



Modeling the Response to Parking Policy

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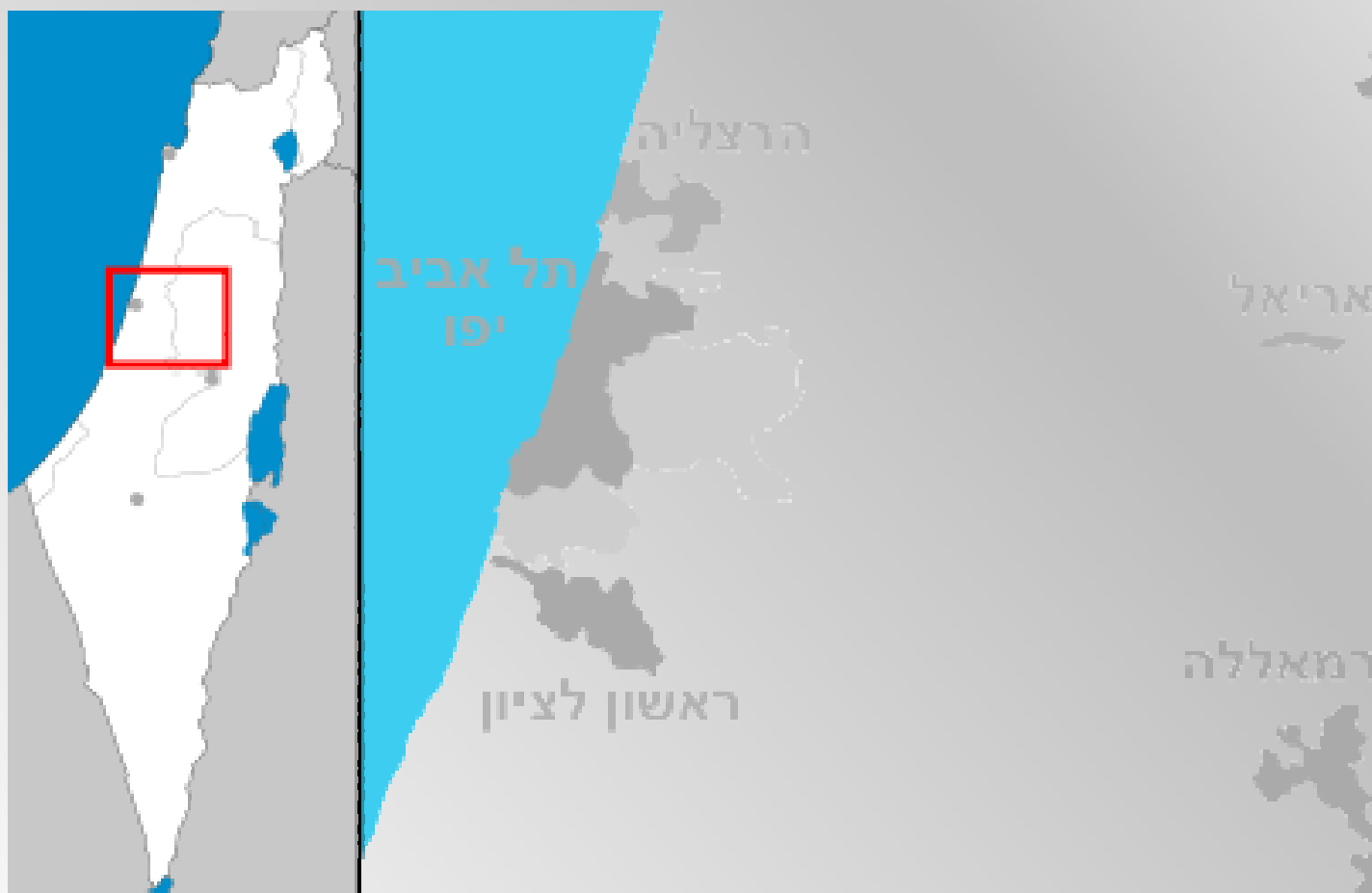


Outline

- Parking in Tel-Aviv
- The activity-based (ABM) approach to model travelers' response to policy (parking and other)
- The recent stated preference parking survey and model
- Integrating the parking model into the ABM
- Congestion pricing study (if times permit)



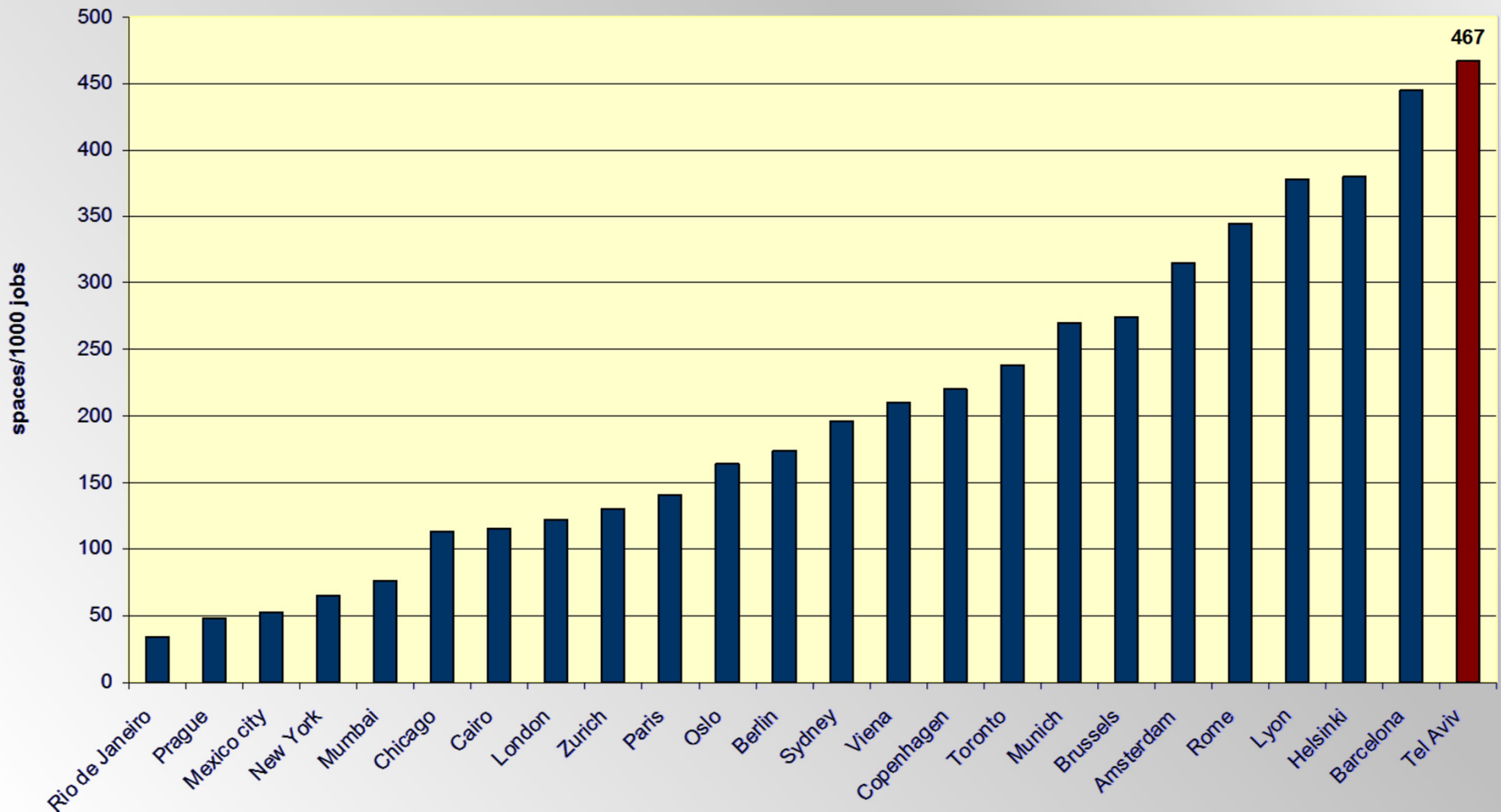
Some Facts About Parking in Tel Aviv





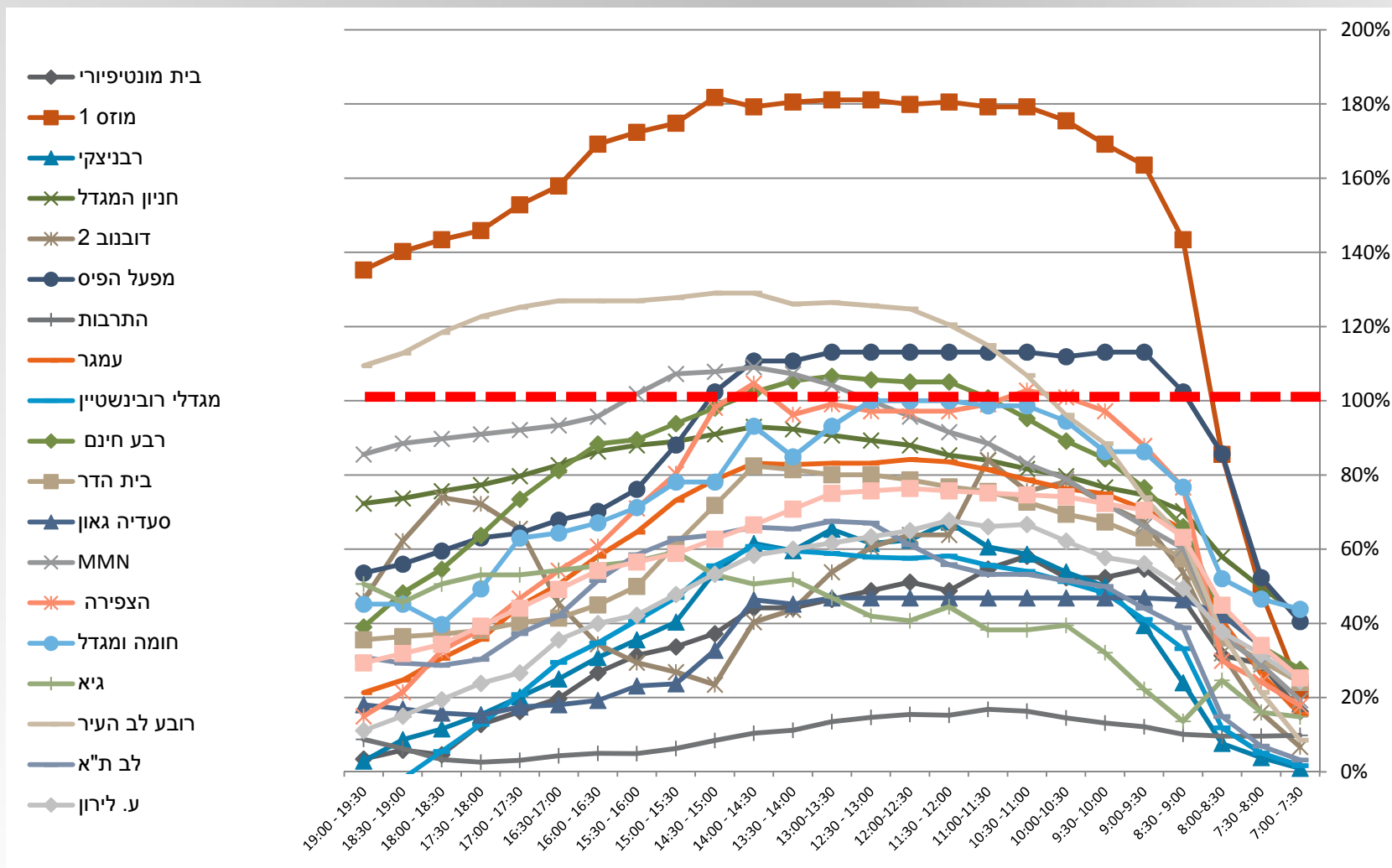
Parking Spaces per 1000 CBD Jobs

Parking Spaces per 1000 CBD Jobs



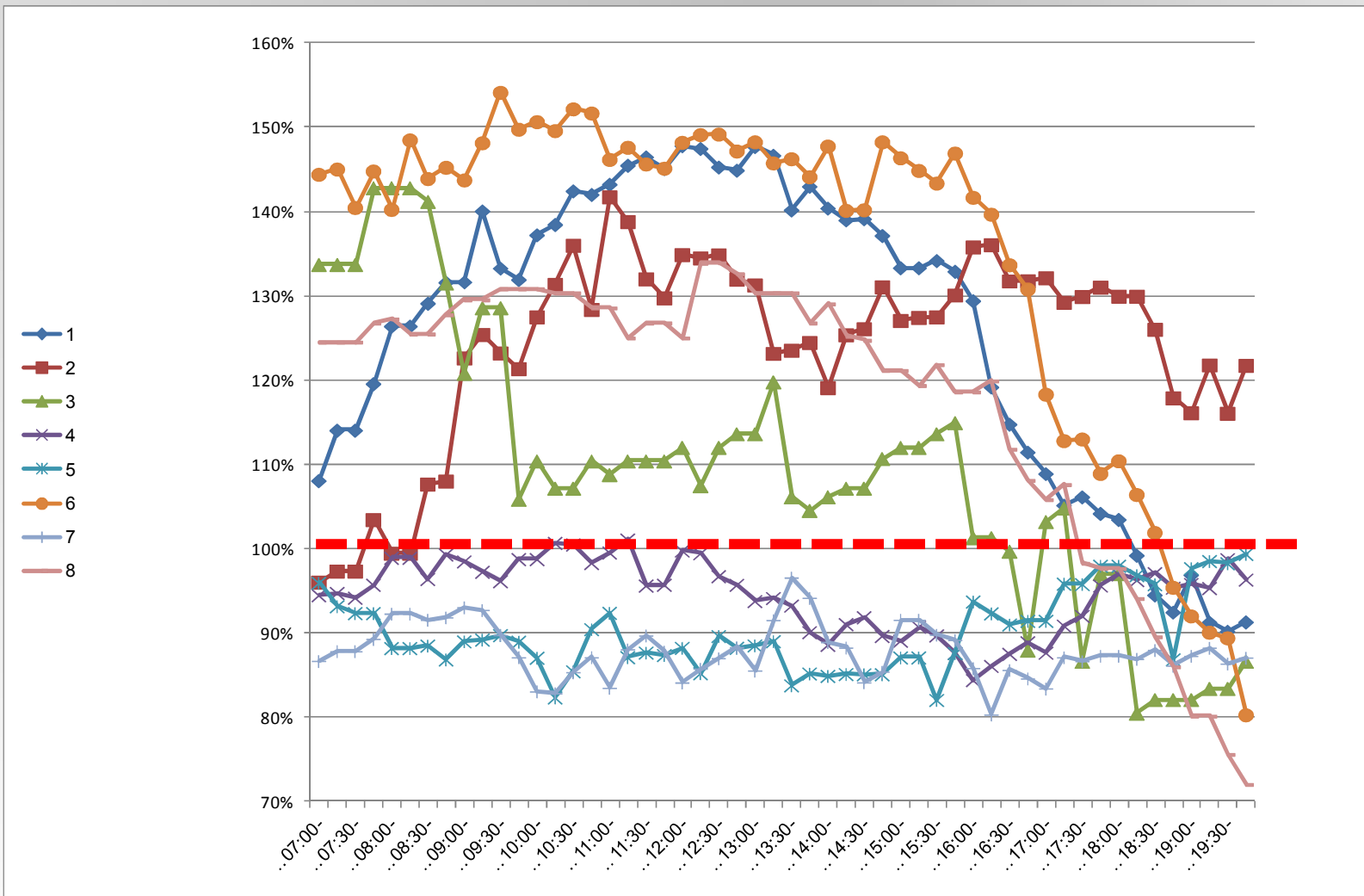


Parking Lot Occupancy Distribution





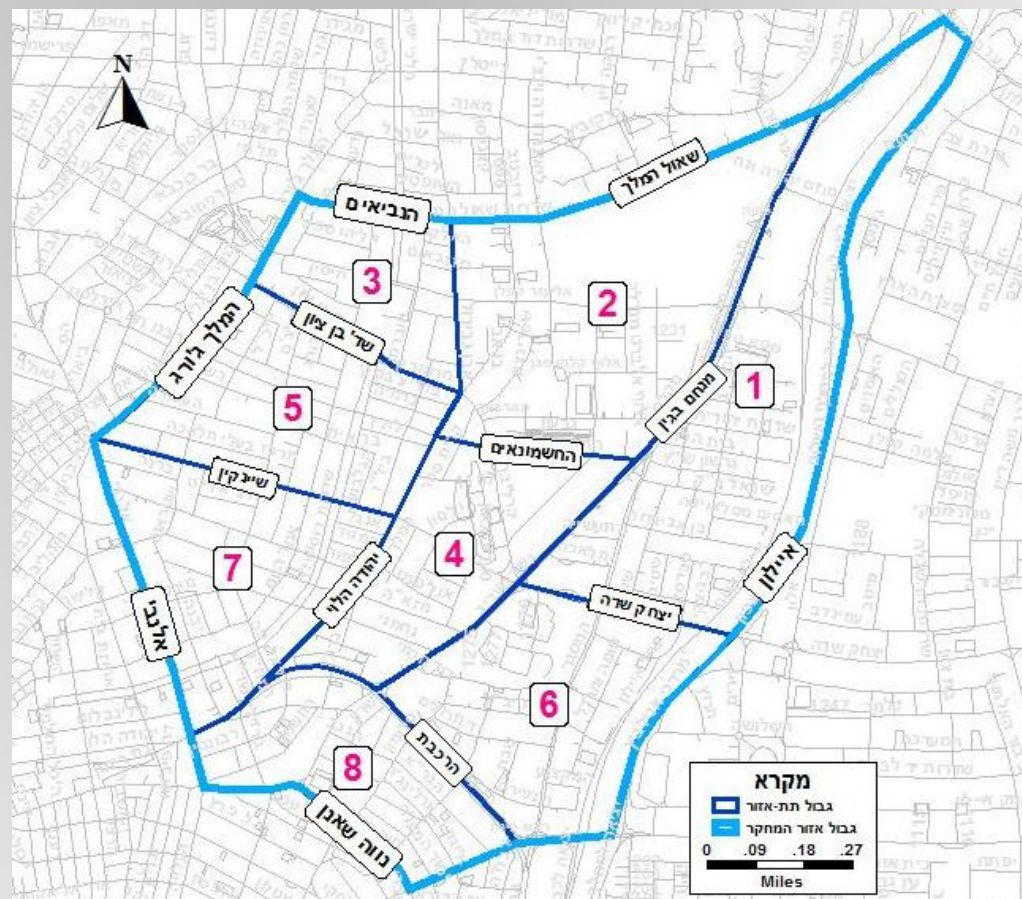
Street Parking Occupancy Distribution





Focus Area Study

The study focuses on an area that includes quarter 6 and the eastern parts of quarters 3 and 5 of the city of Tel Aviv-Jaffa.





Current Parking Characteristics

Respondents' parking characteristics (mean):

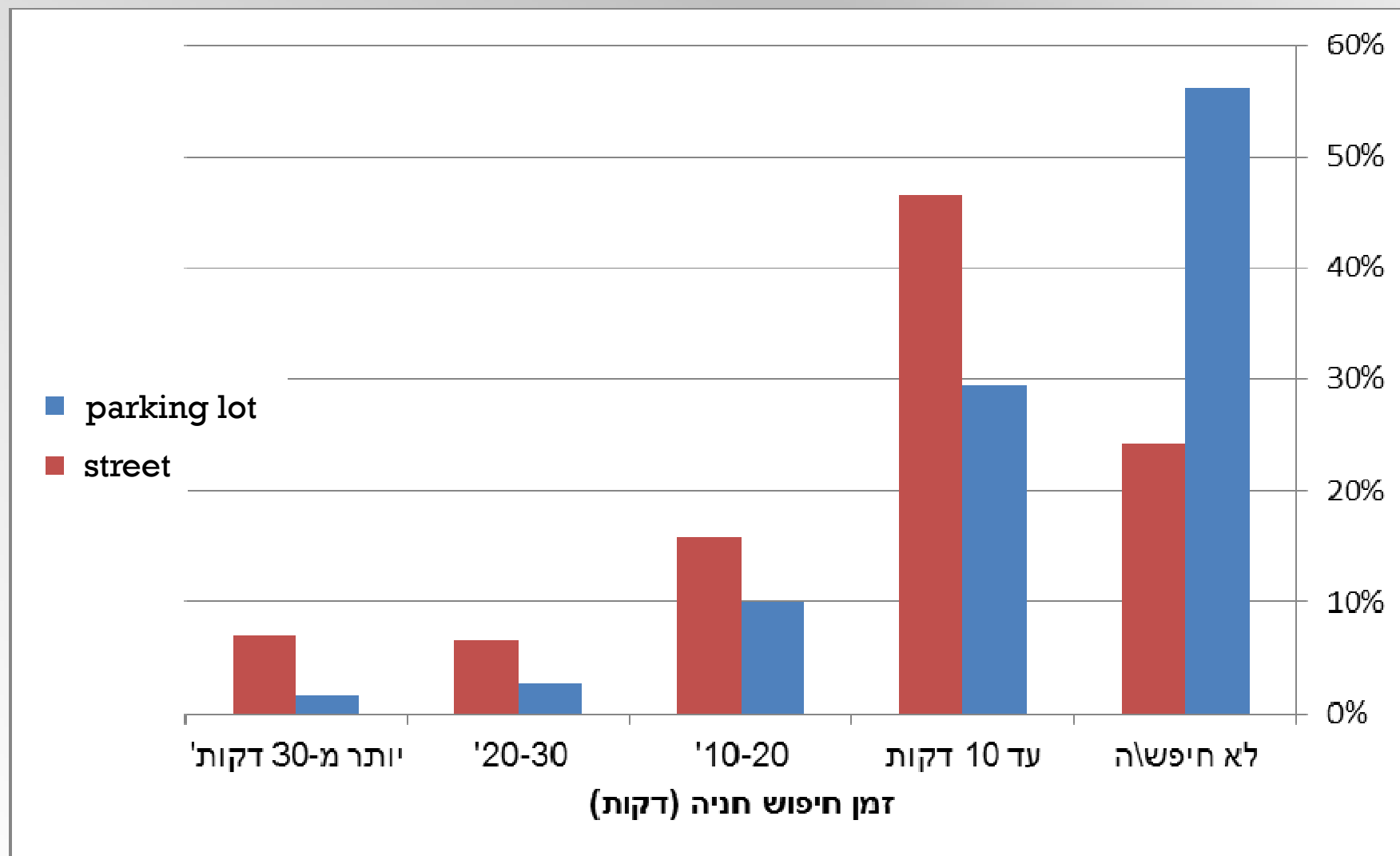
Parking location	Parking search time (min.)	Walking to destination time (min.)	Parking cost per hour (NIS)
parking lot	5.5	5.0	10.3
street	10.5	4.0	4.8
Total	6	4.5	9.8

These data are based on:

- A recent survey of more than 1,000 parkers in the area
- The survey was conducted between 7AM and 7PM, according to a distribution of sub-areas in parking lots and specified streets in the research area.
- Respondents were recruited in parking lots/on the street and the survey was completed via internet/phone.

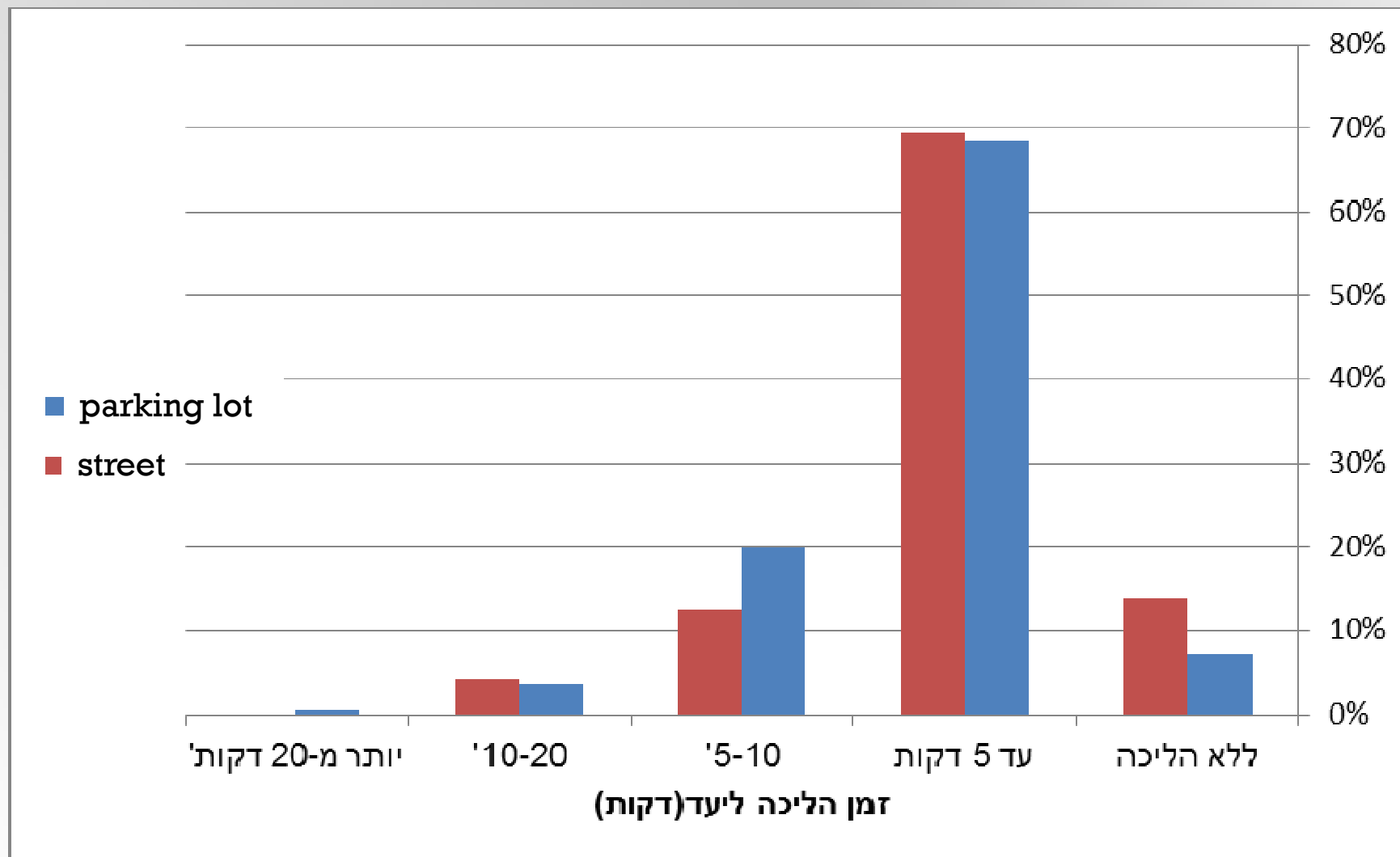


Distribution of Parking Search Time (Min.)



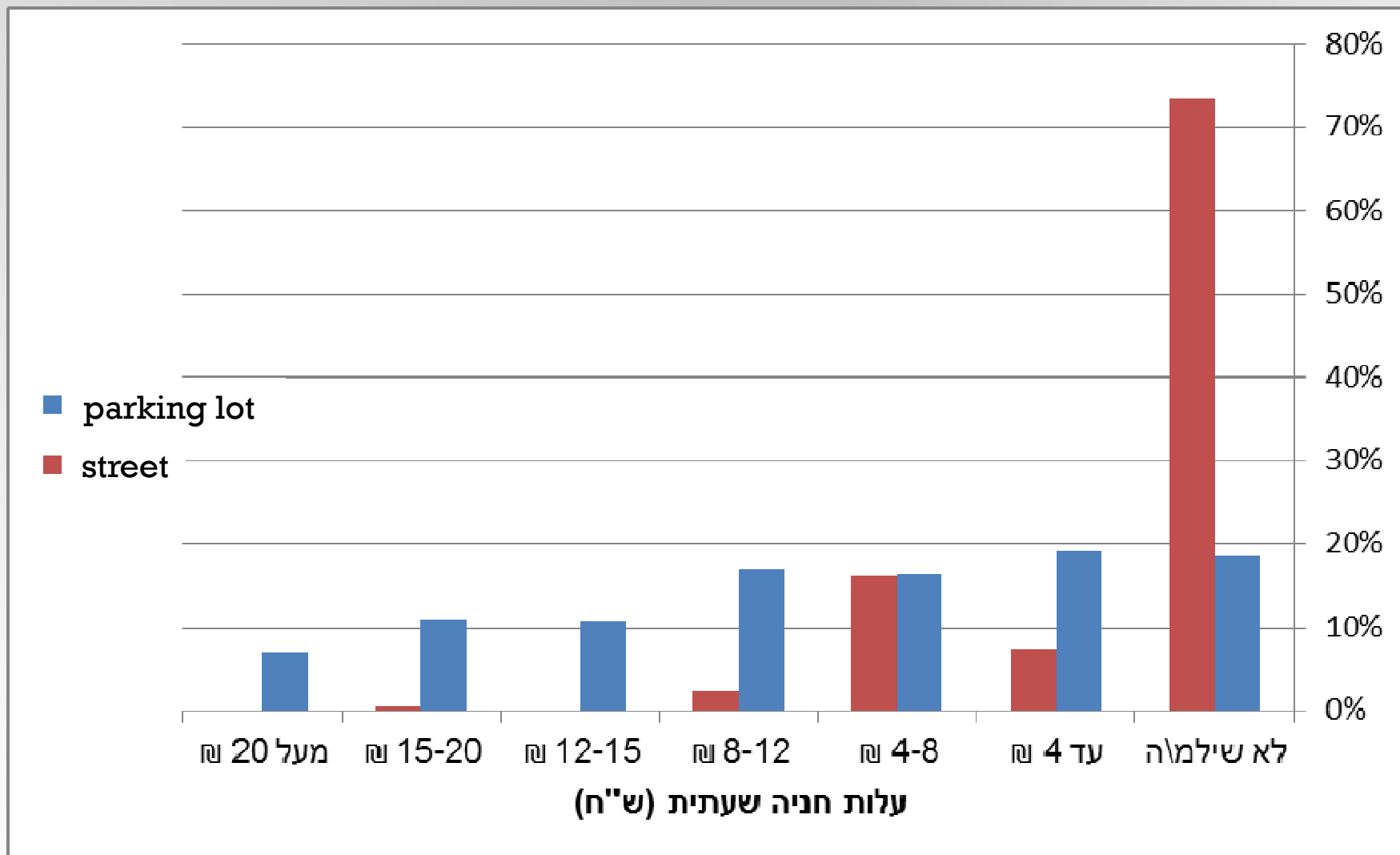


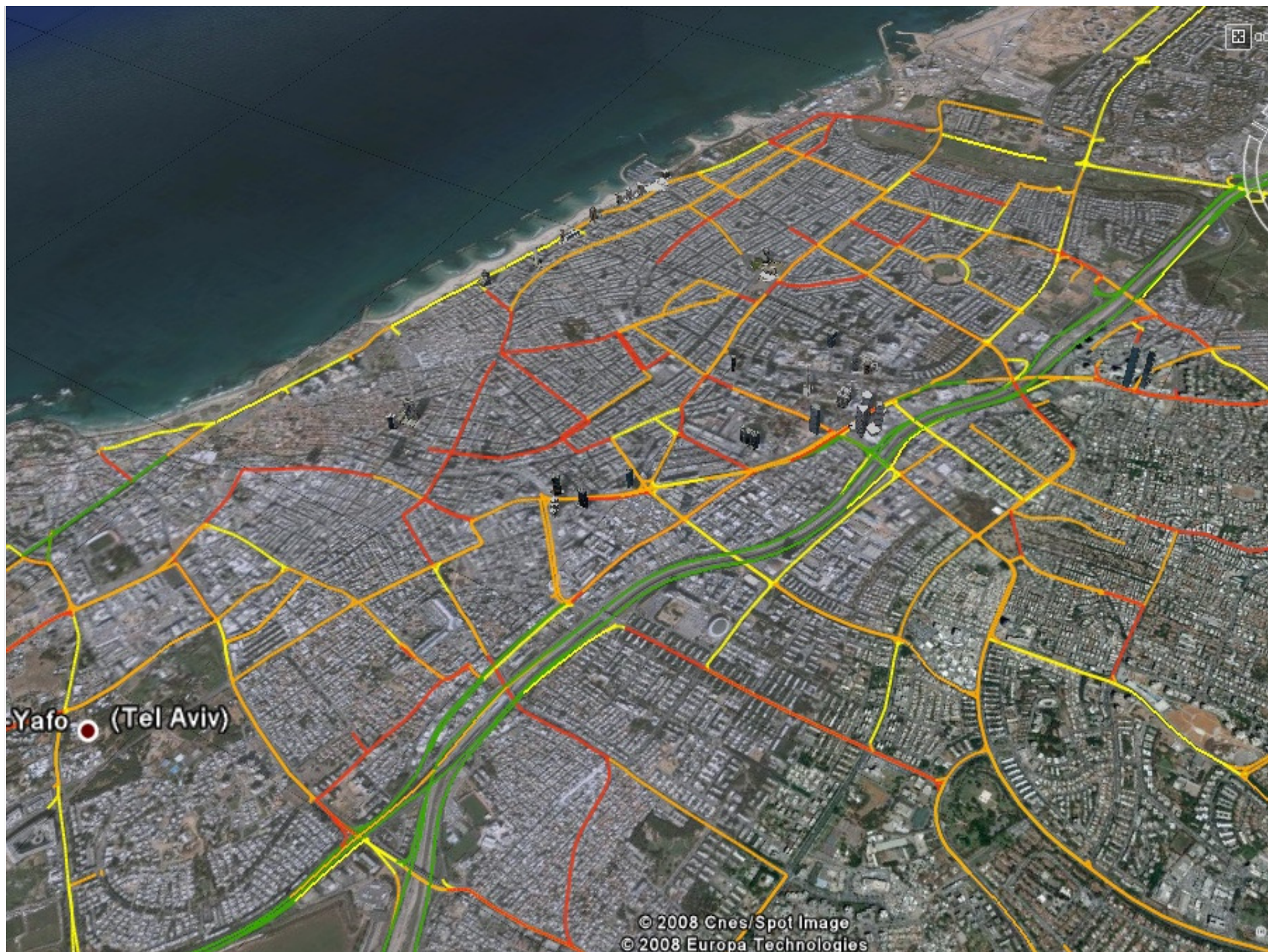
Distribution of Parking Walk Time (min.)





Distribution of Hourly Parking Cost Paid





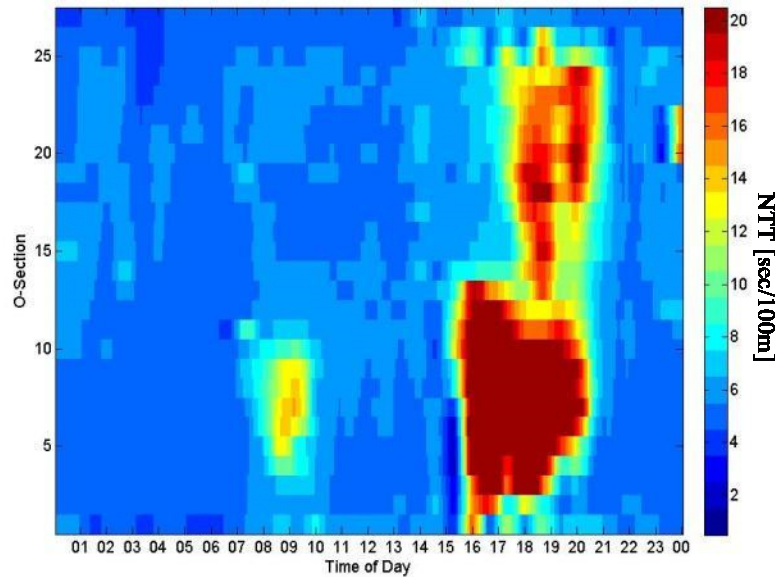
Yafo (Tel Aviv)

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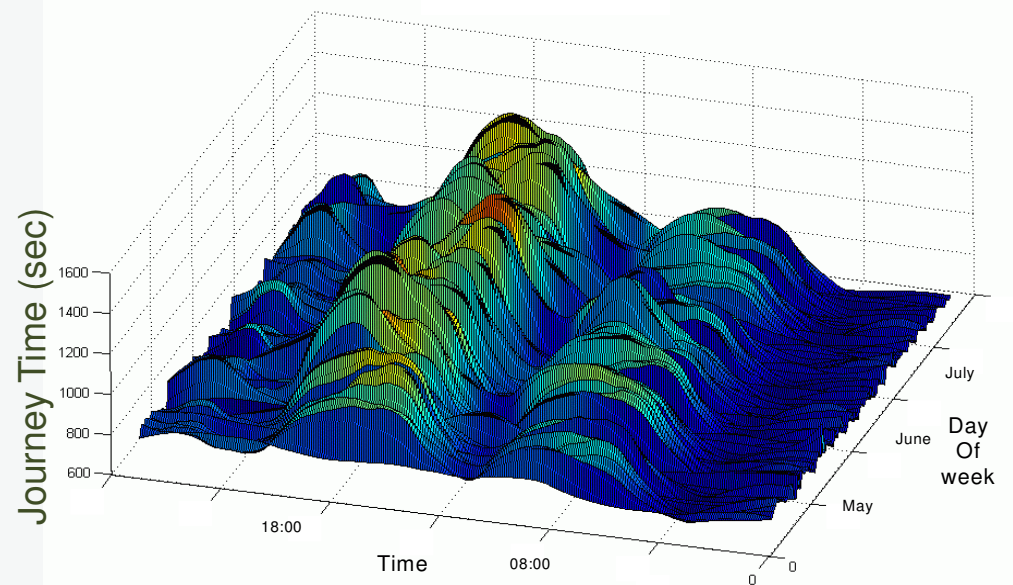


Congestion Patterns at Ayalon Highway

hourly congestion levels

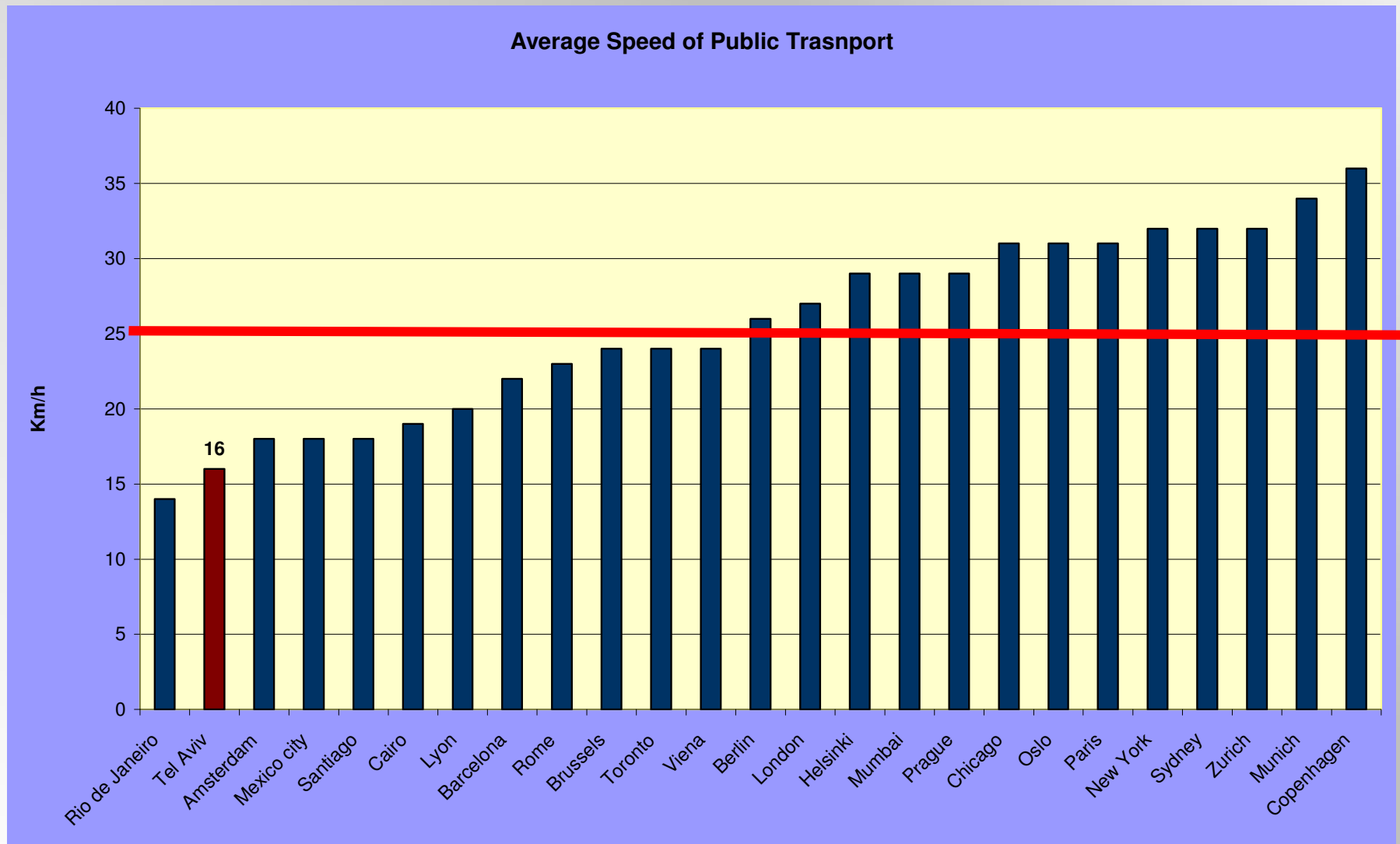


monthly average congestion levels





Average Speed of Public Transport

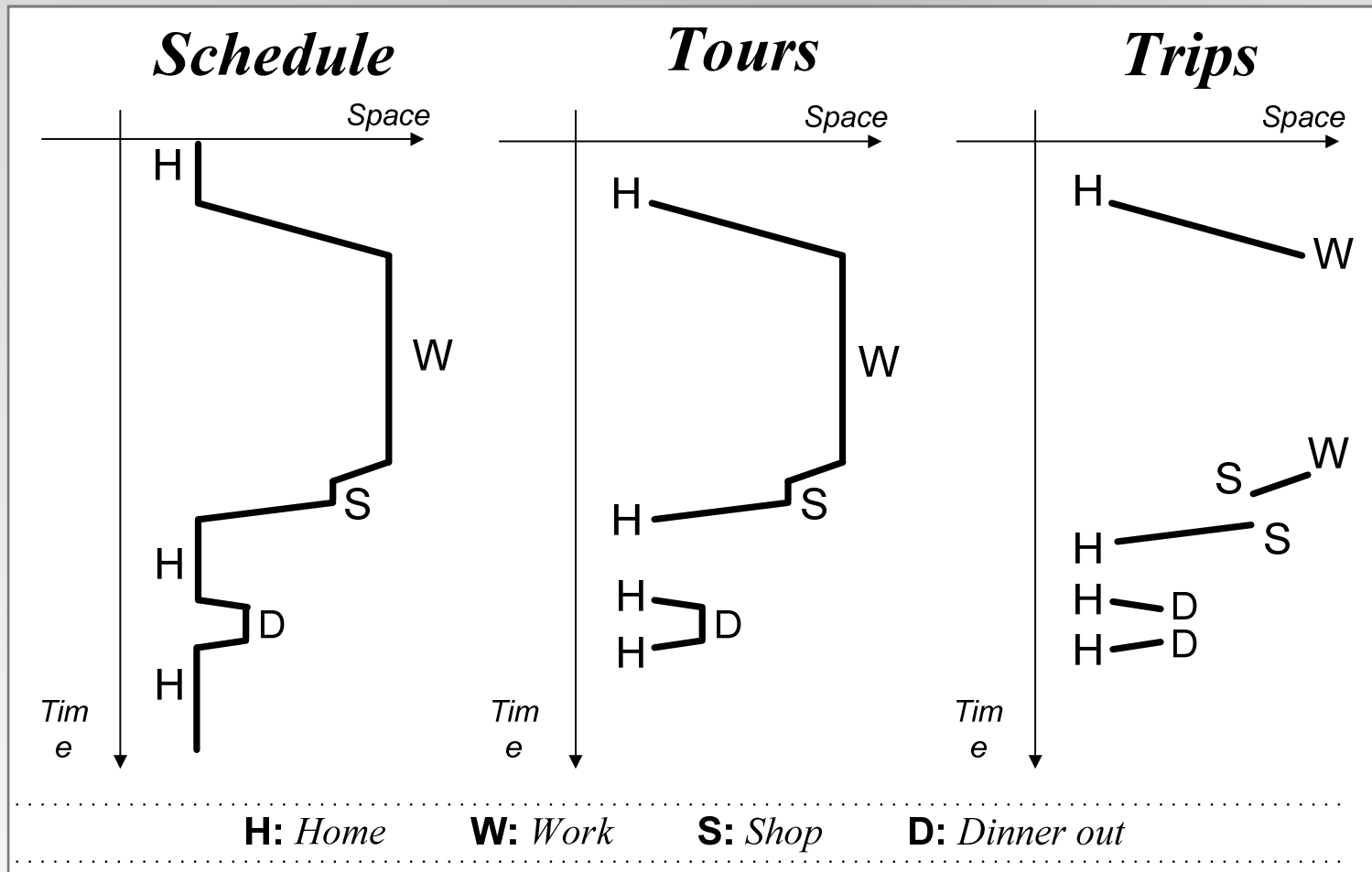




The Activity Based Approach to Model Response to Policies



Why Activity-Based Approach?

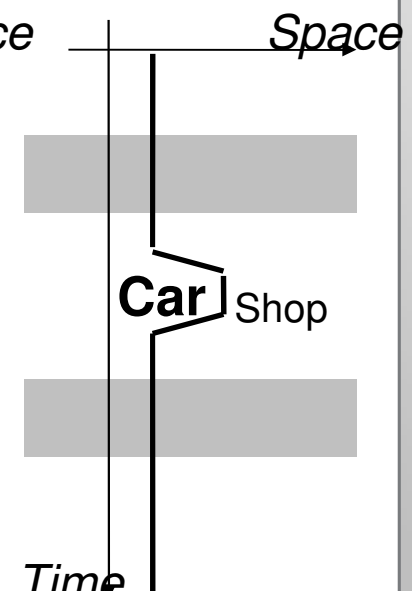




Potential Responses to Toll

*(b) Change
Time & Pattern*

(c) Work at Home



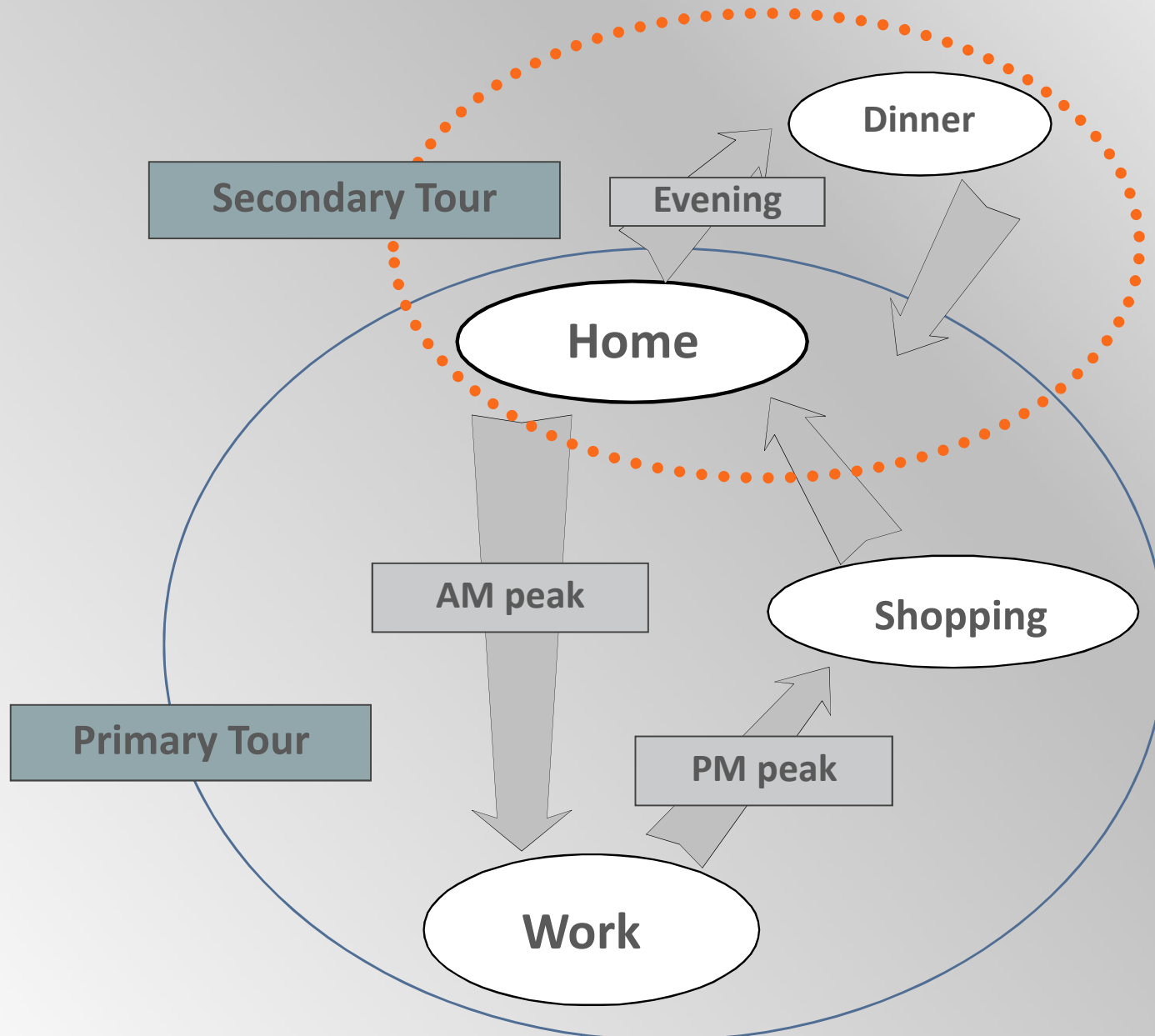
 = Peak Period



Basics of Activity-Based Travel Theory

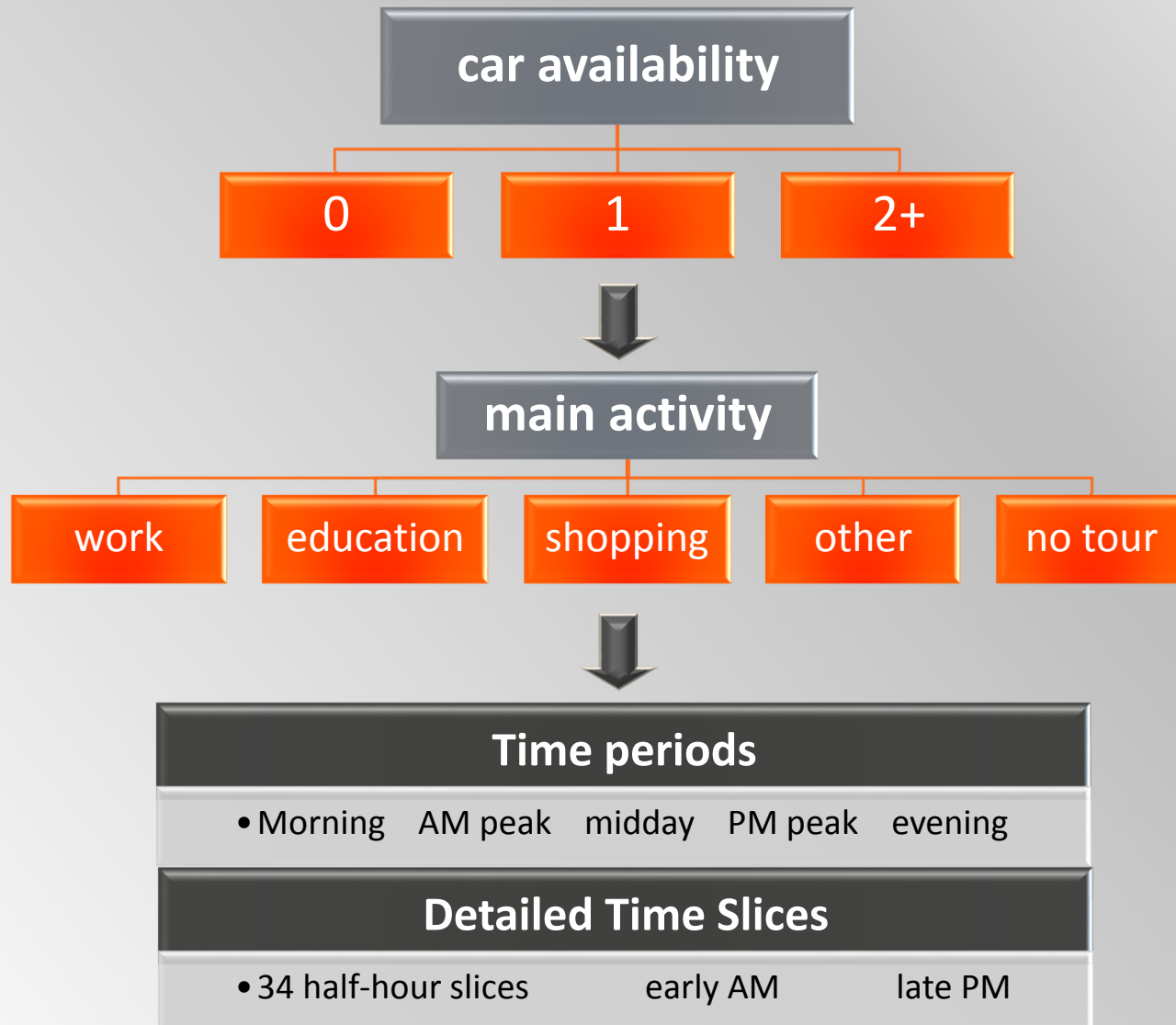
- Travel demand is derived from demand for activities.
- People face time and space constraints that limit their activity schedule choice.
- Activity and travel scheduling decisions are made in the context of a broader framework:
 - Conditioned by outcome of longer term processes.
 - Scheduling process interacts with the transportation system.

Activity Schedule Approach



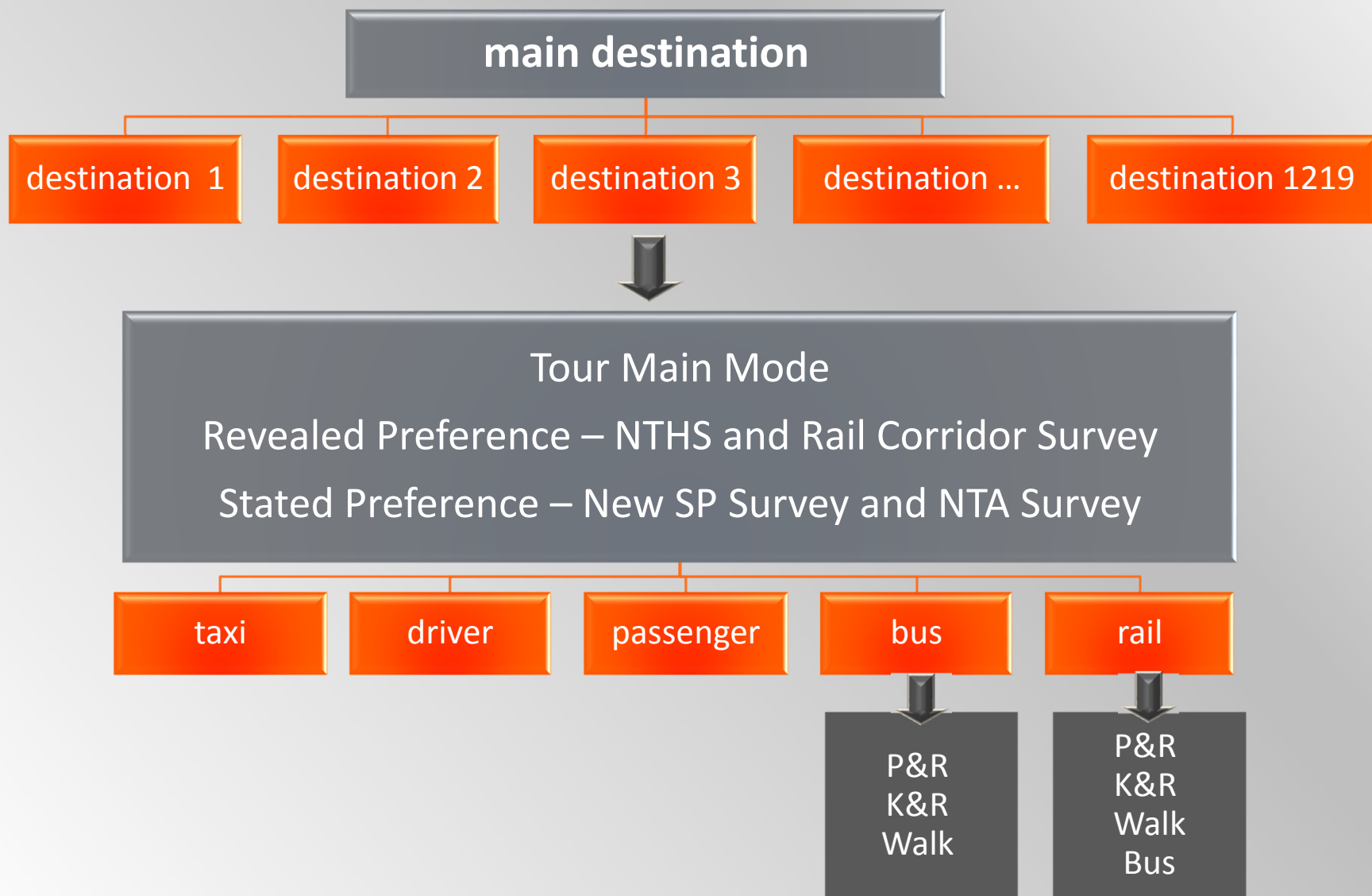


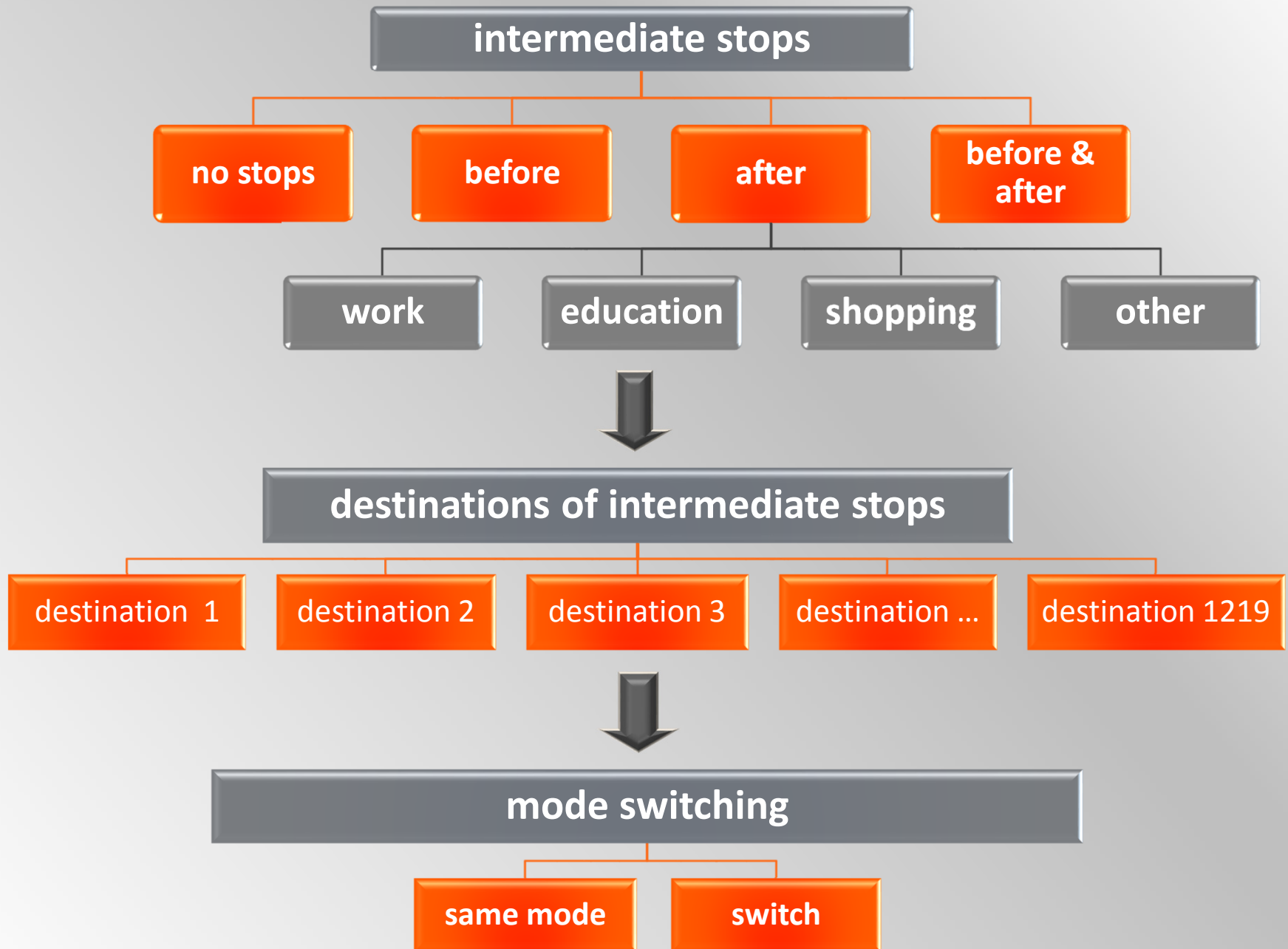
The Tel-Aviv Model Structure





Model Structure (cont.)







Parking Analysis

- Parking variables in the mode choice models:
 - Cost
 - Search time
 - Walk time to destination
- Search time = f (parking supply, demand, other)
- Demand by time of day (occupancy) estimated endogenously from the model
- Supply data from the Tel-Aviv GIS data





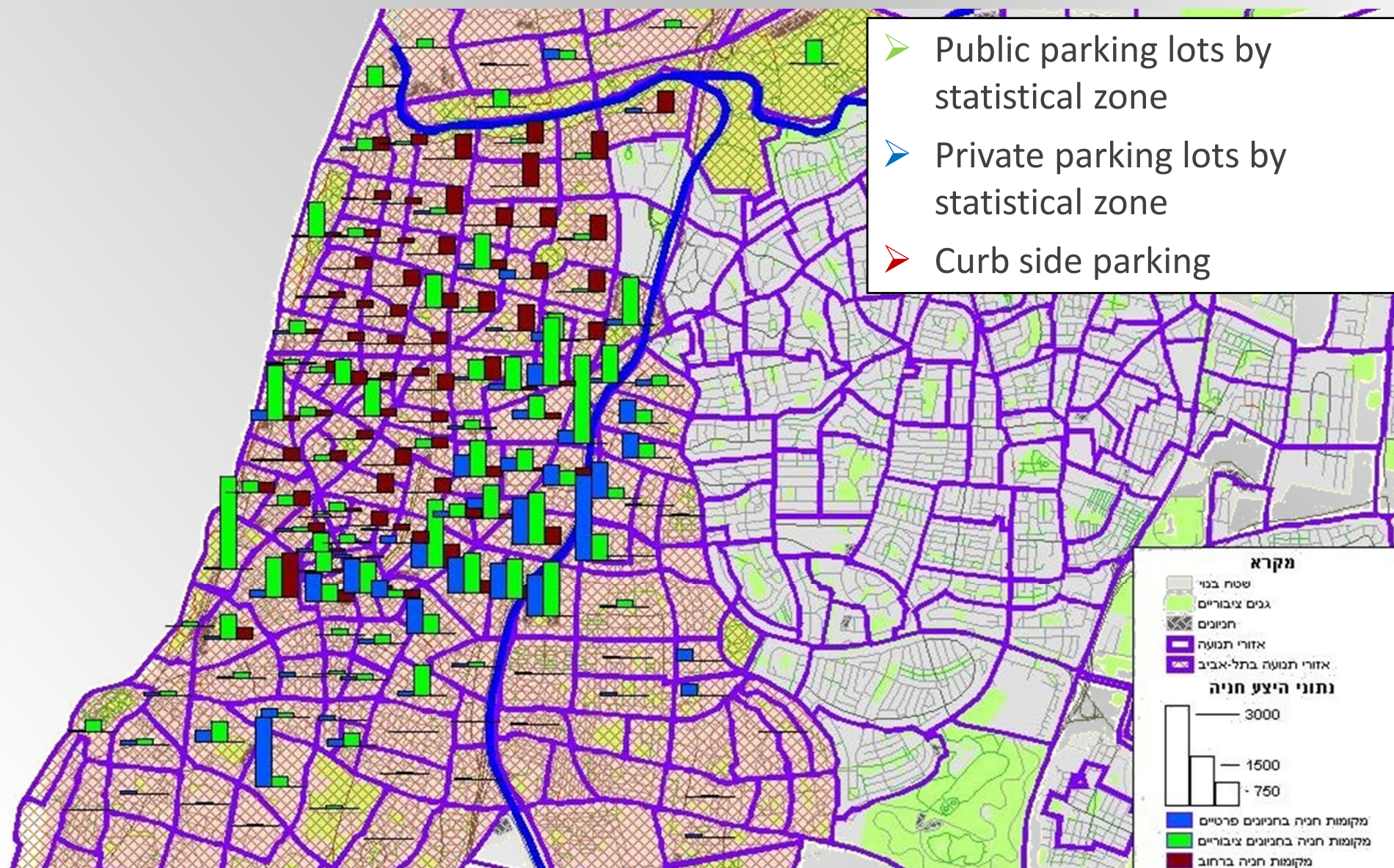
The Tel Aviv GIS Data

- Public parking garages by statistical zones
- Private parking garages by statistical zones
- Curb side parking
- Parking supply by statistical zones were distributed to TAZs in proportion to population and employment data





Parking Data (Only in Tel Aviv)





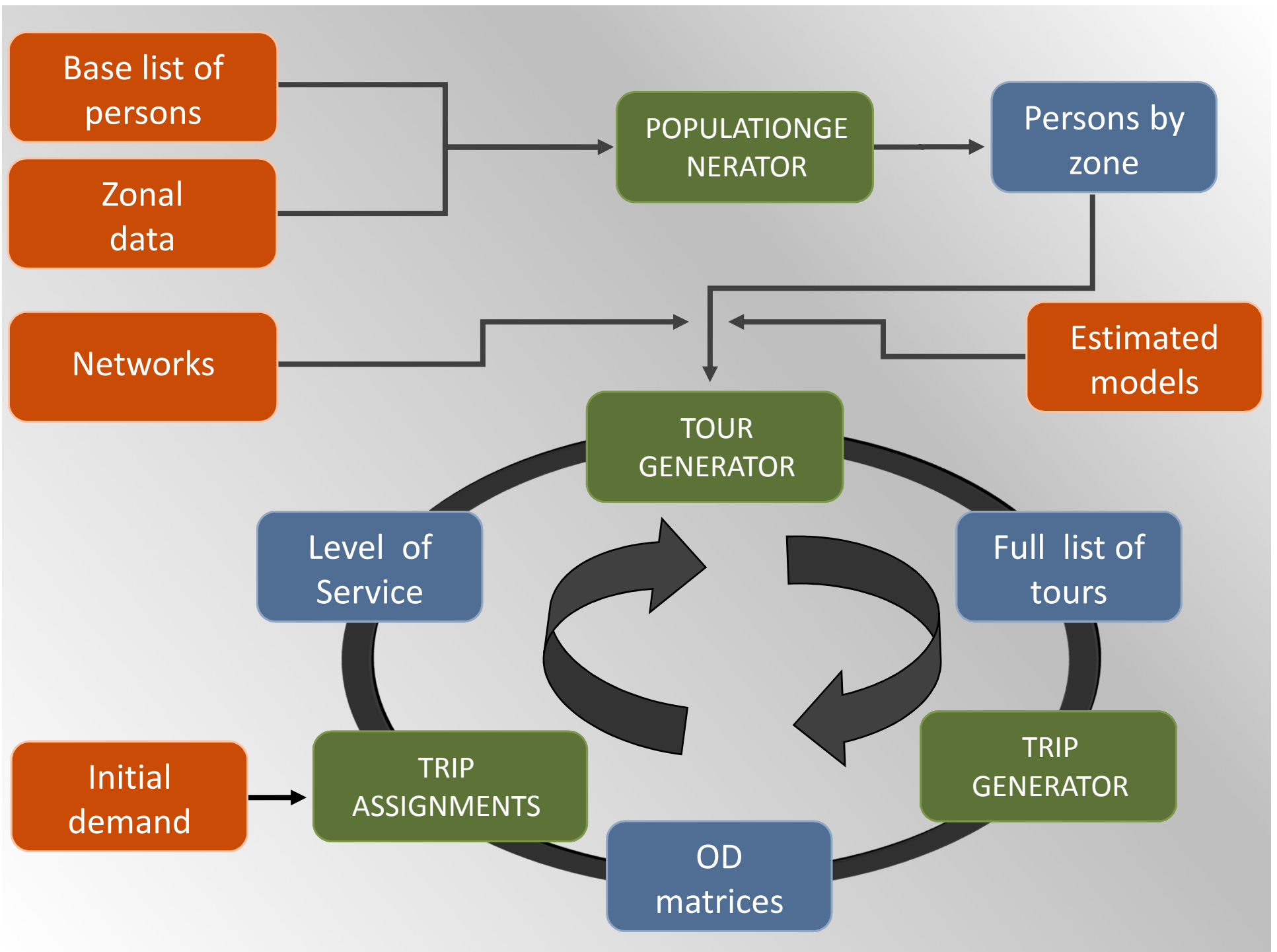
Parking Search Time Model

$$\text{Search Time} = (\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots) \times \left(\frac{\text{Demand}}{\text{Supply}} \right)^\mu$$

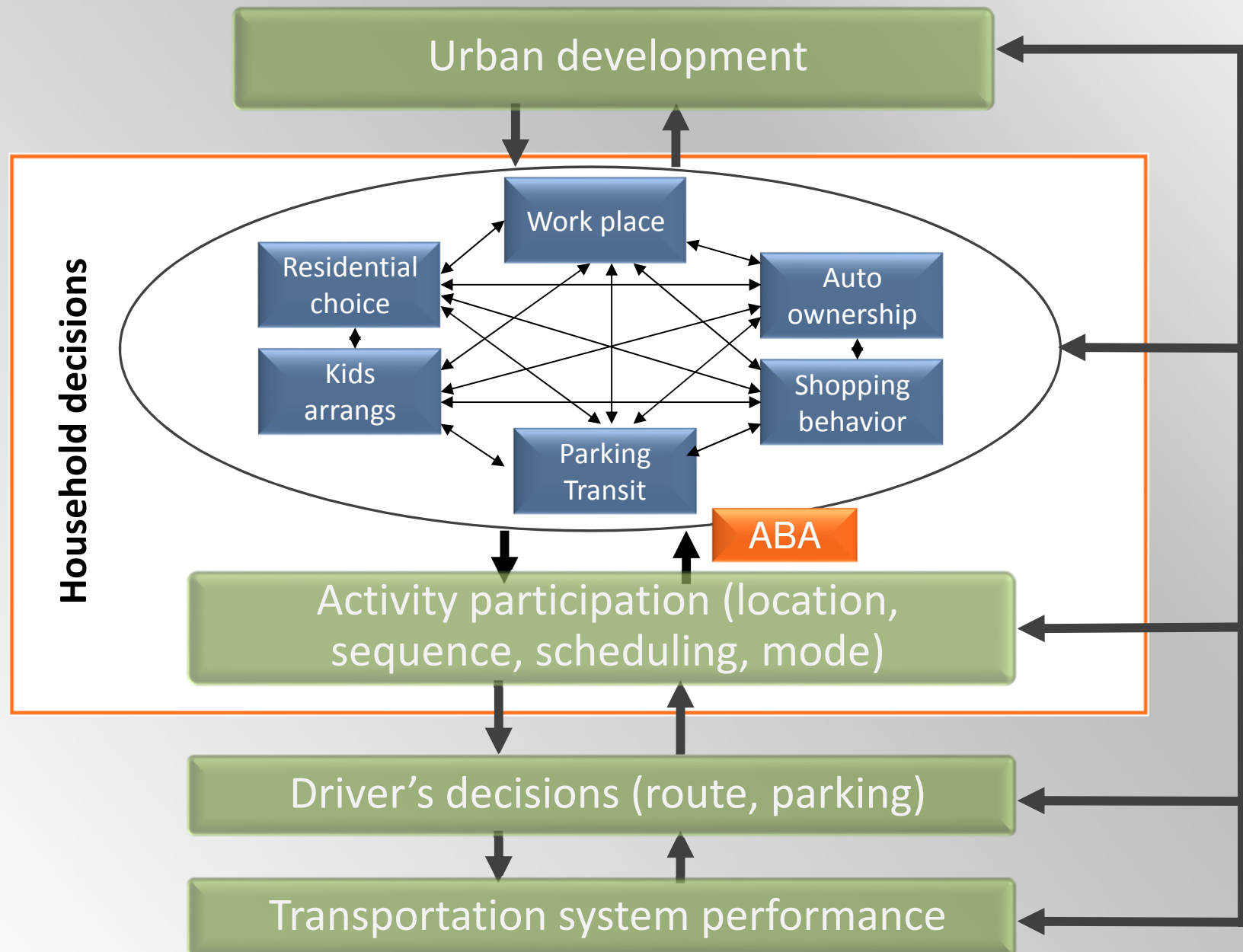
<i>Variable</i>	<i>B</i>	<i>t-value</i>	<i>Explanation</i>
(Constant)	5.547	10.5	Constant
RMALED	.866	2.9	Male Dummy (1 if person is Male).
RAGE1	1.704	2.8	Young age Dummy (1 If person < 24 years)
RDENSITY	.00012	1.9	Density of Area (Population/Area in km ²)
REMPDENSITY	.078	6.7	Employees Density (Employees/Area in km ²)
RAMPEAKD	-5.443	-11.3	AM Peak Period Dummy (1 if Trip is in AM Peak Period)
RPMPEAKD	-3.771	-7.6	PM Peak Period Dummy (1 if Trip is in PM Peak Period)
RAMOFFPD	-3.853	-7.5	AM Off-Peak Period Dummy (1 if Trip is in AM Off-Peak Period)
μ	1.0		

No significant improvement obtained for non-linear models

Time of Day	Minimum Search time (min)	Maximum Search Time (min)
a.m. Peak	0.52	16.43
a.m. Off-peak	2.11	18.02
p.m. Off-peak	5.96	21.87
p.m. Peak	2.19	18.10



Extending the Framework





The Recent Parking Stated Preference Study



Parking Stated Preference Survey

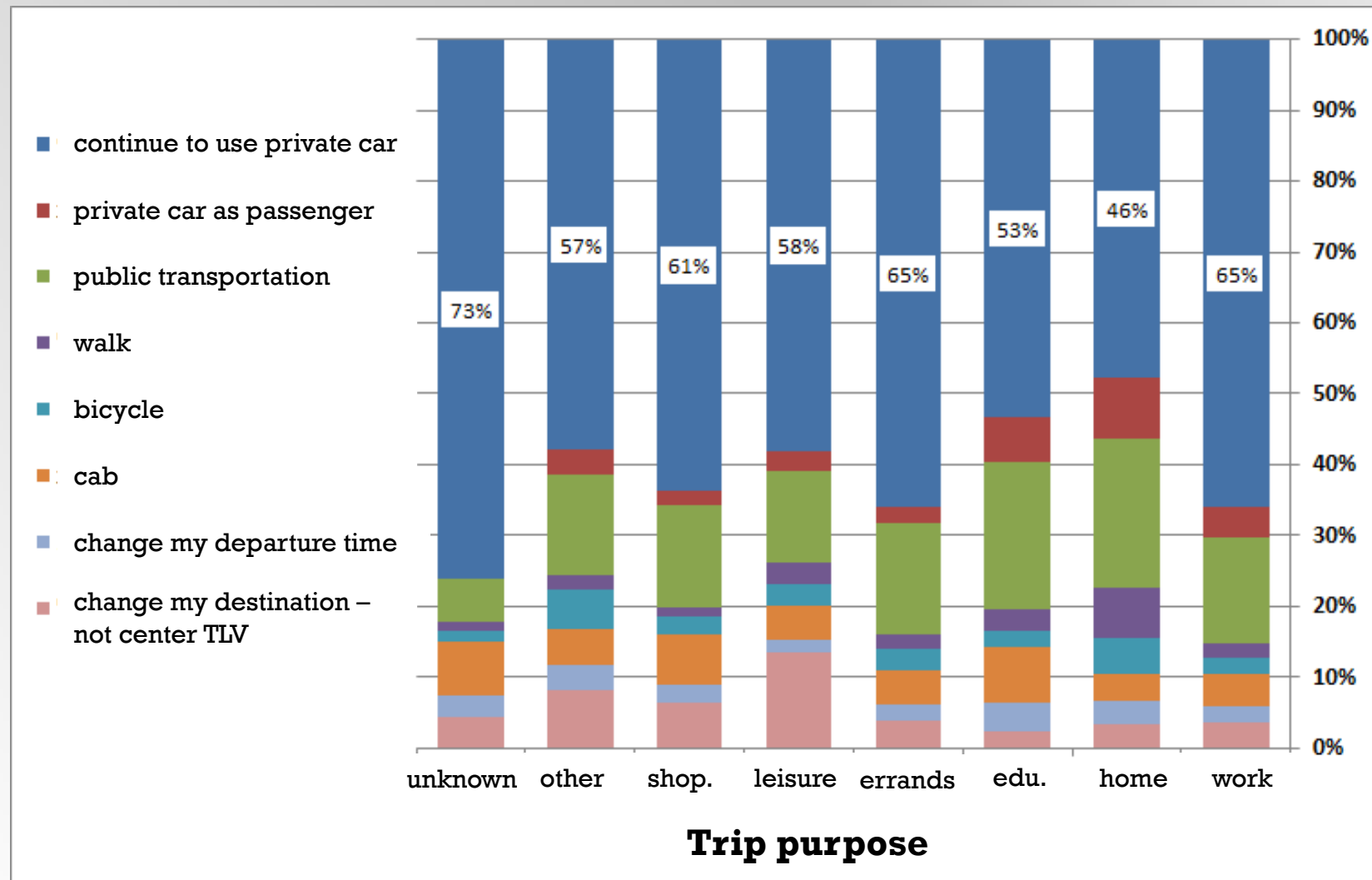
Data asked in the survey:

- Socioeconomic: age, gender, work status, ...etc.
 - Who pays for car expenses, parking and gas?
- Travel & activity behavior: Tours done by person.
- Parking scenarios:
 - Price: + 0/5/10 NIS
 - Walk time: + 0/5/10 MIN
 - Search time: +0/5/10 MIN



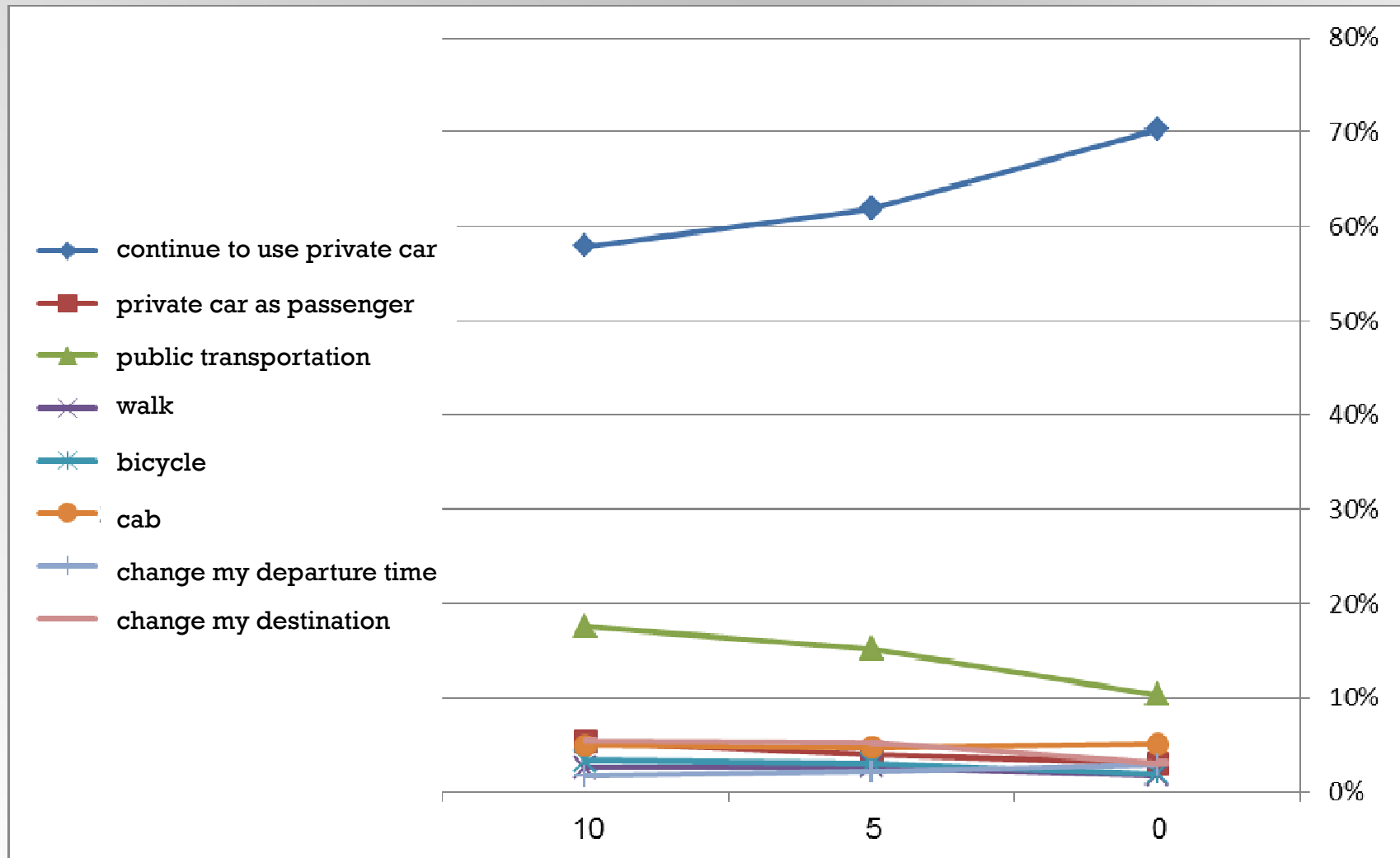


Stated Preference by Trip Purpose to TLV Center





Stated Preference by Hourly Price Increase





Models Estimation Results

Binary model (deciding between private car and other mode):

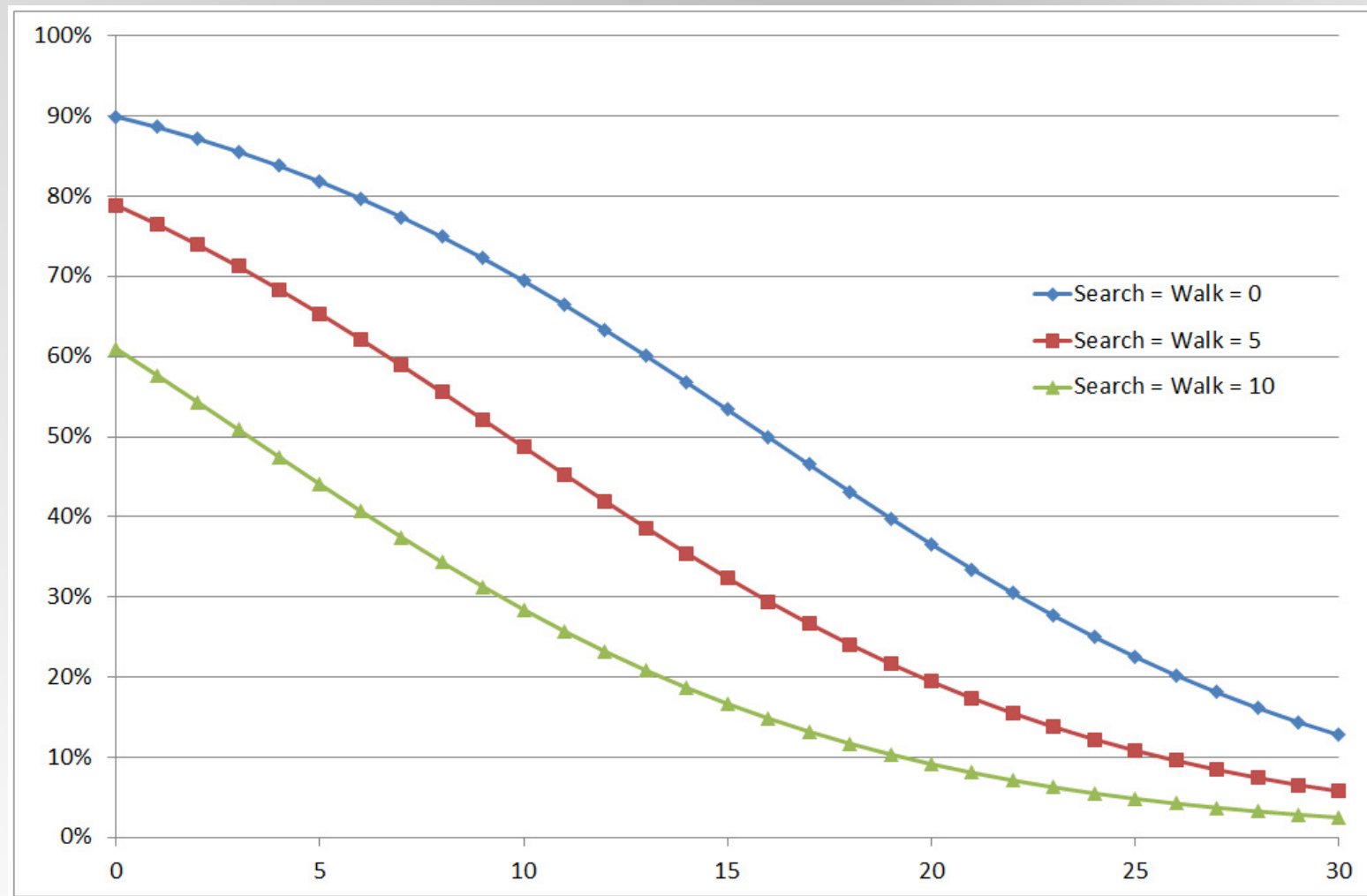
Name	Value	Std err	t-test	p-value	Robust Std err	Robust t-test	p-value
asc_car	2.19	0.171	12.83	0.00	0.17	12.87	0.00
b_cost	-0.137	0.0133	-10.34	0.00	0.0131	-10.44	0.00
b_search	-0.0978	0.0122	-8.04	0.00	0.0122	-7.99	0.00
b_walk	-0.0765	0.0102	-7.51	0.00	0.0102	-7.51	0.00

Value of Time

	NIS per hour
Parking search time	42.6
Parking walk time	33.6



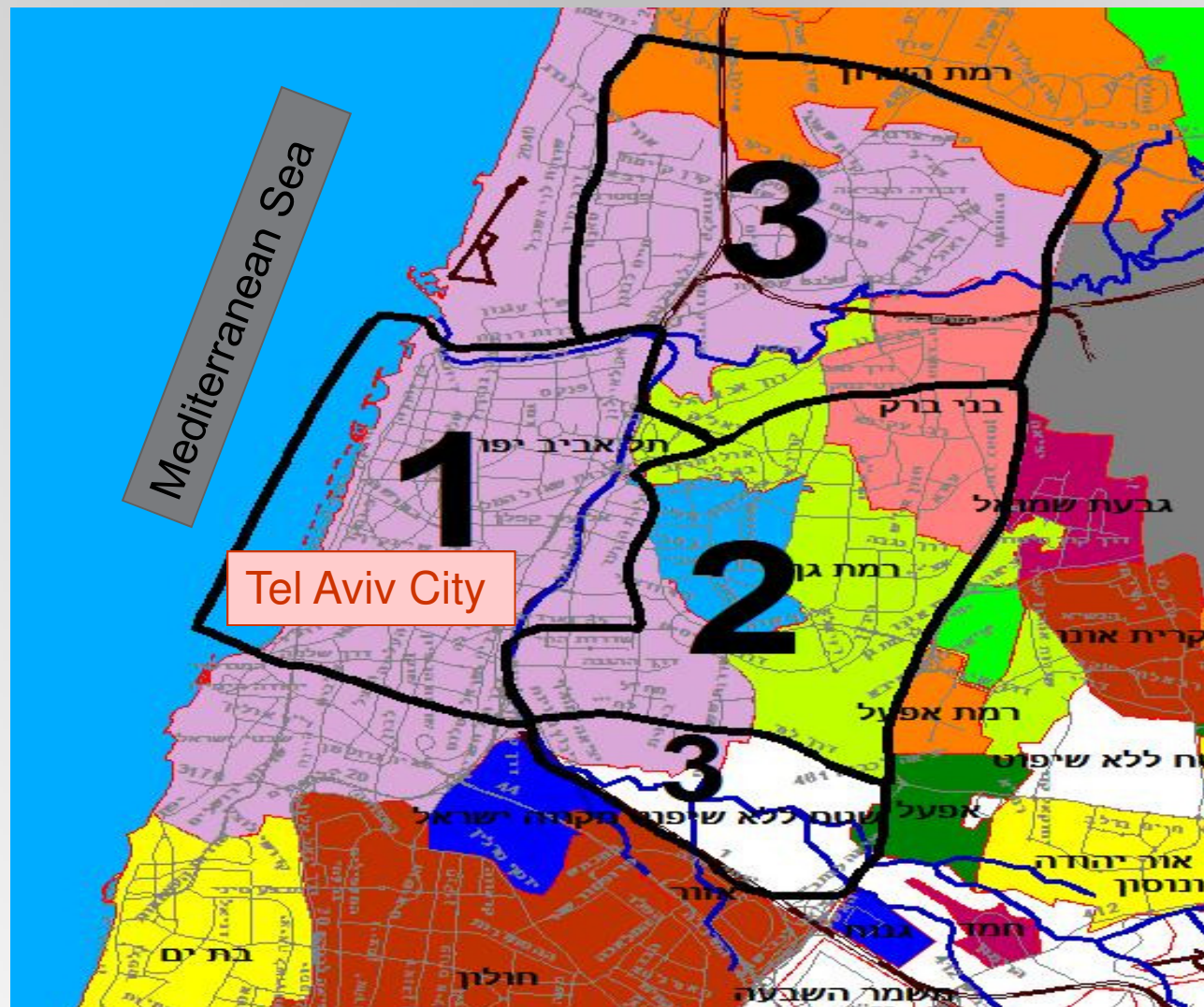
Probability of Continuing to Drive





A Recent Congestion Stated Preference Study

Congestion Pricing Area



Congestion Hours



Daily Hours

06:30-19:00



Morning Peak Hours

06:39-09:30



Morning Peak Hours

Afternoon Peak Hours

06:30-09:30

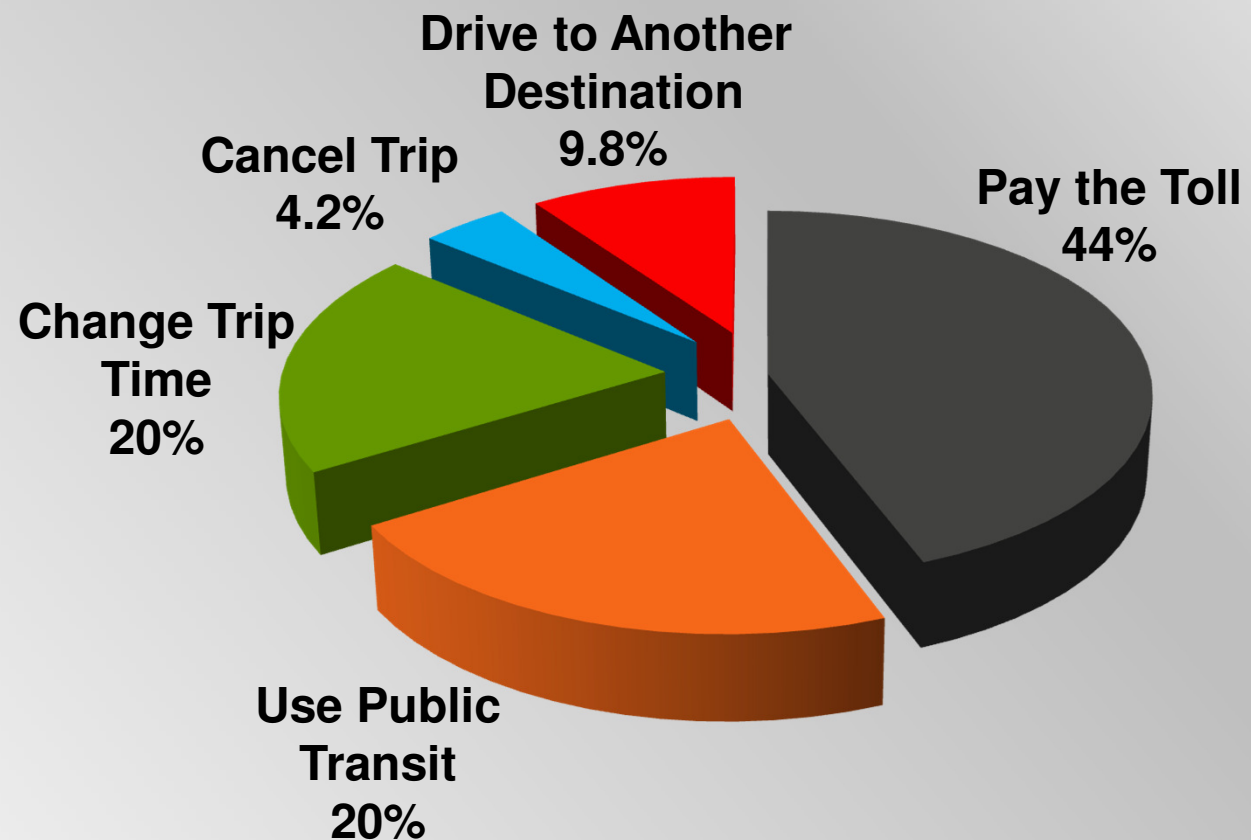
16:00-19:00





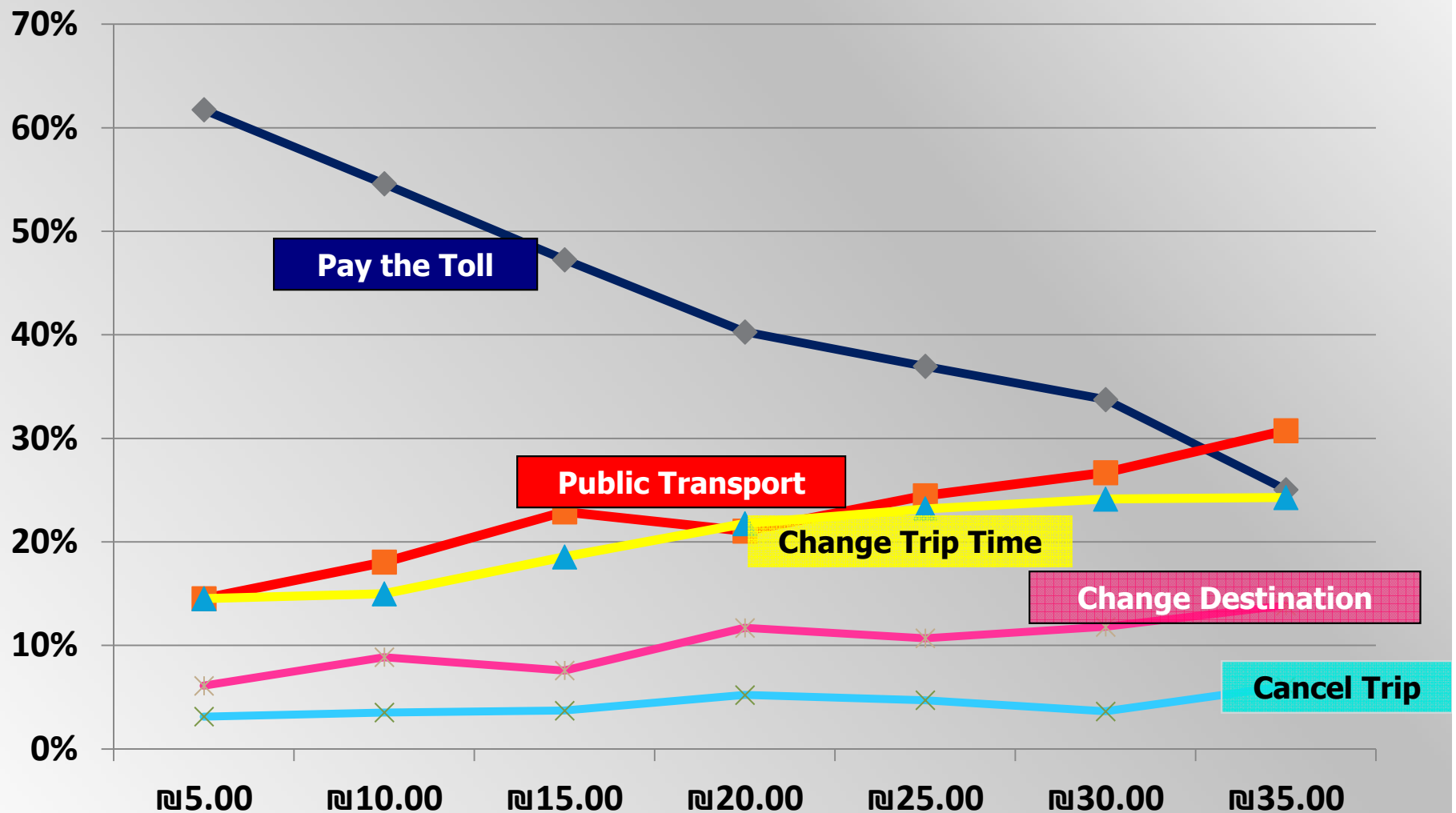
Response to Congestion Pricing

Choice Distribution:





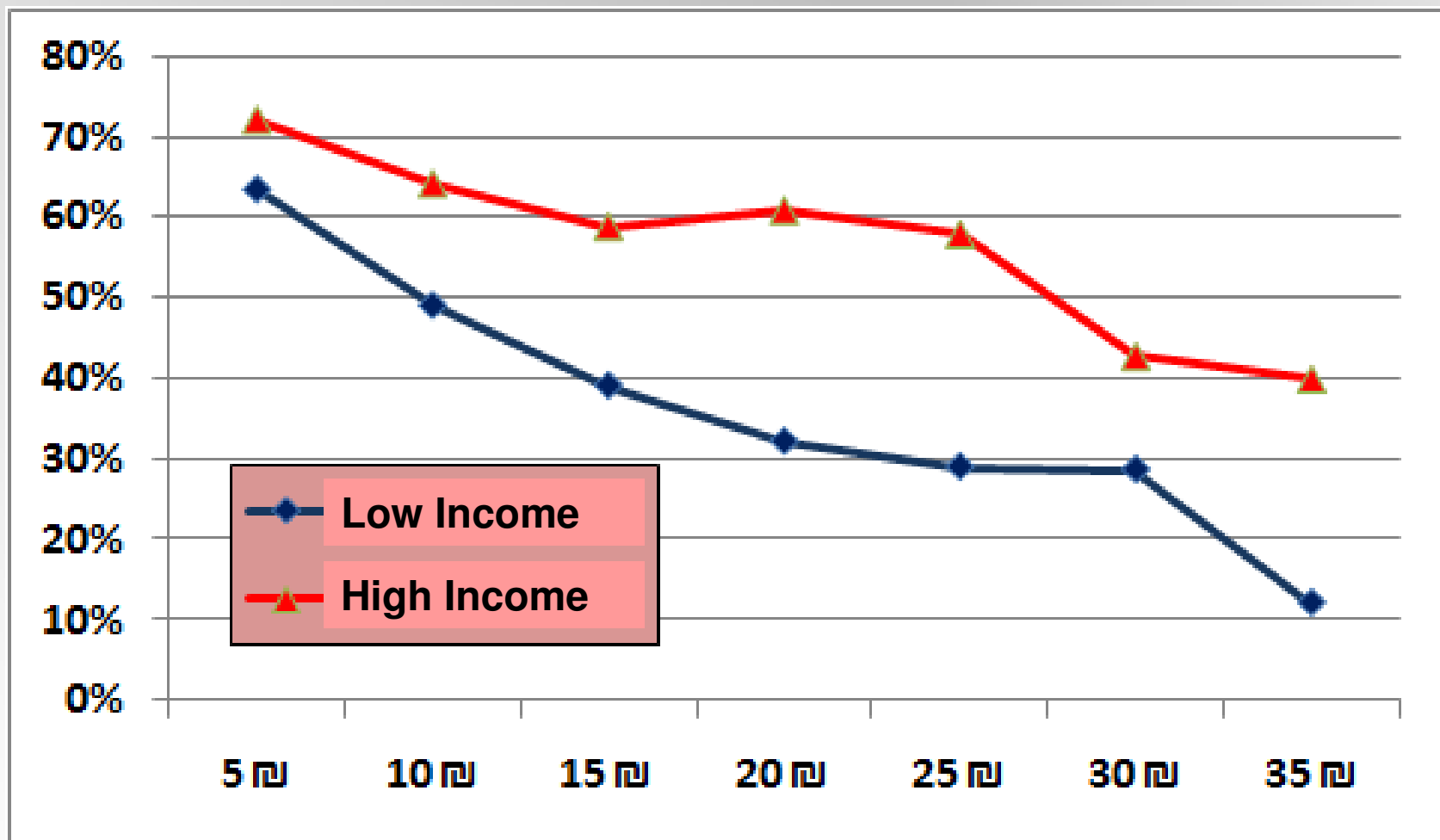
Response by Toll Level





Response by Income Level

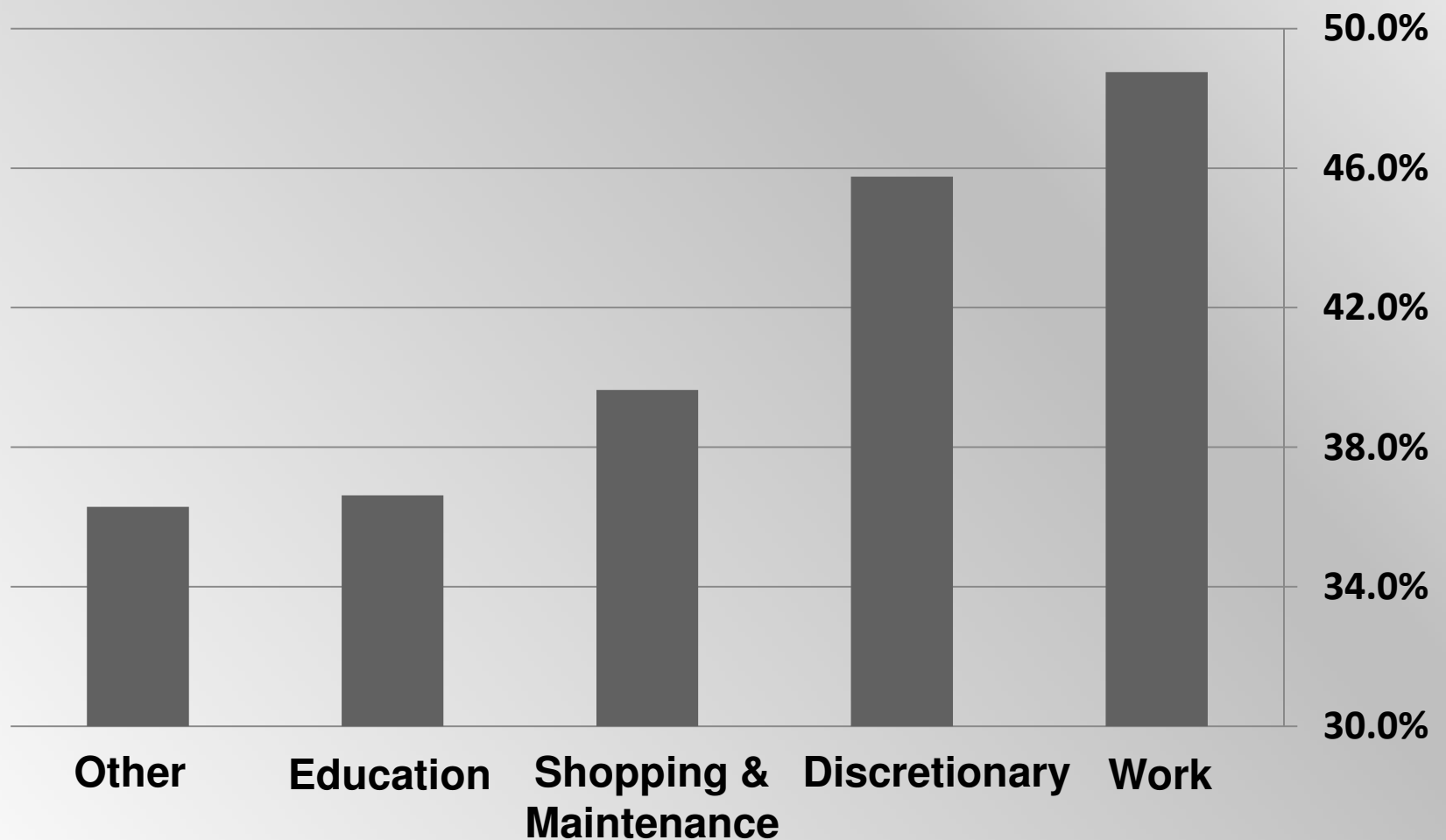
Pay Toll Distribution:





Response by Main Activity

Pay toll distribution vs. purpose:





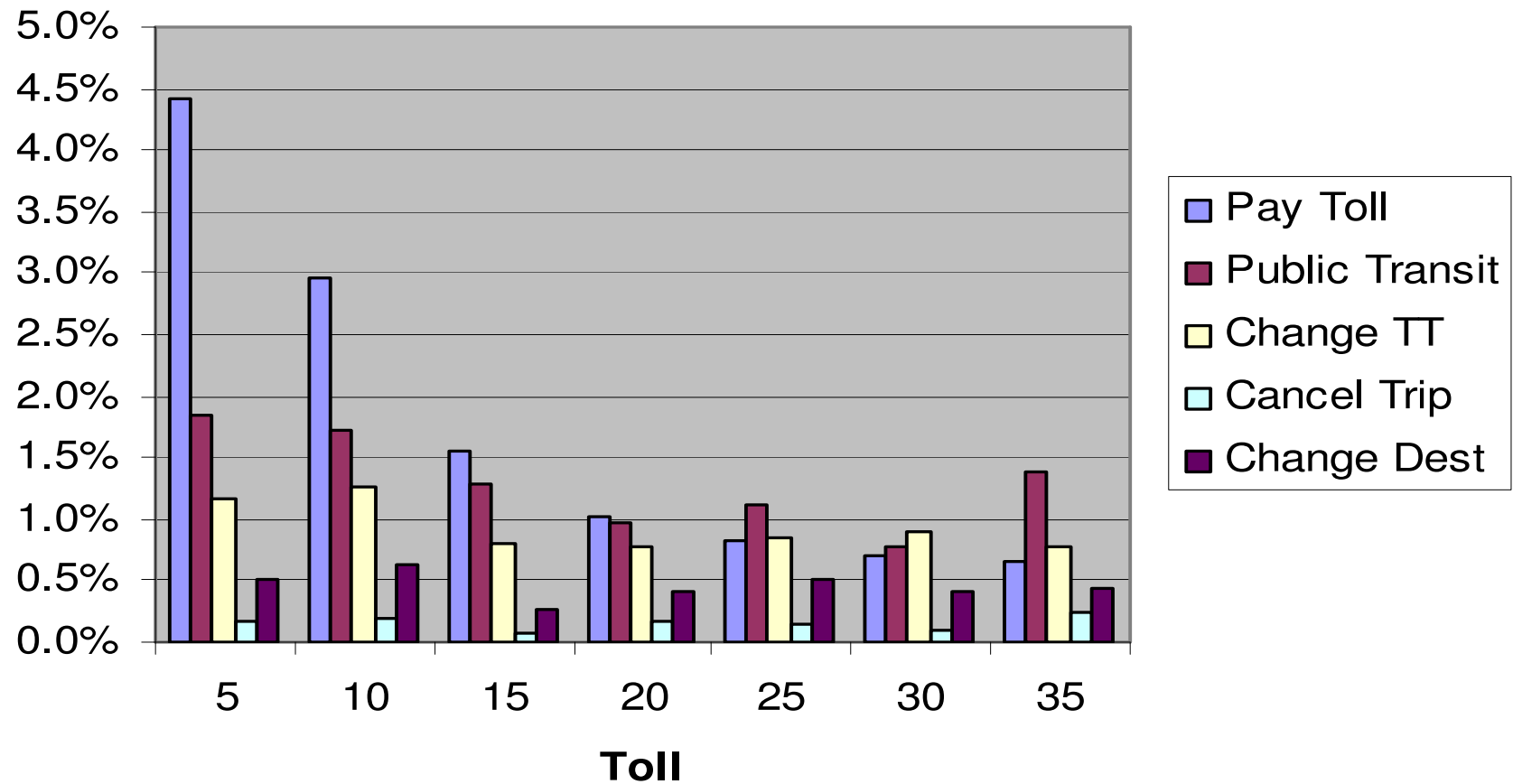
Workers' Responses





Non-Workers' Responses

NonWorkers





Multinomial Logit Results

Choice Utility

Variable	Pay Toll	Public Transit	Change Time	Cancel Trip	Change Destination
Constant [t-test]	4.5 [21.1]				
Constant [t-test]		1.96 [15.87]			
Constant [t-test]			1.63 [16.44]		
Constant [t-test]					1.1 [9.88]



Multinomial Logit Results: Continued

Socioeconomic Variables

Variable	Pay Toll	Public Transit	Change Time	Cancel Trip	Change Destination
Religious Dummy (1 if Person is Not Hiloni) [t-test]		0.141 [2]	0.141 [2]	0.141 [2]	0.141 [2]
Single Dummy (1 if Status is Single) [t-test]			0.118 [1.41]		
Male Dummy (1 if Gender = Male) [t-test]	-0.217 [-3.22]				
Middle Age Person (1 If Person is 25-44 Years Old) [t-test]	0.0578 [0.85]				
Employee Dummy (1 if Employment is Employee) [t-test]	0.268 [3.25]				
Freelancer Dummy (1 if Employment is Self-Employed) [t-test]	0.387 [3.57]				



Multinomial Logit Results: Continued

Scenario Variables

Variable	Pay Toll	Public Transit	Change Time	Cancel Trip	Change Destination
Car Travel Time Saved When Toll Applied [Minutes] [t-test]	0.0109 [3.15]				
High Complexity Tour Dummy (1 if Tour is not Simple i.e. S, H-P-H, H-P-O-H) [t-test]	0.139 [1.3]				
Public Transit "Bus" Cost [Shekels] [t-test]		-0.00559 [-3.09]			
Toll Paid in the Scenario for Average Income [Shekels] [t-test]	-0.0636 [-11.36]				
Toll Paid in the Scenario for High Income [Shekels] [t-test]	-0.0502 [-9.44]				
Toll Paid in the Scenario for Low Income [Shekels] [t-test]	-0.0714 [-13.67]				



Multinomial Logit Results: Continued

Purpose Variables

Variable	Pay Toll	Public Transit	Change Time	Cancel Trip	Change Destination
Main Activity Work Dummy (1 if Main Tour Activity is Work) [t-test]	0.128 1.51	0.128 1.51			
Main Activity Discretionary Dummy (1 if Main Tour Activity is Discretionary) [t-test]			0.272 3.11	0.272 3.11	
Main Activity Education Dummy (1 if Main Tour Activity is Education) [t-test]		0.447 2.73			
Main Activity Maintenance Dummy (1 if Main Tour Activity is Maintenance) [t-test]				0.682 3.64	
Live in Congestion Pricing Area Dummy (1 if Person lives in Congestion Toll Area) [t-test]	-0.307 -3.43				



Value of Time

- High Income: 13.0 NIS/Hr
- Mid Income: 10.3 NIS/Hr
- Low Income: 9.2 NIS/Hr



Scenario Analysis

Percent change for morning peak hour, 2015, all the metro area toll of 15 NIS for entering, 3 NIS for residents.

	Trips	Speed (base 30.5) KMH	Travel Hours	Travel KM
Small Ring	-4	+4	-7	-3
Medium Ring	-6	+6	-12	-6
Large Ring	-6	+7	-13	-7
Small Area	-5	+5	-7	-3
Medium Area	-7	+7	-13	-6
Large Area	-8	+8	-14	-7

The large ring don't add much benefits as many of those entering the medium ring live in the large ring.



Scenario Analysis

Speeds by Ring:

	Small Ring		Medium Ring		Large Ring	
No Toll	11.9		15.4		21.0	
Small Ring	14.2	19%	21.2	38%	23.3	11%
Medium Ring	13.8	16%	22.2	44%	24.6	17%
Large Ring	13.7	15%	22.0	43%	25.2	20%
Small Area	14.5	22%	21.2	38%	23.4	11%
Medium Area	13.9	17%	23.1	50%	24.7	18%
Large Area	13.8	16%	22.1	44%	26.0	24%



Scenario Analysis – Morning Only

Period	Base Auto hourly Pass (1000s)	Base Transit Pass hourly (100s)	% Auto Change	% Transit Change
06:00-07:00	367	155	2.8	0.0
07:00-08:00	486	253	-4.9	5.0
08:00-09:30	377	155	-4.3	4.9
09:30-12:00	358	113	2.9	0.0
12:00-16:00	401	152	-0.6	0.0
16:00-19:00	451	171	-1.3	2.6
19:00-20:00	426	134	-0.3	0.0
Daily Total	5700	2180	-0.7	1.7
Daily both modes			-0.05	

Thank You For Your Attention!

