53	53	50
Collector	77	77	77	76
Expwy	34	35	35	34
Ramp	13	12	14	13
Total	**42**	**51**	**51**	**46**

- Historically, TPB model %RMSE performance has been about 20% for freeways and 40% for all links
- The V2.5.76 model performance is slightly worse than existing 2.3 model

Screenline crossing performance (Est./Obs. ratios)

	E/O Ratio			
Screenline	V2.3.66_SIP	V2.5_CS	V2.5_Base	V2.5.76
1	0.74	0.90	0.89	0.86
2	1.25	1.33	1.32	1.27
3	0.89	0.93	0.91	0.90
4	1.23	1.34	1.33	1.25
5	0.85	0.95	0.95	0.93
6	1.03	1.10	1.09	1.06
7	0.97	1.03	1.01	0.98
8	1.09	1.21	1.21	1.07
9	0.79	0.90	0.91	0.88
10	0.99	1.02	1.03	0.98
12	1.00	1.08	1.08	1.00
13	1.27	1.36	1.36	1.20
14	1.09	1.17	1.16	1.08
15	0.91	0.97	0.97	0.86
16	0.94	1.20	1.19	1.05
17	0.90	0.93	0.91	0.88
18	0.89	1.00	0.83	0.78
19	0.80	0.92	0.81	0.75

	E/O Ratio			
Screenline	V2.3.66_SIP	V2.5_CS	V2.5_Base	V2.5.76
20	0.92	1.34	1.32	1.25
22	1.06	1.14	1.14	1.02
23	1.61	1.65	1.65	1.24
24	0.90	0.96	0.96	0.90
25	1.32	1.46	1.45	1.28
26	2.16	2.15	2.16	1.64
27	1.48	1.65	1.63	1.30
28	0.75	0.80	0.80	0.77
31	2.22	2.23	2.24	2.01
32	1.76	2.14	2.13	2.34
33	1.08	1.10	1.09	1.00
34	1.18	1.27	1.26	1.13
35	0.93	0.98	0.98	1.03
36	2.09	2.63	2.57	2.01
37	2.00	2.03	2.03	1.81
38	0.69	0.71	0.72	0.72
Total	**1.02**	**1.13**	**1.11**	**1.04**

V2.5 Potomac River crossings are over-predicted

Transit ridership performance (est./obs. boardings) by sub-mode

	Obs	V2.3 SIP	V2.5 CS	V2.5 Base	V2.5.76	V2.3 SIP E/O	V2.5 CS E/O	V2.5 Base E/O	V2.5.76 E/O
Metrorail	721,804	748,657	764,833	789,424	733,872	1.04	1.06	1.09	1.02
MARC	36,051	28,285	30,394	22,852	11,277	0.78	0.84	0.63	0.31
VRE	18,166	4,747	7,262	6,537	6,424	0.26	0.40	0.36	0.35
All bus	648,083	717,757	460,714	461,007	414,663	1.11	0.71	0.71	0.64
Total	**1,424,104**	**1,499,446**	**1,263,203**	**1,279,820**	**1,166,236**	**1.05**	**0.89**	**0.90**	**0.82**

- Transit boardings for V2.5 models are under-predicting

Sensitivity Tests: Background

- All tests pivot off of the **V2.5_Base** model
- Based on year **2014**
- Tests examined:
  1. Urban form variables from a Dupont Circle TAZ (45) inserted into a Woodbridge area TAZ (2753)
  2. Close Memorial Bridge
  3. Add one lane (each direction) to American Legion Bridge
  4. Increase transit service frequency for one transit line (X2 bus)
  5. Raise Metrorail fare by 25 cents, systemwide

Sensitivity Test 1

- Test Question: How do intersection density variables effect non-motorized travel?
- Test Description: Inserted Dupont Circle area TAZ (45) intersection densities into a TAZ in the Woodbridge area (2753)

Sensitivity Test 1: Results

Increased intersection densities effects an increase in non-motorized trips in TAZ-2753, from ~200 trips (6% of total) to ~1,100 trips (31% of total)

Non-Motorized Trips in TAZ 2753 Before/After Test

Purpose	Base	Alt
HBW	20	148
Pct	*2.86%*	*20.82%*
HBS	23	206
Pct	*3.31%*	*29.40%*
HBO	106	451
Pct	*8.78%*	*37.18%*
NHW	30	121
Pct	*9.11%*	*36.47%*
NHO	42	158
Pct	*7.21%*	*27.17%*
Total	**222**	**1,084**
Pct	***6.28%***	***30.63%***

Sensitivity Test 2

- Test Question: How does model respond to reductions in roadway capacity?

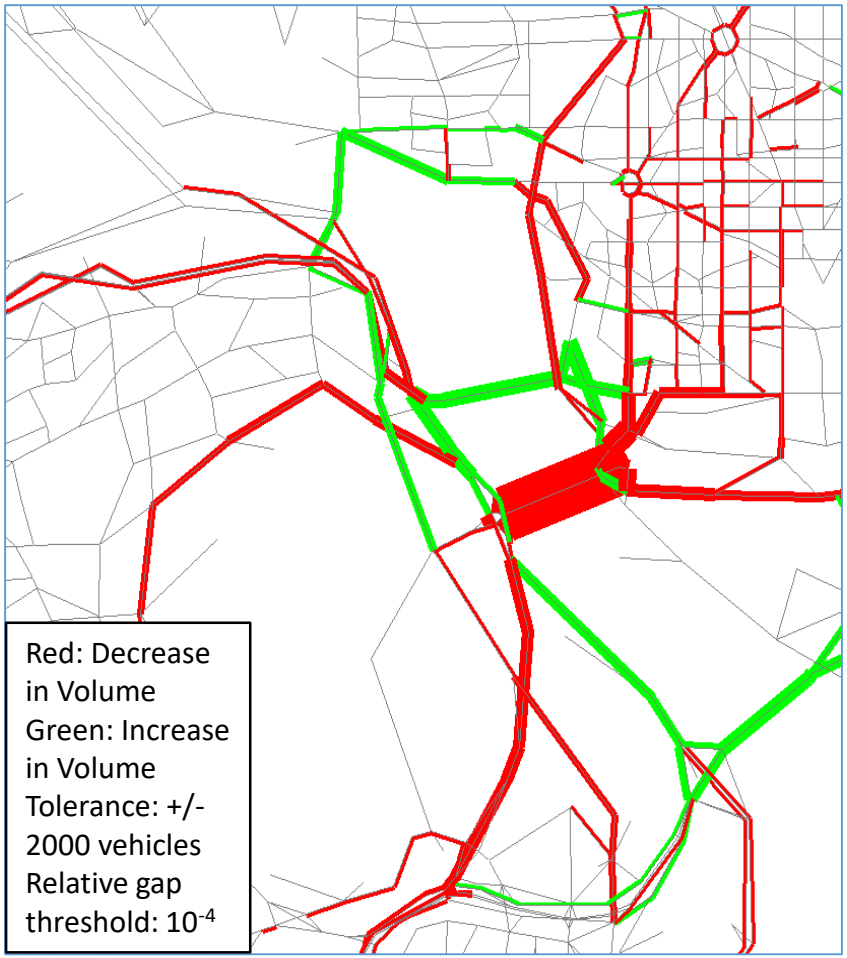
- Test Description: Remove Memorial Bridge from the highway network

Sensitivity Test 2: Results

- Regional VMT decreases by about 0.1%
- Auto drivers to DC (from all jurisdictions) decrease by 4,600 vehicle trips
  - But change is not evenly distributed
    - Auto driver trips from DC: +3,603
    - Auto driver trips from VA: -14,172
    - Auto driver trips from MD: +5,982
- Transit increased by 14,600 trips or 1.38%

Sensitivity Test 2: Results

- Reasonable displacement pattern results in the daily volume change plots



Sensitivity Test 3

- Test Question: How does model respond to increases in roadway capacity?

- Test Description: Add one lane to the American Legion Bridge in each direction

Sensitivity Test 3: Results

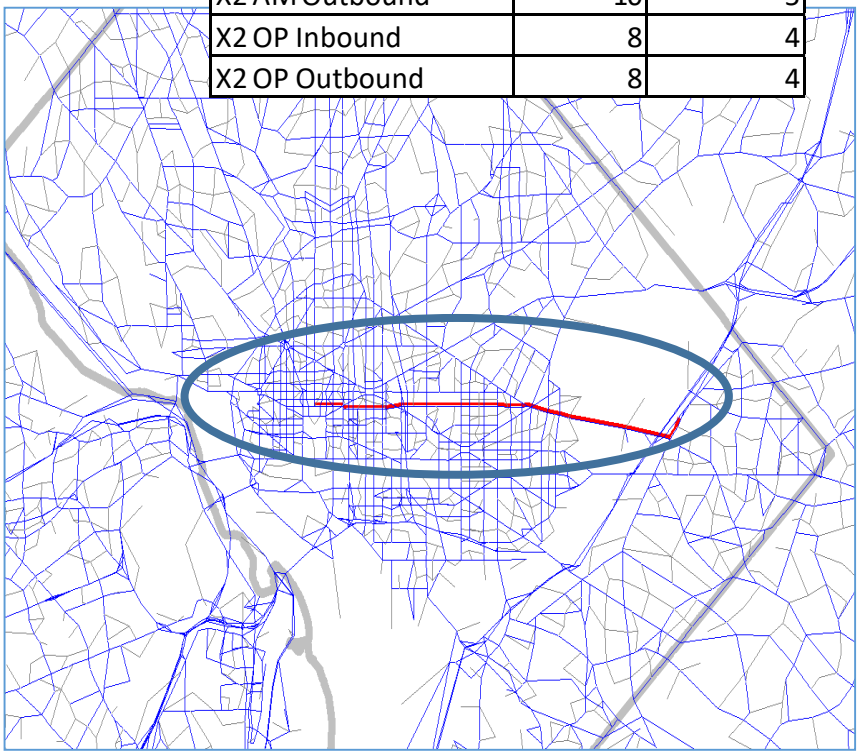
- Added capacity on the American Legion Bridge results in increased volumes, decreased V/C ratios and increased speeds
- Resulted in a net increase in regional VMT by 39,400 (0.02%)

		Westbound			Eastbound		
		Base	Alt	Diff	Base	Alt	Diff
	Lanes	5	6	1	5	6	1
AM	Volume	34,674	35,282	608	32,361	32,734	373
	V/C	1.45	1.23	-0.22	1.35	1.14	-0.21
	Speed (mph)	7	21	14	12	30	18
	Lanes	5	6	1	5	6	1
MD	Volume	57,842	58,295	453	55,243	55,548	305
	V/C	1.02	0.86	-0.16	0.98	0.82	-0.16
	Speed (mph)	43	58	14	48	60	12
	Lanes	5	6	1	5	6	1
PM	Volume	49,826	50,689	863	49,417	50,170	753
	V/C	1.46	1.24	-0.22	1.45	1.23	-0.22
	Speed (mph)	7	19	13	7	21	13
	Lanes	5	6	1	5	6	1
NT	Volume	41,582	41,850	269	43,738	44,007	268
	V/C	0.62	0.52	-0.10	0.66	0.55	-0.11
	Speed (mph)	64	65	0	64	65	1

Sensitivity Test 4

- Test Question: How does model respond to increase transit service on an urban transit line?
- Test Description: Increase (double) the WMATA X2 bus service frequency

Route	Headway (min)	
	Base	Alternative
X2 AM Inbound	7	3.5
X2 AM Outbound	10	5
X2 OP Inbound	8	4
X2 OP Outbound	8	4



Sensitivity Test 4: Results

- X2 bus ridership increased by 55 %

	V2.5_Base	Reduced_Hdway	Change	% Change
Total daily ridership	1106	1715	609	55%

- Total linked transit trips increased by 0.15%

Sensitivity Test 5

- Test Question: How does model respond to a transit fare increase?

- Test Description: Metrorail fares are increased by 25 cents, systemwide

Sensitivity Test 5: Results

- Base Metrorail fair was raised by 25 cents:
  - AM peak from $2.24 to $2.49 (11% increase)
  - Off-peak from $1.84 to $2.09 (14% increase)
- Metrorail, and other transit sub-modes decline with higher fares

Mode	V2.5_Base	Raised Fare	Change	% Change
Metrorail	789,424	756,204	-33,220	-4.21%
MARC	22,852	22,573	-279	-1.22%
VRE	6,537	6,409	-128	-1.96%
All bus	461,007	447,915	-13,091	-2.84%
Total	**1,279,820**	**1,233,101**	**-46,719**	**-3.65%**

- Total transit ridership declined by ~4 %
- Auto person trips increase by ~0.2 %
- Total VMT increases by ~0.1%

Conclusions

- More V2.5 testing is warranted, especially with regard to tolling
- Staff plans to continue refining the model and investigating
- Testing V2.5 with the current V2.3 AQC scenarios inputs will allow staff to more effectively compare both models

Appreciation

TPB staff members in the technical trenches!

- Meseret Seifu
- Ray Ngo

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