SERPM 6.7
Development, Calibration & Results

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Topics

- Model objectives & schedule
- Transit survey findings
- Transit model development activities and results
- Transit model calibration/validation process and results
- FTA reaction
- Summary

SERPM 6.7 Objectives

- The new transit model should:
  - Be a solid technical tool for multi-modal planning analysis, long-range transit planning and New/Small Starts analysis
  - Understand key transit travel patterns and behaviors
  - Include changes and adjustments that resolve non-transit issues identified since the release of SERPM 6.5
  - Reflect all major findings of recent transit on-board surveys
  - Utilize PT throughout transit model, removing any use of TRNBUILD
  - Be reviewed and discussed with Federal Transit Administration staff

Schedule

Activities	2010		2011				2012+
	Q3	Q4	Q1	Q2	Q3	Q4	Q1+
Transit Survey Processing & Analysis	√	√					
Transit Model Development			√	√			
Transit Model Calibration / Validation					√	√	
FTA Coordination / Meeting	√	√		√		√	
Application							√

Transit survey fieldwork in 2008, 2009, & 2010

Transit Survey Findings

Southeast Florida Transit Survey Overview (in chronological order)

First ever comprehensive picture of transit patterns & behavior in Southeast Florida!

System / Survey Year	Weekday Boardings during Survey	Sample Rate (Expandable Surveys)	Sample Rate (Geocodable Surveys)
Metrobus 2004	229,164	4.3%	1.4%
Tri-Rail 2008	15,358	40%	18%
Metrorail 2009	58,908	18%	13%
I-95 Express Bus 2010	2,990	39%	n/a *
Broward County Transit 2010	119,624	6.5%	6.5%
Palm Tran 2010	34,019	9.9%	9.8%

An expandable survey has been reviewed for reasonableness (e.g., does not reflect home-to-home trip, etc.) contains a minimum amount of basic information (e.g., auto ownership, trip purpose, boarding location)

A geocodable survey is a subset of the expandable surveys that have at least a geocodable origin and destination.

* The I-95 Express Bus survey did not request detailed origin and destination information

Key Survey Findings – Overview

- There are two major types of transit markets in the South Florida region:
    1. Mobility-dependent market using local services for all trip-making
    2. Commuter market utilizing premium transit service for longer work trips

Summary of Differences between Mobility-Dependent & Commuter Markets

Trip Characteristic	Mobility-Dependent Market	Commuter Market
Dominant market segment(s)	Zero-car households	Car-owning households
Travel patterns	Dispersed travel patterns; no meaningful CBD market	Primary destinations are Miami CBD area and suburban employment areas
Primary access modes	90+% Walk	57% Walk (Metrorail); 70+% Auto (I-95EX,Tri-Rail)
Average trip length	~6.5 miles	Ranges from 7.6 miles (Metrorail) to 28.7 miles (Tri-rail)
Dominant trip purpose(s)	No dominant trip purpose	Work

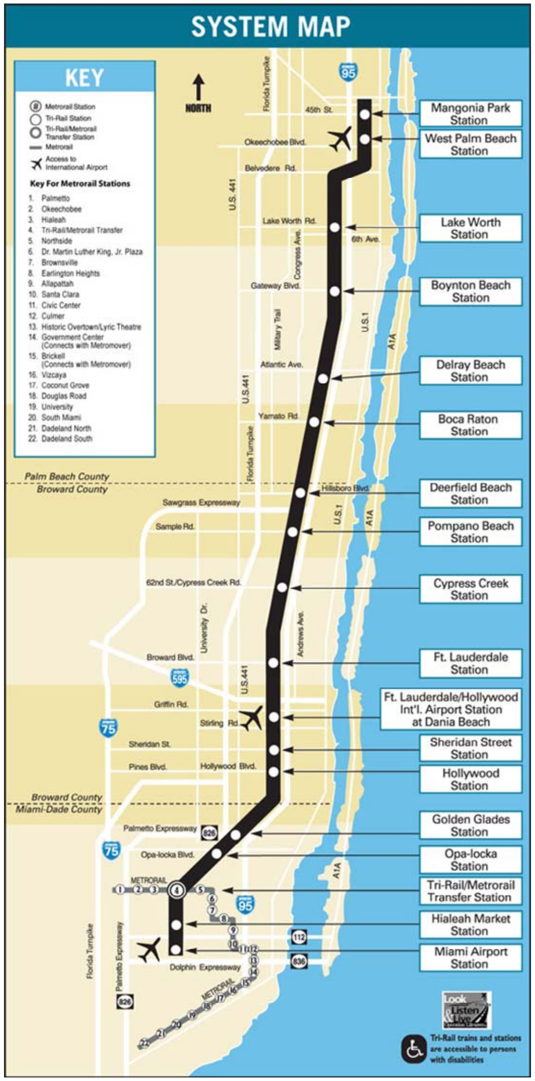
Key Survey Findings – Overview

- While work trips from car-owning households comprise the commuter market, the market itself consists of three distinct sub-markets:
  1. Traditional commuter market utilizing urban rail to distribute Miami-Dade workers to jobs in and around the Miami CBD
  2. Second traditional commuter market utilizing express bus service to connect Broward County workers to jobs in and around the Miami CBD
  3. Non-traditional inter-county market utilizing commuter rail to connect workers with jobs throughout the 3-county region, with these trips beginning and ending in different counties with no dominant destination

Summary of Differences among Commuter Sub-Markets

Trip Characteristic	Traditional Commuter #1 Miami-Dade County to Miami CBD	Traditional Commuter #2 Broward County to Miami CBD	Non-Traditional Commuter Inter-County Movements
Dominant origin/ production	Miami-Dade County	Broward County	No dominant origin/production
Dominant destination/ attraction	Miami CBD and surrounding area		No dominant destination/attraction
Primary access mode(s)	57% walk, 43% auto	~75% auto, ~25% walk	
Average trip length	7.6 miles	Ranges from 12-20 miles depending on route	28.7 miles
Primary egress mode(s)	Walk		77% walk, 23% auto

Tri-Rail Overview



- 72-mile commuter rail system
- 18 stations across 3 counties
- 1:45 traveling time
- 50 trains/day service
- 13,500 daily riders
  (12,200 in 2010)
- Not easily accessible to any major attraction by walking

- Survey conducted in October 2008
- Counts collected Oct/Nov 2008

Tri-Rail
Key Ridership Patterns/Findings (1 of 2)

- **Tri-Rail is used for long, inter-county trips by choice riders accessing by auto**
  - 80% of non-school/college trips travel between stations in different counties
  - 87% of all trips travel more than 2 stations (at least ~8 miles)
  - Mean travel distance on Tri-Rail: 30 miles for non-school/college trips and 23 miles for school/college (28.7 miles overall)
  - 95% of riders are from 1- or 2+-car households
  - 70% auto-access (all trips)

- **Riders have very dispersed travel patterns, even for work trips**
  - No station produces more than 8% of all trips
  - Only 2 attraction stations receive over 10% of trips
  - Metrorail station – 17%, Boca Raton – 11%, All other stations <=9%
  - NB/SB travel direction evenly split
  - 54% southbound with college/school trips
  - 58% southbound without college/school trips
  - 23% of park-ride trips transfer to Metrorail via Metrorail Transfer station (with the Miami CBD as a likely final destination)

Tri-Rail
Key Ridership Patterns/Findings (2 of 2)

- **Most riders (73%) access and egress Tri-Rail through non-walk modes**
  - 79% of all trips require a non-walk mode to reach their final destination
- **Tri-Rail is used primarily for work trips, with higher non-work usage than traditional commuter rail systems**
  - 66% work trips
  - 18% trips are college- or school-related
  - 12% home-based non-work; 4% non-home-based
- **Major markets are strongly peaked and access Tri-Rail by auto, other markets occur mostly in off-peak**
  - Work, school and college trips (85% of total) have 70%/30% peak/off-peak split
  - All other trips, HBNW and NHB (15% of total) have 40%/60% peak/off-peak split

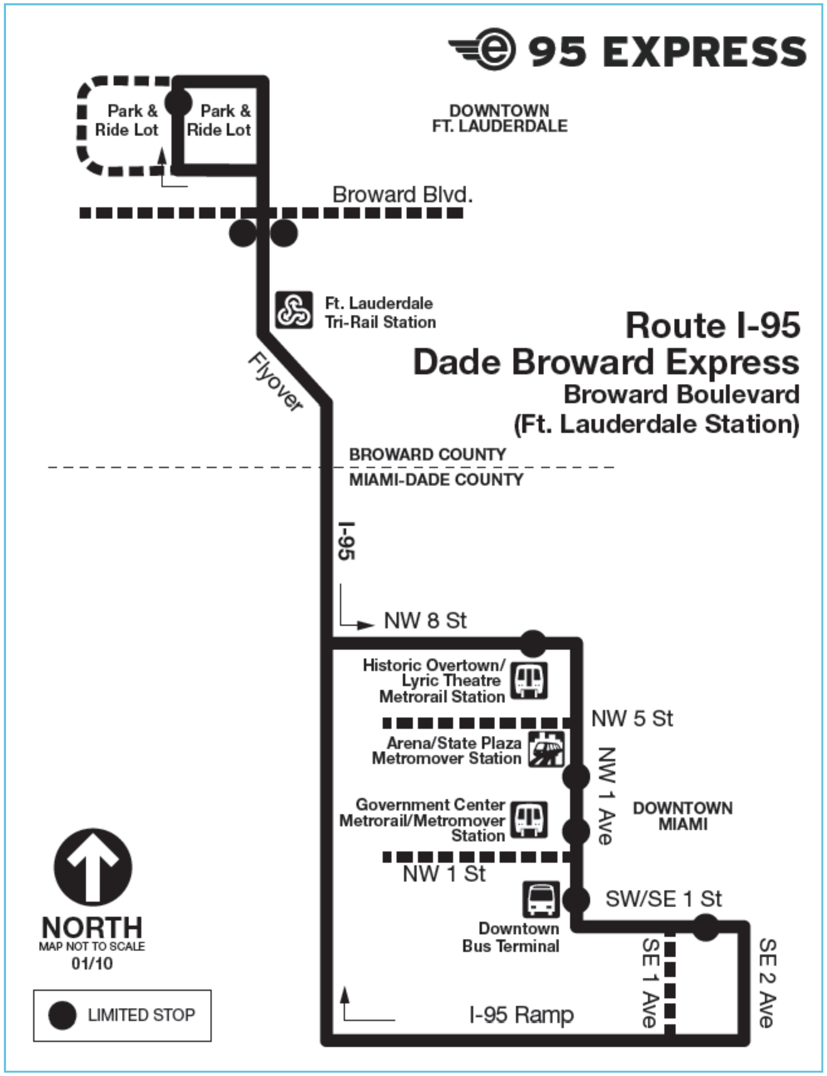
Metrorail Overview

- 22.5 miles within Miami-Dade County
- 22 stations
- 10-min pk/15-min op service
- 63,000 boardings/weekday (58,908 during survey)
- 5 "core" stations serving downtown Miami and adjacent activity centers
- Survey conducted Spring 2009
- Station-to-station flows from Fall 2009

Metrorail
Key Ridership Patterns/Findings

- **Metrorail is primarily used by choice riders traveling to/from the Miami core, which has connections to other transit services and a high concentration of jobs**
  - 76% work trips to/from core
  - 66% non-work trips to/from core
  - 81% of riders are from 1- or 2+-car households
  - 92% of work park-ride trips to/from core
- **Metrorail is used more south of the core than north of the core**
  - 67% of all trips use one station south of the core
  - 50% of all work trips are between the core and the stations south of the core
  - The 3 southernmost stations produce 37% of all trips and 46% of work trips

I-95 Express Bus Overview



<u>95 Express (95E)</u>

- 4 limited-stop bus routes between Broward County and downtown Miami
  - Broward Boulevard
  - Sheridan Street
  - Pembrooke Pines
  - Miramar (initiated January 2011)
- 15-30 min service during peak periods, provided by both BCT and MDT
- ~1,100 daily boardings

<u>95X</u>

- 2 routes between Golden Glades and downtown Miami/Earlington Heights
- <15-min combined headways during peak periods provided by MDT
- ~1,900 daily boardings

Survey conducted May 2010

I-95 Express Bus
Key Ridership Patterns/Findings

- **Both I-95 Express and 95X services are used largely by choice riders accessing by car**
  - <5% riders are from zero-car households
  - 70+% have car available for trip
  - 74-77% access by auto (either PNR or KNR)

- **I-95 Express riders make more extensive use of Metrorail, Metromover & other bus services when they egress in downtown Miami than 95X riders, even though both sets of riders are destined for the same location**
  - 35% of I-95 Express riders egress by Metrorail (18%), Metromover (12%) and bus (5%)
  - 11% of 95X riders egress by Metrorail (2%), Metromover (2%) and bus (7%)

- **52% of I-95 Express riders previously used other transit services, compared to 15% of 95X riders**

- **Overall, I-95 Express and 95X riders have similar characteristics**

BCT, Palm Tran and MDT Overview

Broward County Transit (BCT)

- 40 routes servicing Broward County
- ~120,000 daily boardings in 2010
- Survey conducted in March-May 2010

Palm Tran

- 35 routes servicing Palm Beach County
- ~34,000 boardings in 2010
- Survey conducted in February-March 2010

Miami-Dade Transit

- 88 routes servicing Miami-Dade County
- ~217,000 boardings in 2010
- Survey conducted in March-June, 2004

Broward County Transit
Key Ridership Patterns/Findings

- **Local bus riders are mobility dependent**
  - Heavily walk-dependent for access/egress (~90% for both access and egress)
  - High transfer rate (59%) reflecting BCT's grid system
  - 49% of riders are from 0-car households; 71% either are from 0-car households or do not have a valid driver's license
- **Dispersed travel patterns, with Ft. Lauderdale CBD attracting <10% trips**
  - Limited-stop bus riders are slightly less dependent for mobility, are more work-oriented & travel longer distances
  - 5-30% fewer riders from 0-car households; 8-30% more riders from household with cars
  - 60-70% work trips (cf. 46-50% for underlying local bus)
  - Travel 30-50% longer than riders on underlying local bus service

Palm Tran
Key Ridership Patterns/Findings

- **Palm Tran bus riders are mobility dependent**
  - 45% of riders are from 0-car households; 70% either are from 0-car households or do not have a valid driver's license
  - Heavily walk-dependent for access/egress (Over 90% for both access/ egress)
  - 32% transfer rate seems low but is consistent with Palm Tran staff supposition
- **Dispersed travel patterns, with most trips occurring between West Palm Beach and Delray Beach (east central Palm Beach County)**
  - ~80% of productions and attractions in this area
  - Only 3% of trips travel to West Palm Beach CBD

Metrobus
Key Ridership Patterns/Findings

- **Survey questionnaire provides limited information, so definitive conclusions are challenging**
  - Limited address information
  - No route listing of entire trip
  - No time-of-day information available on survey records
- **Results show that Metrobus riders generally appear to be similar to BCT and Palm Tran riders but with a higher participation of "choice" riders**
  - Walk is dominant access modes
  - Dispersed travel patterns
- **Survey not able to be used for model calibration/validation → used estimated trips from SERPM 6.5 where necessary**

Survey Findings – Summary

- **Strong differences in ridership patterns between “local” and “premium” transit riders**
  - Local transit riders have dispersed travel patterns, high level of mobility dependents
  - Metrorail and express bus riders have work travel patterns oriented towards downtown Miami
  - Tri-Rail riders have characteristics similar to Metrorail and express bus riders with destinations to downtown Miami and suburban employment centers
- **Further analysis indicated minute competition among transit modes, even rail transit modes**
  - 0.3% of unique zonal interchanges have viable competitive option (18k)
  - 0.6% of linked survey trips have viable option (182k)
  - Metrorail and Tri-Rail are used together more often than they are in direct competition

Transit Model Development Activities and Results

Major Model Development Activities

- Transition to 2010 base year
- Distribution refinements
- Path and mode choice structure
- Mode choice coefficients and constants

- *Many other changes and updates have been made, but are not discussed in this presentation*

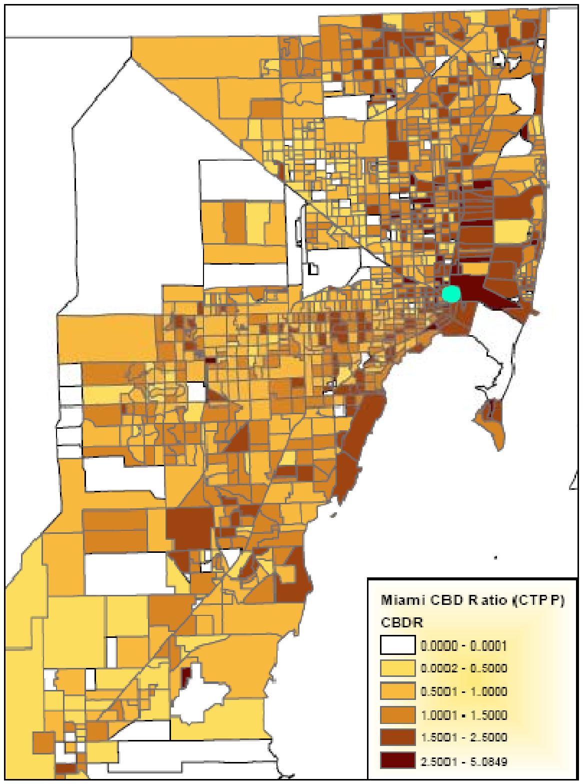
Transition to 2010 Base Year

Model Component	Development Process
Population	Interpolated 2005 and 2035 values and scaled to 2010 Census counts for each county
Employment	Interpolated 2005 and 2035 values and scaled to 2009 BEBR control totals for each county
External trips	Interpolated 2005 and 2035 values
Airport trips	Scaled to enplanement figures
Highway and transit networks	Updated to 2010 conditions
Parking costs	Updated based on 2008 regional parking survey

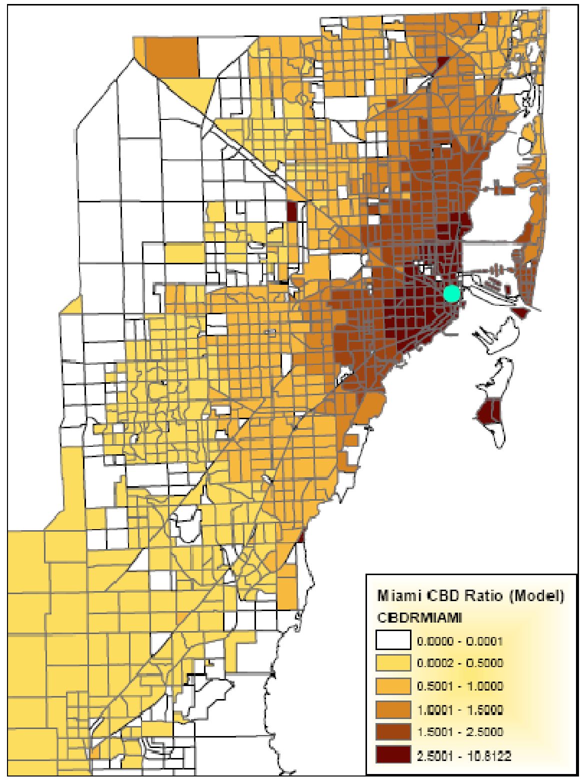
Distribution Refinements

- Work trip purposes
  - Model's estimates of HBW P's and A's fratared using CTPP journey-to-work data as seed table; this is performed separately for 0-car and 1+-car households
  - Zones with very high growth uses distribution patterns from a nearby similar zone (similarity defined in terms of land use)
- Non-work trip purposes
  - Peak period distribution is based on 6-iteration feedback process (2 iteration feedback in SERPM 6.5)
  - Off-peak period distribution is based on a 2-iteration feedback process (rather than free-flow speeds in prior SERPM versions)

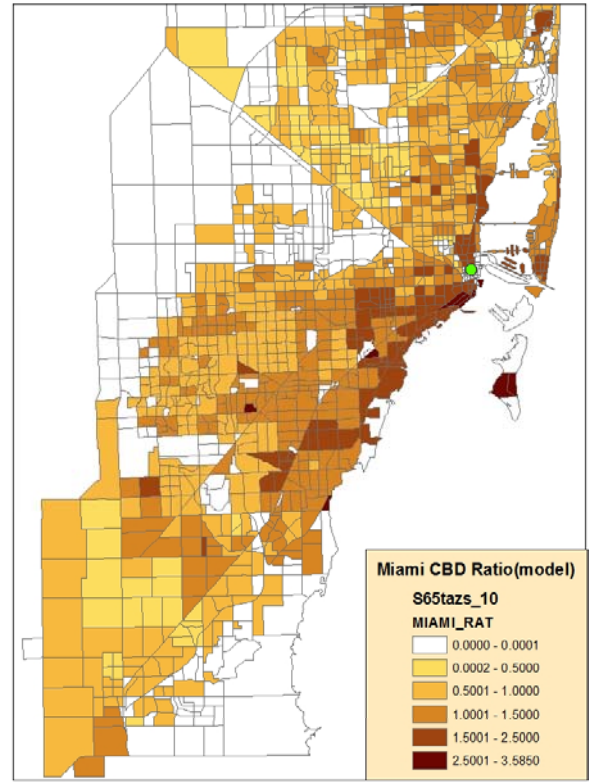
Using CTPP Journeys for Work Distribution
Results – Journeys to downtown Miami



CTPP



SERPM 6.5



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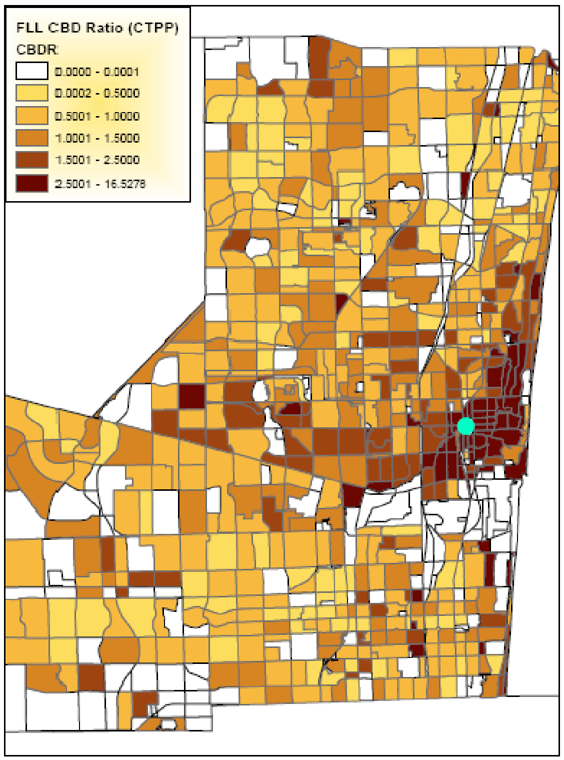
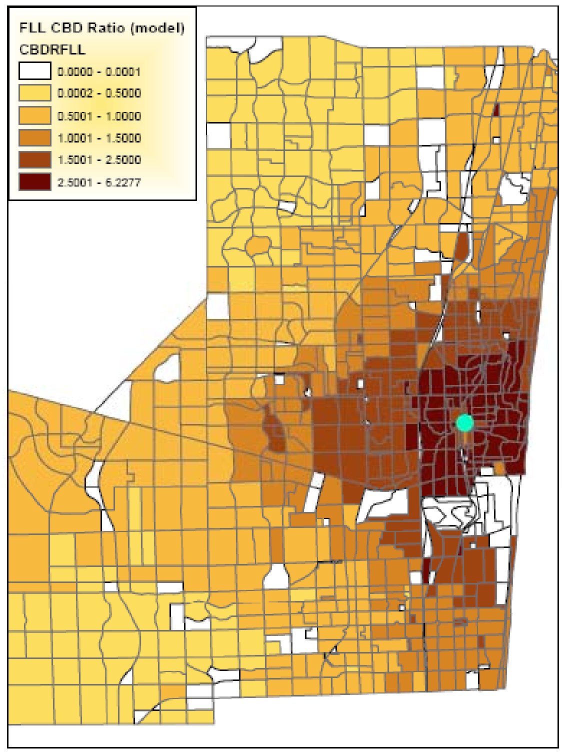
Using CTPP Journeys for Work Distribution
Results – Journeys to downtown Ft. Lauderdale



CTPP



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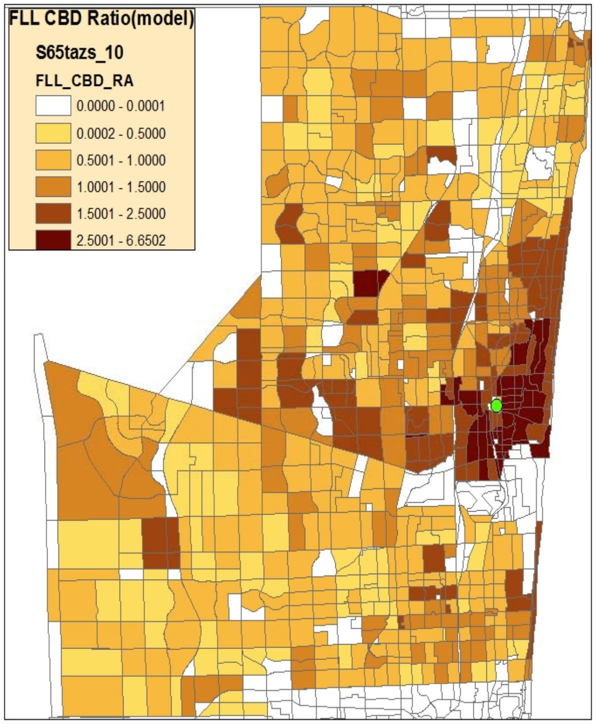

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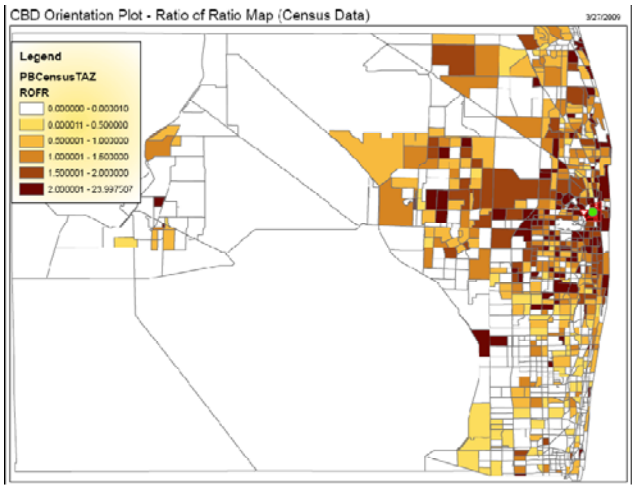
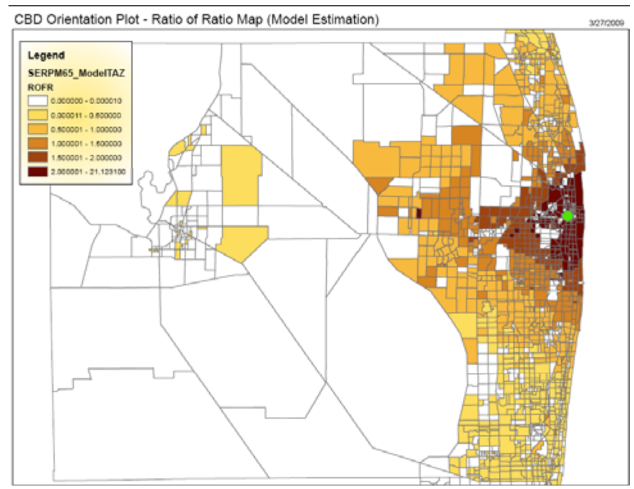
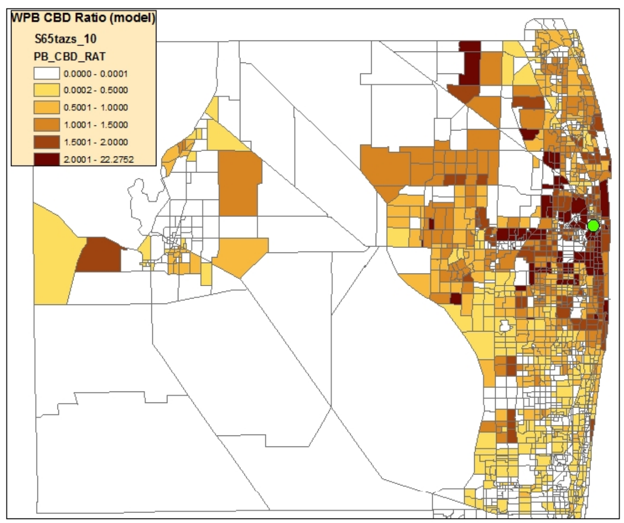
Using CTPP Journeys for Work Distribution
Results – Journeys to downtown West Palm Beach



CTPP



SERPM 6.5



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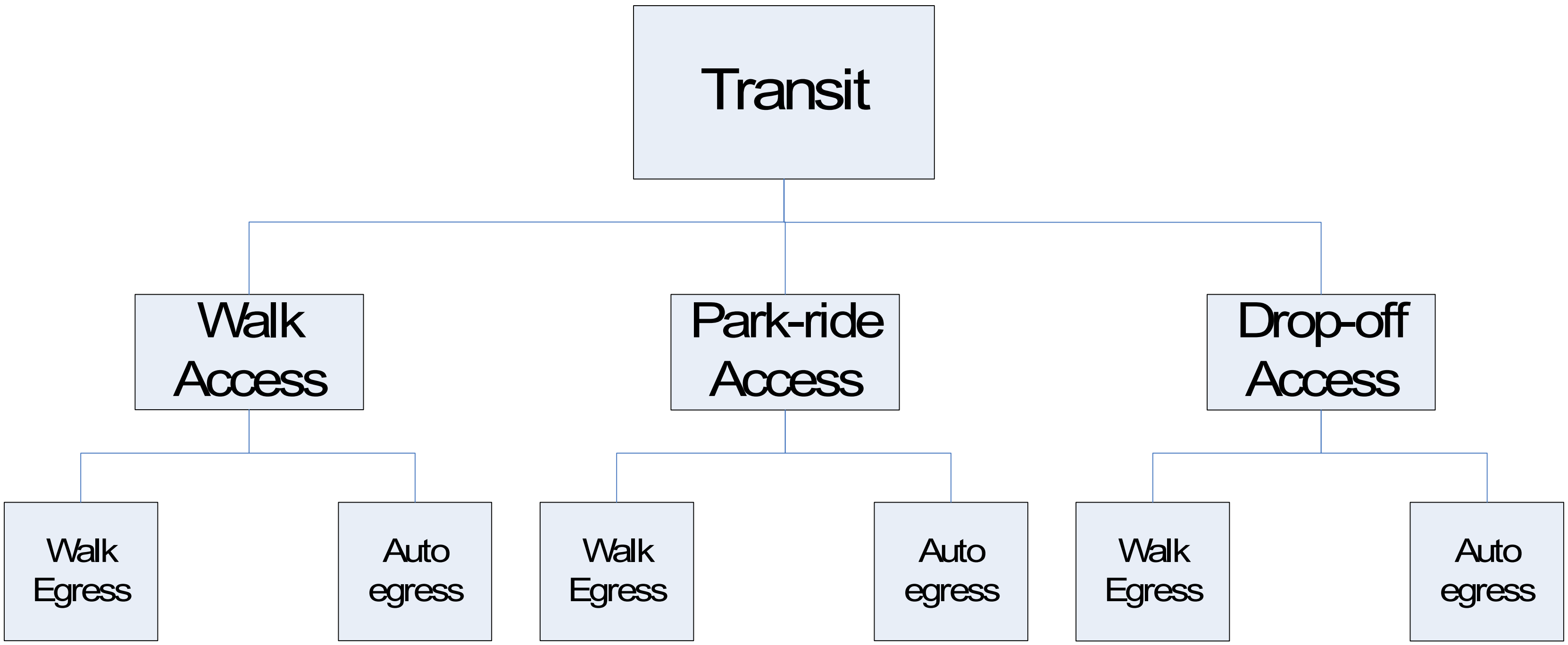
Path Structure

- Survey results indicated that there is minimal competition between rail modes and, in fact, rail modes are used in combination more than in competition → new path structure needed to reflect this observation
- Applied innovative method to develop and validate new path/mode choice structure
  1. Performing a preliminary check on observed line-haul path competition (via the surveys),
  2. Proposing the simplest structure based on the line-haul path competition check,
  3. Assigning of the survey trips to the network using the proposed structure,
  4. Reporting the path/boarding results and comparing them to observed values,
  5. Making refinements to the structure and travel component weights to improve path/boarding results,
  6. Repeating steps 3-5 until assigned trips match generally survey results, and
  7. Transferring structure and weights directly to mode choice and begin calibrating/validating mode choice model.

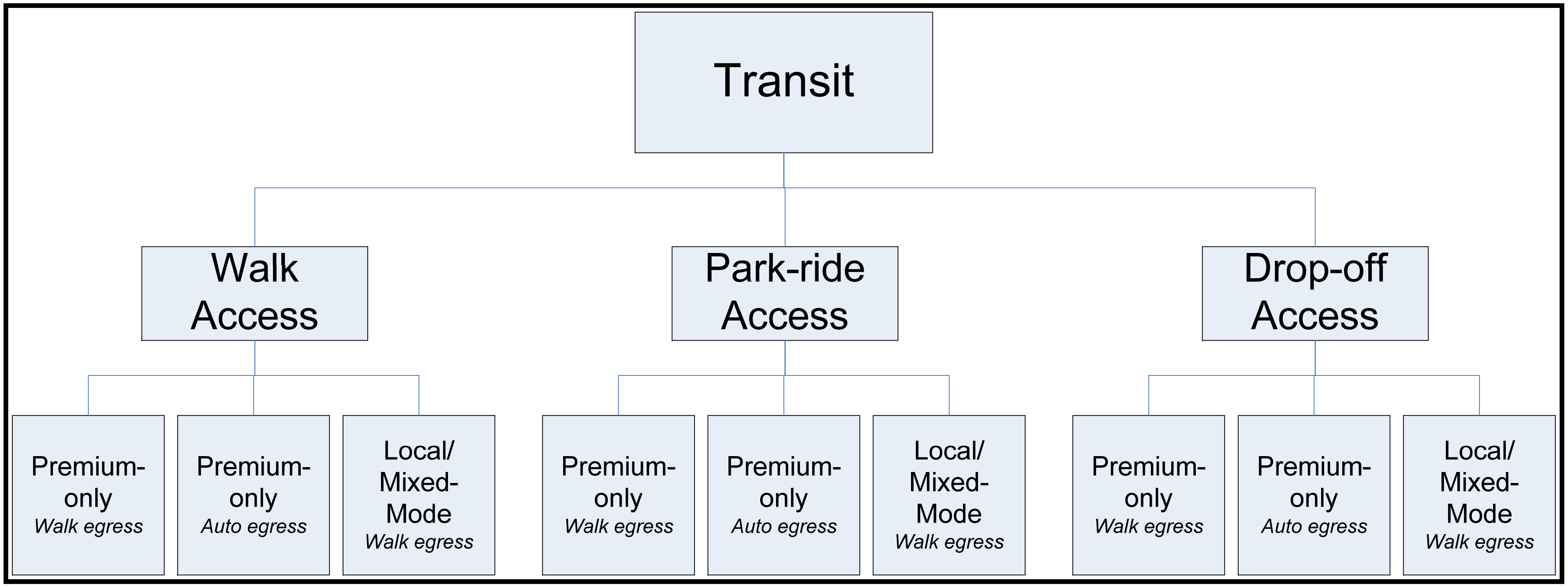
Initial Path/Mode Choice Structure (6-path)



Evaluating the Structure

- Two key metrics used to evaluate new path structure
  - Line-haul path accuracy – if survey trip were to use modeled path, does model correctly pick the surveyed line-haul mode?
  - Transfer/assignment accuracy – when survey trips are assigned to network, do the aggregate number of boardings match observed values?
- Initial results for the 6-path structure were acceptable, but in some cases the model tended to favor local bus paths over the premium transit survey path ← long access times
- Proposed 9-path structure to account for differences between paths using both local and premium transit and premium-only paths

Proposed Path/Mode Choice Structure (9-path)



- Premium services – not generally subject to auto signals and/or traffic delays (95 Express, 95X, Metrorail, Tri-Rail)
- Local services – generally subject to auto signals and/or traffic delays (Metrobus, BCT, Palm Tran)
- Mixed-mode – path utilizing both local and premium services

Path Structure Evaluation (Validation) Tests

	Observed Boardings	"6-path" Accuracy		"9-path" Accuracy	
		Line-haul Path	Assignment	Line-haul Path	Assignment
Tri-Rail	15,155	76%	-10%	85%	5%
Metrorail	58,330	73%	-21%	83%	-9%
Palm Tran	33,806	97%	12%	98%	9%
BCT	119,721	98%	-5%	99%	-4%
Metrobus *	256,512	100%	-2%	100%	-9%
Tri-Rail Shuttle	1,636	n/a	121%	n/a	206%
Metromover	28,546	n/a	-55%	n/a	-51%
Total	513,706	93%	-7%	96%	-8%

- 9-path structure performs better overall, and is being used in SERPM 6.7

Mode Choice Coefficients / Constants

- Relative coefficients taken directly from travel component weights in path-builder

- Market segmentation switched to auto availability rather than auto ownership
  - CTPP data → large percentages of "zero-car" households driving to work
  - Identification that driver's license has huge impact on transit ridership, more so than auto ownership
  - Zero-car market fairly small in size

Mode Choice Coefficients

Actual Transit Path Building Weights (relative to IVTT coefficient)

Variable	Peak			Off-Peak		
	HBW	HBO	NHB	HBW	HBO	NHB
Transit run time, highway run time	1.00	1.00	1.00	1.00	1.00	1.00
Transit walk time, highway terminal time	2.00	2.00	2.00	2.00	2.00	2.00
Pre-weighted* transit auto access/egress time	1.00	1.00	1.00	1.00	1.00	1.00
Transit first wait (<=7 minutes)	2.00	2.00	2.00	2.00	2.00	2.00
Transit first wait (>7 minutes)	1.00	1.00	1.00	1.00	1.00	1.00
Transit transfer wait time	2.00	2.00	2.00	2.00	2.00	2.00
Transit number of transfers (Walk access)	5.00	5.00	5.00	5.00	5.00	5.00
Transit number of transfers (Park-ride access)	20.00	20.00	20.00	20.00	20.00	20.00
Transit number of transfers (Kiss-ride access)	10.00	10.00	10.00	10.00	10.00	10.00
Transit fare (Value of time in $/hr)	$ 8.13	$ 6.94	$ 7.49	$ 8.13	$ 6.94	$ 7.49
Highway auto operating costs (Value of time in $/hr)	$ 8.13	$ 6.94	$ 7.49	$ 8.13	$ 6.94	$ 7.49
Highway parking costs (Value of time in $/hr)	$ 8.13	$ 6.94	$ 7.49	$ 8.13	$ 6.94	$ 7.49
HOV time difference	0.72	1.00	1.00	0.90	1.00	1.00

Variables not used in transit path building process but used in mode choice utility calculations

Other Major Model Development Activities (Not Presented Here)

- Travel generation is now balanced by auto availability category:
  1. 0-car
  2. Cars < Workers (People)
  3. Cars >= Workers (People)
- Non-work distribution is stratified by auto availability market segments
- Non-work zero-car HH travel distribution is now based on auto impedances rather than transit impedances.
- Transit mode and operator numbers have been revised to avoid awkward and potentially confusing modal definitions
- Transit fares have been revised to “best daily pass” rather than full cash fare
- Both the highway and transit networks have been updated to a 2010 base year
- The parking costs have been updated to reflect the values proposed by recent CS report
- Pathbuilding and assignment processes now performed in PT (rather than TRNBUILD)
- Incorporated fare into pathbuilding weights
- Transit access and egress connectors have been simplified to avoid cliffs
- Percent walk procedures have been removed to take advantage of the relatively small zones in SERPM
- Mode choice is now stratified by auto availability segment

Transit Model Calibration and Validation

SERPM 6.0-6.6 Transit Model Shortcomings

- Limited transit survey data available during model development
  - Limited knowledge on transit → insufficient model calibration/validation
- "Over-specified" mode choice model
  - Alternate-specific constants were much larger (~20-70 min) than FTA allows
  - Model relied too heavily on constants and layers of constants, rather than on behavior
  - Large constants overwhelm transit variables may result in illogical results
- Bus speed methodology does not easily provide for high accuracy of regional bus speeds
  - Accurate bus speeds are needed to accurate reflect project benefits
  - Easier system needed for improved maintenance and accuracy
- Existing model calibration/validation <u>not sufficiently rigorous</u> for FTA New/Small Starts planning
  - Used traditional model calibration → adjusting constant to match linked trip totals
  - Used traditional model validation → matching aggregate boardings

Key Calibration/Validation Issue

- Previous attempts at mode choice calibration and transit validation replicated the appropriate numbers, but the model did not capture transit ridership patterns and did not properly react to changes

Solution for SERPM 6.7:
A More Robust Calibration/Validation Process

- Ensure that the key behaviors are right:
  - Mode usage by access mode, time of day, market segment
  - Transit travel patterns by mode (O/D or station-to-station) by access mode, time of day, market segment
  - Transit trip lengths
  - Rail/bus vs. rail-only (or bus-only)
  - Boardings
  - Tri-Rail sensitivity to recent fuel and service changes
- Simplify path/mode choice model to the extent possible
- Review/address expanded range of model attributes
- Analyze model's sensitivity of Tri-Rail boardings to key transportation variables

Solution for SERPM 6.7:
A More Robust Calibration/Validation Process

- Review/address expanded range of model attributes
  - Work trip distribution (already done via CTPP-based distribution)
  - Auto speeds (AM peak, midday)
  - Transit speeds (AM peak, midday)
  - Transit trips by mode, O/D or S2S, access mode, trip purpose and time of day
  - Transit boardings by mode and route/station

- Analyze model's sensitivity of Tri-Rail boardings to key transportation variables
  - Introduction of I-95E inter-county bus service
  - Tri-Rail and Tri-Rail shuttle service changes
  - Higher fuel prices

Auto & Transit Speeds

- Auto speeds: Improved relationship between volumes and speeds and improved consistency between free-flow and congested speeds
  - Removed free-flow speed adjustment factors
  - Introduced 2-iteration feedback loop for off-peak speeds
- Bus speeds: functions now based on auto speed and dwell time per transit stop → estimated speeds <u>much</u> improved
  - Local bus dwell times 0.46-0.70 min/stop
  - Limited-stop and express bus dwell times 1.20 min/stop

Auto Speed Results
Off-Peak Period

			SERPM 6.5			SERPM 6.7		
County	Posted Speed	Observed Speed	Estimated	Avg. Diff	Avg. Abs Diff	Estimated	Avg. Diff	Avg. Abs Diff
INTERSTATES/FREEWAYS								
Miami-Dade	55.0	60.9	50.7	-10.2	11.0	50.9	-10.0	11.3
Broward	65.0	62.2	60.3	-1.8	2.8	62.5	0.3	4.9
Palm Beach	65.0	-	59.5	-	-	57.1	-	-
Regionwide	**63.0**	**61.9**	**57.8**	**-4.1**	**4.4**	**58.3**	**-3.6**	**6.2**
ARTERIALS								
Miami-Dade	43.0	26.2	35.9	9.9	9.0	31.2	5.0	5.2
Broward	44.0	26.2	37.6	11.4	11.1	34.8	8.6	8.4
Palm Beach	43.0	29.0	37.9	8.5	8.5	36.5	7.5	6.9
Regionwide	**44.0**	**26.8**	**37.1**	**10.3**	**9.8**	**33.9**	**7.1**	**7.0**

			Off-peak Period Auto Speeds (mph)					
			Northbound/Eastbound			Southbound/Westbound		
County	Roadway	Corridor	Observed	SERPM 6.5	SERPM 6.7	Observed	SERPM 6.5	SERPM 6.7
Miami-Dade	I-95 GP	FEC	60.9	50.4	49.6	60.9	50.5	49.8
	I-95 ML	FEC	-	51.3	58.3	-	51.7	57.7
	US-1	FEC	23.2	31.6	26.9	22.3	31.7	26.0
Broward	I-95 GP	FEC	63.4	58.7	59.7	61.8	59.0	58.4
	I-95 HOV	FEC	-	60.7	63.9	-	60.5	64.1
	I-595	EW	62.1	62.1	58.2	67.0	58.3	60.5
	US-1	FEC	25.3	33.2	31.6	27.3	33.1	30.8
	Dixie Hwy	FEC	22.1	34.1	32.1	22.3	34.2	32.0
	Oakland Park	EW	25.2	39.0	35.6	26.7	39.1	35.9
	Sunrise Blvd	EW	29.4	39.7	37.5	22.2	39.7	37.5
Palm Beach	I-95 GP	FEC	-	58.7	56.9	-	58.2	56.4
	I-95 HOV	FEC	-	60.9	58.5	-	60.2	56.9
	US-1	FEC	31.3	37.6	36.2	29.2	37.6	36.1
	Old Dixie	FEC	39.4	39.3	38.4	39.1	40.2	39.2

Speeds improved in SERPM 6.7

Speeds better in SERPM 6.5

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Auto Speed Results Peak Period

			SERPM 6.5			SERPM 6.7		
County	Posted Speed	Observed Speed	Estimated	Avg. Diff	Avg. Abs Diff	Estimated	Avg. Diff	Avg. Abs Diff
INTERSTATES/FREEWAYS								
Miami-Dade	55.0	36.4/39.5	40.7	4.2	12.0	40.9	1.4	10.4
Broward	65.0	55.7	49.4	-6.3	7.9	57.5	1.8	9.0
Palm Beach	65.0	65.0	48.6	-16.4	16.3	47.6	-17.4	14.4
Regionwide	**63.0**	**51.0**	**47.0**	**-4.0**	**11.0**	**50.5**	**-3.5**	**10.7**
ARTERIALS								
Miami-Dade	43.0	21.8	24.7	2.9	6.1	25.1	3.2	4.7
Broward	44.0	23.9	32.3	8.4	8.4	31.9	8.0	8.0
Palm Beach	43.0	30.4	37.0	6.6	6.0	36.9	6.5	6.2
Regionwide	**44.0**	**24.4**	**30.2**	**5.8**	**7.1**	**30.3**	**5.8**	**6.5**

			Peak Period Auto Speeds (mph)					
			Northbound/Eastbound			Southbound/Westbound		
County	**Roadway**	**Corridor**	**Observed**	**SERPM 6.5**	**SERPM 6.7**	**Observed**	**SERPM 6.5**	**SERPM 6.7**
Miami-Dade	I-95 GP	FEC	62.7	46.2	48.8	28.9	34.7	31.9
	I-95 ML	FEC	-	49.0	58.3	62.0	42.7	56.6
	US-1	FEC	21.1	20.1	19.4	19.8	24.0	26.2
Broward	I-95 GP	FEC	53.4	45.9	52.0	57.9	49.0	49.5
	I-95 HOV	FEC	59.9	55.4	66.6	67.5	55.4	60.5
	I-595	EW	37.6	40.3	40.8	61.1	55.9	63.7
	US-1	FEC	25.1	26.6	27.0	24.6	29.9	30.4
	Dixie Hwy	FEC	21.7	32.4	32.0	19.7	30.4	27.6
	Oakland Park	EW	21.7	29.1	29.0	26.1	36.9	36.3
	Sunrise Blvd	EW	19.8	31.8	31.8	26.8	37.8	37.1
Palm Beach	I-95 GP	FEC	65.2	47.7	60.1	61.4	44.6	35.9
	I-95 HOV	FEC	66.9	53.0	67.4	66.8	49.8	40.5
	US-1	FEC	30.3	34.9	35.9	30.4	35.8	33.6
	Old Dixie	FEC	39.8	38.6	38.4	35.0	38.2	38.2

Speeds improved in SERPM 6.7

Speeds better in SERPM 6.5

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Transit Speed Results

AM Peak Period	SERPM 6.5		SERPM 6.7	
	% Avg. Difference	% RMSE	% Avg. Difference	% RMSE
Palm Tran Routes	23%	54%	2%	12%
BCT Routes	0%	16%	1%	10%
MDT Routes	9%	28%	4%	15%

Off-Peak Period	SERPM 6.5		SERPM 6.7	
	% Avg. Difference	% RMSE	% Avg. Difference	% RMSE
Palm Tran Routes	11%	43%	0%	13%
BCT Routes	-5%	20%	0%	11%
MDT Routes	-13%	30%	-3%	16%

Mode Choice Calibration Process

- 3-step innovative calibration process
  1. Compare modeled transit trip tables to survey trip tables by line-haul path, access and egress mode, O/D district and time period
  2. Resolve significant differences by making mode-neutral adjustments to the utility equations that are directly tied to a proposed behavior
  3. Repeat steps 1-2 until there are no significant differences by the four trip dimensions

Behavioral Enhancements (1 of 2)

Observed Behavior	Original Issue	Solution
Transit is a competitive modal option for longer distance work trips, especially Tri-Rail	Model originally under-stated transit attract-iveness for long trips	Weight auto time in excess of 45 minutes by OVT coefficient; Discount Metrorail (15%) and Tri-Rail (20%) IVTT in path/mode choice
Park-riders do not use premium transit for short trips	Model originally produced large amounts of short Tri-Rail trips	Add time penalty for very short premium transit trips

Behavioral Enhancements (2 of 2)

Observed Behavior	Original Issue	Solution
Transit is more accessible in higher-density areas with easier walk environments	Model originally did not adequately reflect differences in walk-accessibility	Add time penalty for lower-density zones
Transit riders do take fare into account in their path/modal decision	Mode choice accounted for transit fare, but the pathbuilder did not	Incorporate fares in transit pathbuilder

Alternative-Specific Constants

Observed Behavior	Original Issue	Solution
Riders do take modal characteristics into account in their path/modal decision	Earlier SERPM versions had ASCs as high as 70 IVTT minutes (FTA normally accepts 10-15 minutes)	Metrorail = up to 10 min Tri-Rail = up to 15 min BRT systems with advanced attributes = up to 7 min

- In the utility expression, constants represent the cumulative effects of un-included (or non-quantitative) attributes:

$$Y = k + ax_1 + bx_2 + cx_3$$

where Y is the utility of some transit mode, k is the constant; x_1, x_2, x_3 are times, costs, and other measure attributes, and a, b, and c are the coefficients

Transit Path Consistency Check

	Observed Transit Trips			Estimated Transit Trips		
	Bus only	Rail/Bus	Rail only	Bus only	Rail/Bus	Rail only
Tri-Rail	0%	24%	76%	0%	20%	80%
Metrorail	0%	48%	52%	0%	44%	56%
I-95 buses	84%	16%	0%	77%	23%	0%
Palm Tran	94%	6%	0%	98%	2%	0%
BCT	98%	2%	0%	98%	2%	0%
MDT	83%	17%	0%	84%	16%	0%

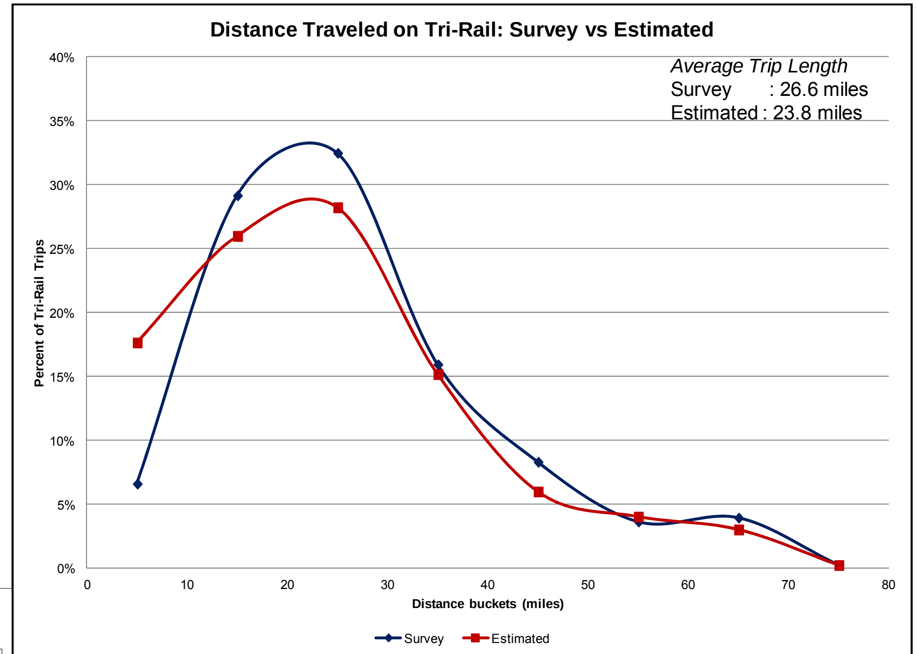
- Strong consistency in representation of transit paths by mode is important to ensure that the model fully reflects transit travel patterns
- These results show that SERPM 6.7 is replicating the observed transit modes used by riders

Tri-Rail Activity by Station
Average Daily Boardings

Station	Observed	Estimated	Difference
1-Mangonia Park	828	579	-248
2-West Palm Beach	895	921	26
3-Lake Worth	622	792	170
4-Boynton Beach	617	654	37
5-Delray Beach	462	625	163
6-Boca Raton	1,125	1,108	-17
7-Deerfield Beach	633	830	197
8-Pompano Beach	569	896	327
9-Cypress Creek	913	1,087	174
10-Fort Lauderdale	794	900	105
11-Fort Lauderdale Airport	647	748	101
12-Sheridan Street	593	493	-100
13-Hollywood	533	311	-222
14-Golden Glades	441	477	36
15-Opa-locka	195	448	253
16-Metrorail	1,362	1,229	-133
17-Hialeah Market	210	154	-56
18-Miami Airport	762	729	-33
Total	12,200	12,980	780

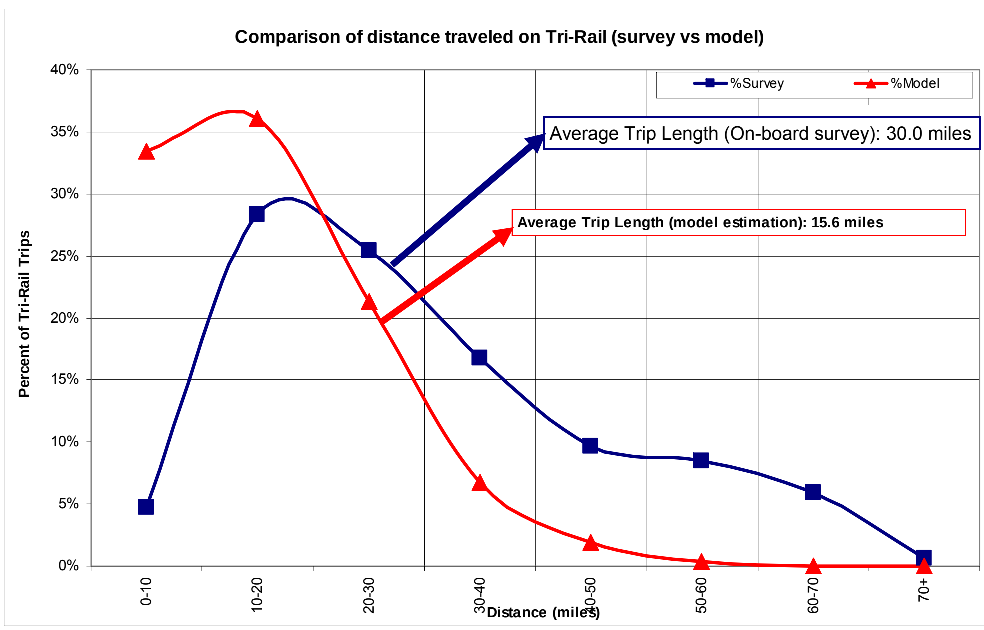
Tri-Rail Trip Length: Survey vs. Estimated

- Much improved representation of Tri-Rail trip lengths and station-to-station patterns!



SERPM 6.7

SERPM 6.5

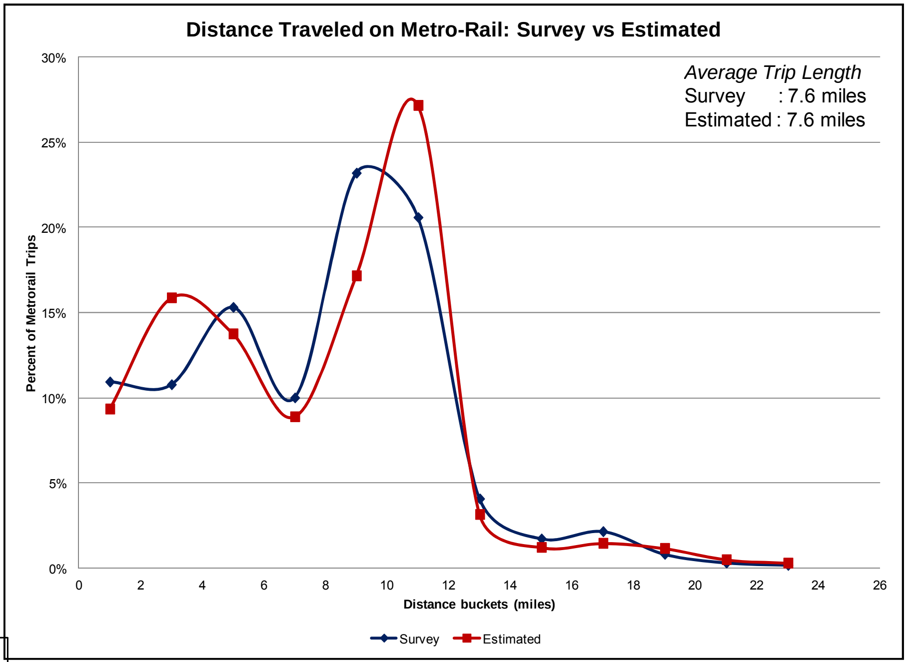


Metrorail Activity by Station
Average Daily Boardings

Station	Observed	Estimated	Difference
1-Palmetto	1,388	1,744	356
2-Okeechobee	1,128	1,239	112
3-Hialeah	1,375	1,047	-328
4-Tri-Rail	1,747	1,310	-437
5-Northside	1,783	815	-968
6-Dr.MLK Jr.	1,173	800	-373
7-Brownsville	878	516	-362
8-Earlington Heights	1,178	978	-200
9-Allapattah	1,265	1,336	72
10-Santa Clara	514	492	-22
11-Civic Center	7,024	6,612	-412
12-Culmer	938	657	-281
13-Overtown	1,385	2,020	635
14-Government Center	10,405	7,564	-2,841
15-Brickell	2,783	3,265	482
16-Vizcaya	1,077	695	-382
17-Coconut Grove	1,465	1,815	350
18-Douglas Road	3,348	2,804	-544
19-University	2,899	3,579	680
20-South Miami	2,956	2,059	-897
21-Dadeland North	5,117	5,664	547
22-Dadeland South	6,057	10,449	4,392
Total	57,884	57,463	-421

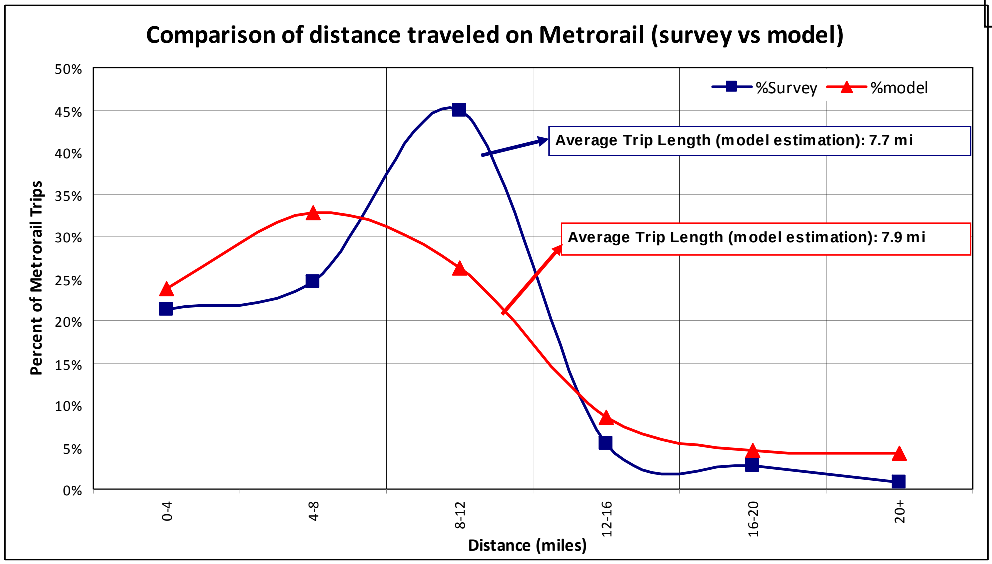
Metrorail trip length: Survey v/s Estimated

- Much improved representation of Metrorail trip lengths and station-to-station patterns!



SERPM 6.7

SERPM 6.5



I-95 Express Bus Boardings

- I-95X boardings

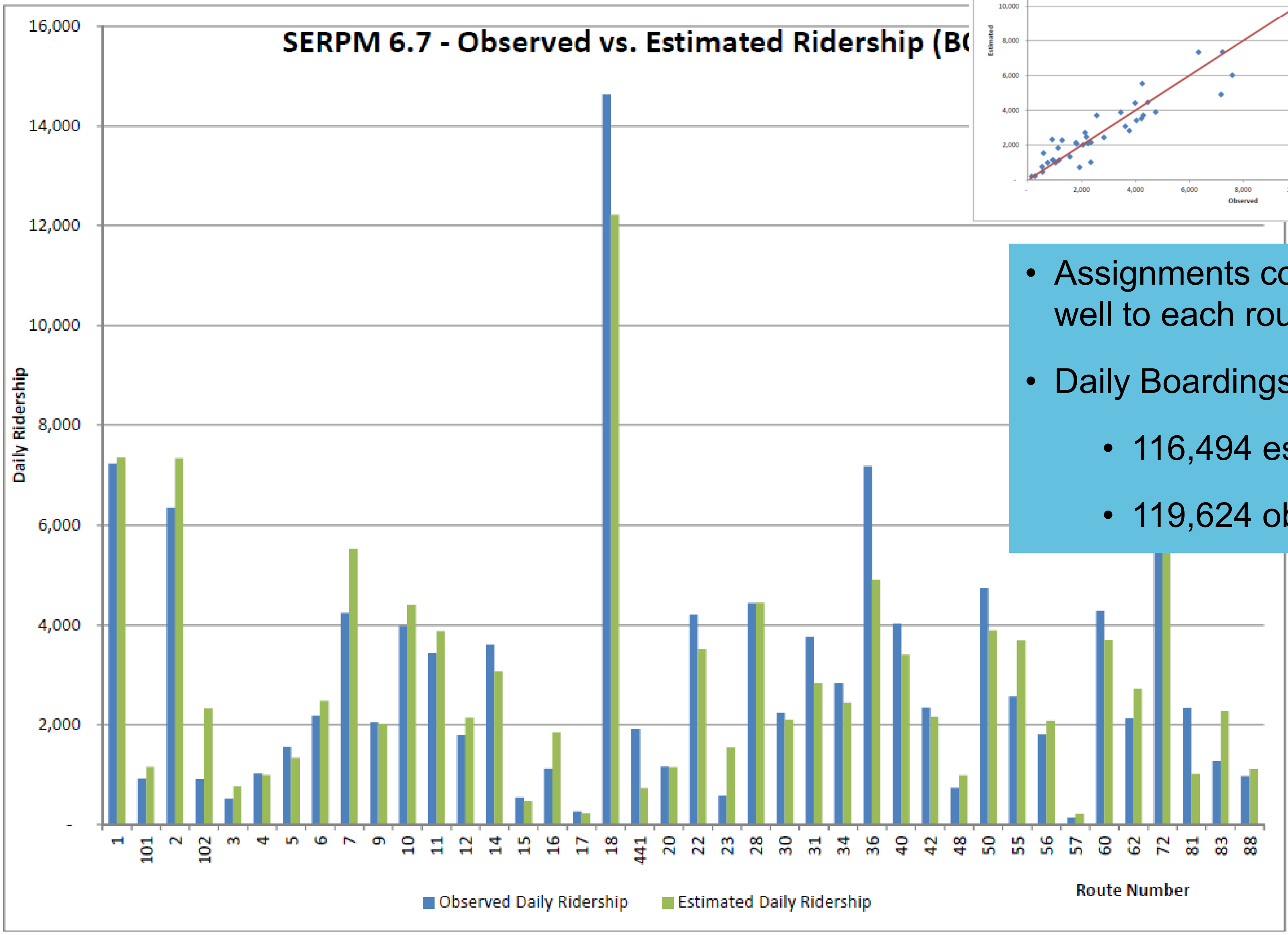
95X	Observed	Estimated	Difference
Biscayne Blvd.	1,078	2,043	965
Civic Center	471	1,021	550
Brickell	357	296	-61
Total	*1,906*	*3,360*	*1,454*

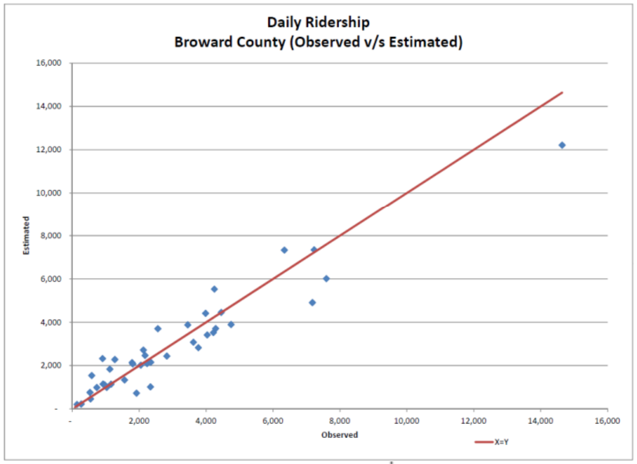
- I-95E boardings

95E	Observed	Estimated	Difference
Sheridan St.	377	517	140
Fort Lauderdale	470	853	383
Pines Blvd.	218	774	556
Total	*1,065*	*2,144*	*1,079*

- Express bus boardings are over-estimated, but well within reasonable aggregate limits

BCT Boardings





- Assignments compare well to each route
- Daily Boardings
  - 116,494 estimated
  - 119,624 observed

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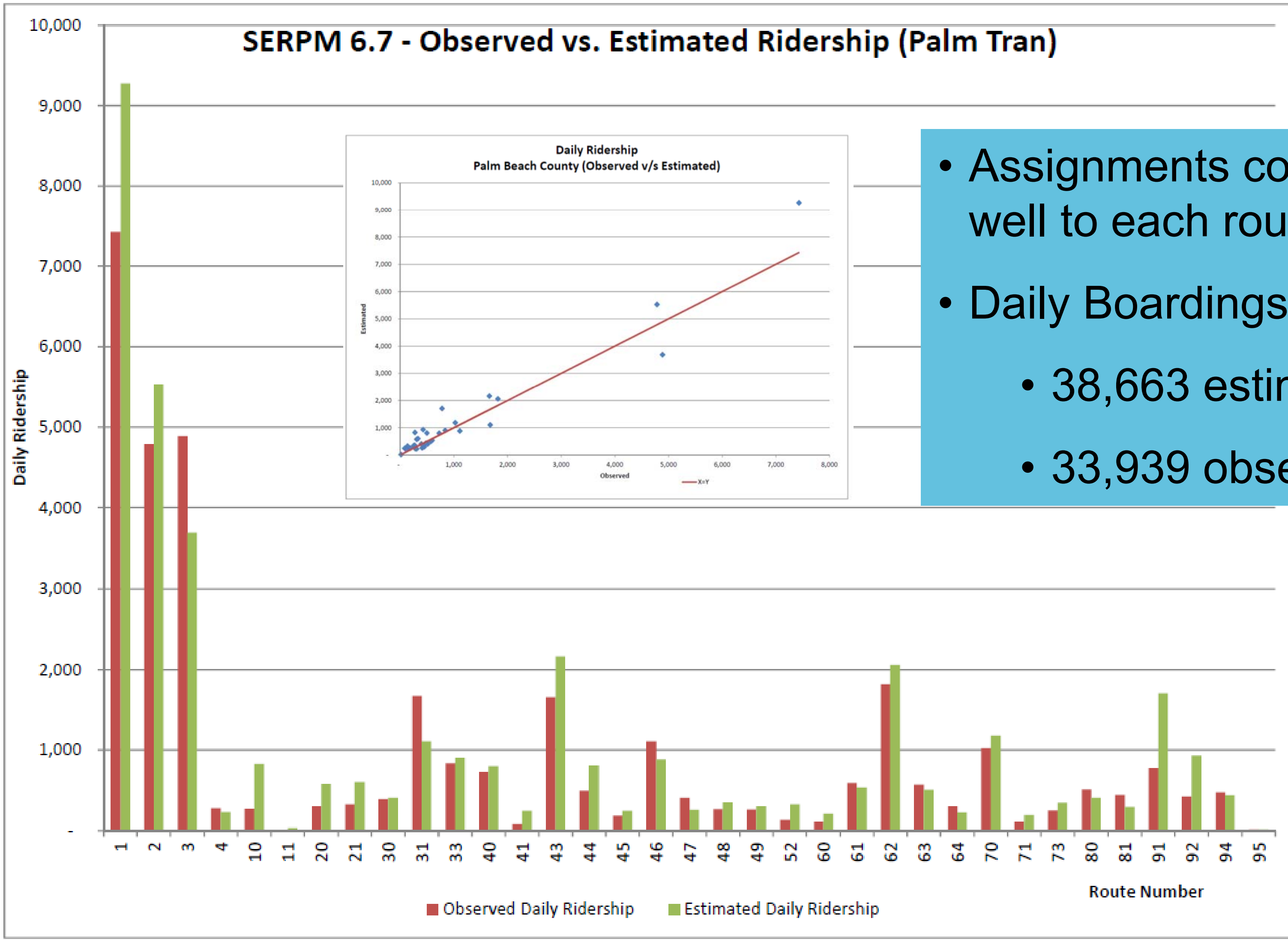
Palm Tran Boardings



- Assignments compare well to each route
- Daily Boardings
  - 38,663 estimated
  - 33,939 observed

Longitudinal Validation Tests

- Longitudinal tests are correlational comparisons across periods of time
- Powerful tests because they validate model's ability to forecast
  - Robust model validation → does model replicate existing patterns?
  - Longitudinal tests → does model correctly react to key variables?
- For SERPM 6.7, verify the model's sensitivity of Tri-Rail boardings to:
  - Introduction of 95E inter-county bus service
  - Higher fuel prices
  - Tri-Rail and Tri-Rail shuttle service changes

Longitudinal Validation Tests
Introduction of 95E Service

- Inter-county bus service introduced in early 2010 in conjunction with opening of 95 Express lanes
- Tri-Rail survey used for calibration conducted in 2008
- 95E bus surveys showed that <u>434</u> trips previously used "other transit" before switching to 95E service
- New transit model → introduction of 95E service decreases Tri-Rail boardings by <u>603</u> boardings per weekday
- <u>Conclusion</u>: model effectively replicates impact of 95E bus service on Tri-Rail ridership

Longitudinal Validation Tests
Higher Fuel Prices

- Fuel prices experienced strong increases in 2008, which impacted Tri-Rail ridership
  - March 2008 $3.34 monthly average
  - June 2008 *$4.16 monthly average*
  - June 2010 $2.72 monthly average
- Test: adjust auto operating cost to reflect higher fuel prices and assess impact on Tri-Rail ridership
  - Observed elasticities → +0.43-0.48
  - Estimated elasticities → +0.17-0.21
- Conclusion: model results are consistent with other research, observed elasticities heavily influenced by macroeconomic impacts

Longitudinal Validation Tests
Tri-Rail Service Changes

- Tri-Rail service increased from 32 trains/day in 2005 to 50 trains/day in 2010
- Tri-Rail shuttle service, which provides distribution service for Tri-Rail riders, increased nearly 300% in 2005-2010
- Test: compare impacts of service increases on Tri-Rail boardings
  - Observed elasticities → +0.61
  - Estimated elasticities → +0.57
- <u>Conclusion</u>: model effectively replicates ridership changes from service increases

Model Calibration / Validation Summary

- Performing a robust validation is <u>extremely</u> helpful in preparing model for forecasting!
- Model is validated across wide range of model attributes
  - Work trip distribution
  - Auto and transit speeds
  - Transit trips by mode, O/D or S2S, access mode, trip purpose and time of day
  - Transit boardings by mode and route/station
- Model's forecast-ability is validated across 3 variables
  - Introduction of I-95E inter-county bus service
  - Tri-Rail and Tri-Rail shuttle service changes
  - Higher fuel prices

FTA Reaction and Summary

FTA Coordination and Reaction

- 4 face-to-face meetings with FTA Planning staff in Washington DC
  - 2010 July: reviewed SERPM 6.5 attributes, discussed model improvement strategy
  - 2010 December: reviewed transit survey findings and model development process
  - 2011 July: reviewed model development activities, discussed calibration/validation process
  - 2011 October: reviewed calibration/validation results
- Very positive reaction to development and calibration/validation process
  - Development based on transit survey data, not pre-conceived ideas
  - Calibration meant adding previously unknown travel behaviors,not adjusting constants
  - Validation based on replicating key behaviors, not “number matching”
  - Longitudinal checks extremely helpful in assessing model’s forecasting abilities *before* planning analysis begins
- FTA agrees that SERPM 6.7 can be used for multi-modal planning and New/Small Starts analysis

Summary

- Seven successful SERPM "1st's"
  - 1st ever comprehensive picture of transit patterns & behavior
  - 1st robust calibration/validation based on replicating key behaviors
  - 1st validation of pathbuilding structure
  - 1st calibration/validation based on detailed transit survey data
  - 1st use of longitudinal tests to assess forecastability
  - 1st transit model fully reviewed by FTA
  - 1st transit model with very positive reaction from FTA

- SERPM 6.7 represents a significant improvement over previous SERPM transit models

Summary

- SERPM 6.7's transit model:
  - Meets all stated objectives
  - Captures key transit travel behaviors
  - Reasonably reacts to changes to transportation variables
- FTA has reviewed SERPM 6.7 and agrees its use for New/Small Starts analysis
- SERPM 6.7 is currently being used for multi-modal projects:
  - South Florida East Coast Corridor Study, Phase 3 (FEC)
  - Central Broward Transit Study
  - Oakland Park Boulevard AA
  - Broward Boulevard AA
- Findings from new transit surveys will be incorporated as those results and findings become available

Thank You!

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