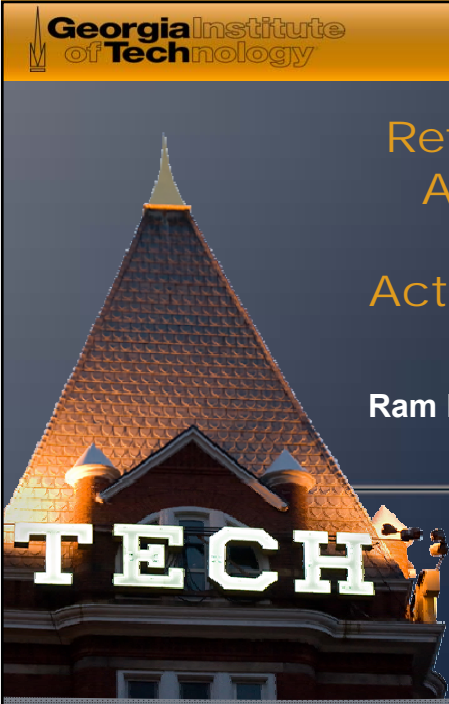


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# Reflecting the Interaction between Activity-Travel Engagement and Subjective Well-being in Activity-Based Travel Model Systems

Ram M. Pendyala, Venu M. Garikapati, and Daehyun You  
Georgia Institute of Technology




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## Motivation

- People derive satisfaction or feelings of well-being from their daily activity-travel patterns
- Possible two-way relationship between activity-travel engagement patterns and feelings of well-being



2

## Motivation

- Variables usually included in activity-travel demand models
  - Socio-demographic characteristics
  - Zonal attributes
  - Level-of-service measures
- Lifestyle preferences and attitudinal/perception variables seriously missing
- Activity-Time Use Pattern → Well-being, but also possible that Well-being → Activity-Time Use Pattern
- No existing operational framework to reflect the possible two-way relationship

3

## Research Objectives

- Identify and quantify the relationship between activity-travel patterns (time use) and feelings of well-being
- Incorporate the relationships in an operational framework that can be integrated into activity-based travel model systems

4

## Data

- Data from the Well-being (WB) Module of American Time Use Survey (ATUS) is used
- WB Module available for years 2010, 2012, 2013
- Respondents rate well-being for 3 randomly selected activities



5

## Data

- Data used for analysis
  - Adults  $\geq$  18 years
  - Workers (employed at work or absent)
  - Weekdays (Monday  $\leftrightarrow$  Thursday)
  - Without missing values for well-being scores
- After filtering/cleaning, the data included  $\sim$ 20,000 episodes (reported by  $\sim$ 6,800 individuals)

6

## Data Description

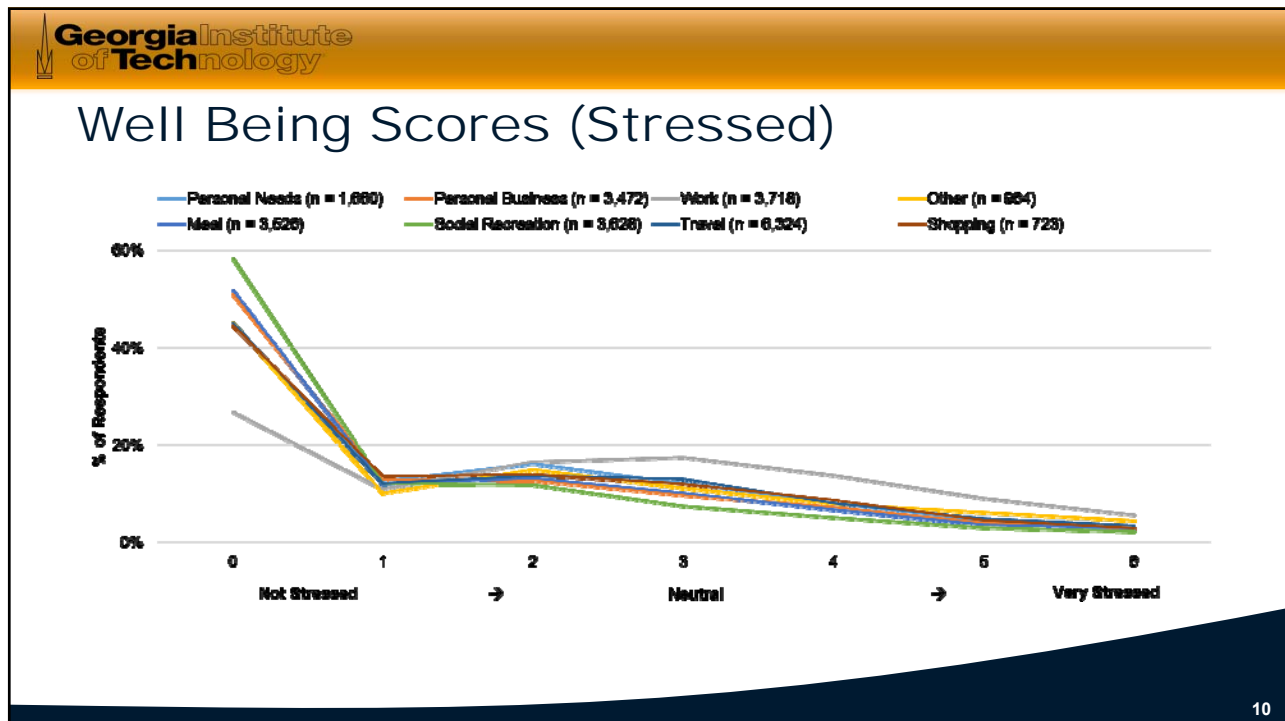
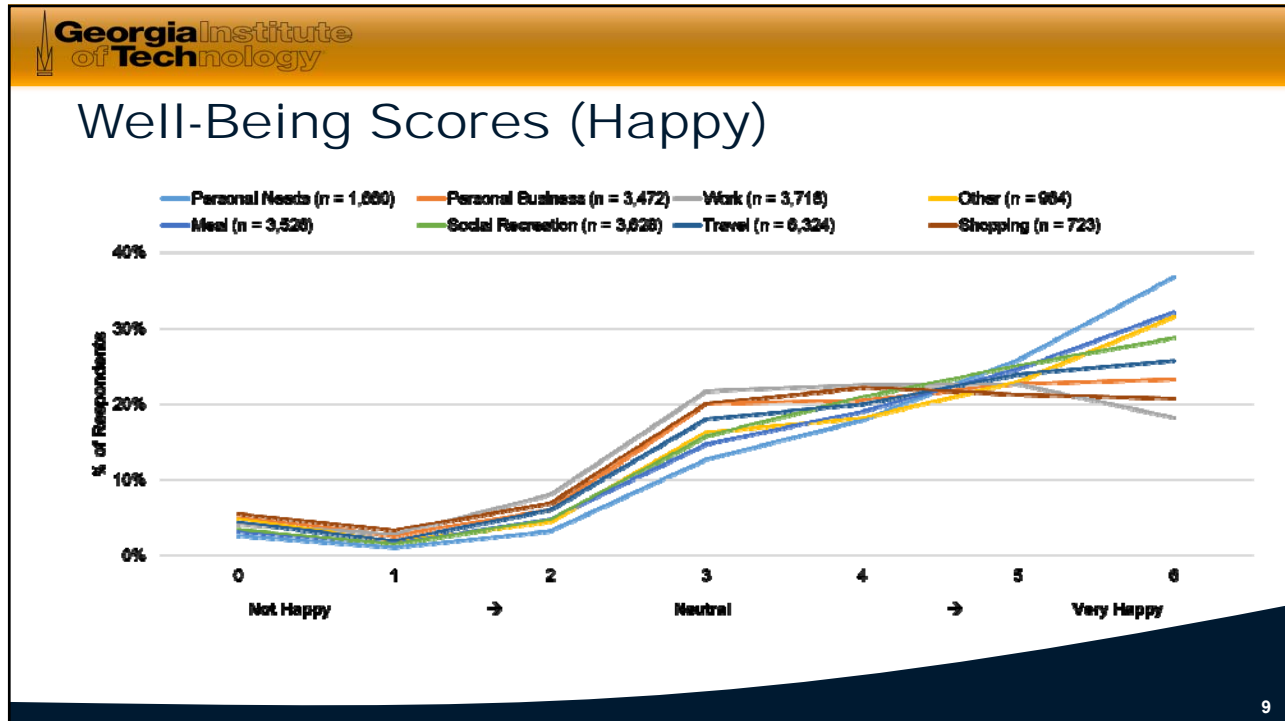
Characteristic	Mean	Standard Deviation
Household Size	2.81	1.48
% Child $\leq$ 15 years present in the household	46.2%	0.50
% Full-time employees	81.3%	0.39
% Male	49.3%	0.50
Age (18-24)	5.0%	0.22
Age (25-44)	48.0%	0.50
Age (45-64)	41.9%	0.49
Age (65 or more)	5.0%	0.22
% Living in own house	72.2%	0.15
% Employed in private firms	72.0%	0.45
% Spouse employed	44.0%	0.50
Some College or Associate Degree	30.1%	0.46
Bachelors Degree Holder	25.6%	0.44
Masters Degree or More	15.8%	0.36
Low Income Person ( $\leq$ \$25K)	27.5%	0.45
Medium Income Person ( $>$ \$25k and $\leq$ 50K)	31.6%	0.46
High Income Person ( $>$ \$50k)	30.2%	0.46
<b>Sample Size, N</b>	<b>6,795 Respondents</b>	

7

## Activity Types

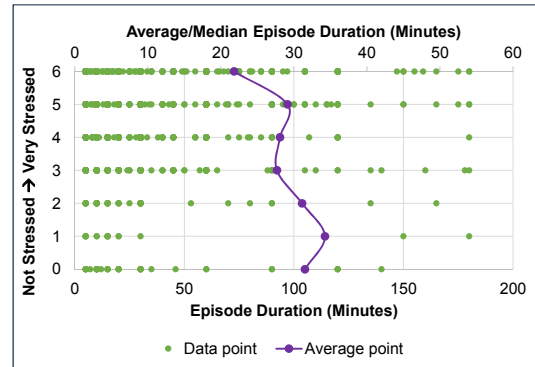
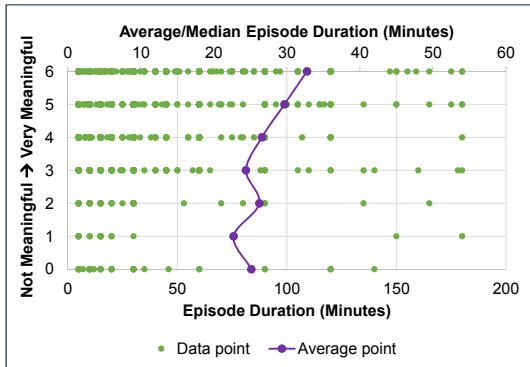


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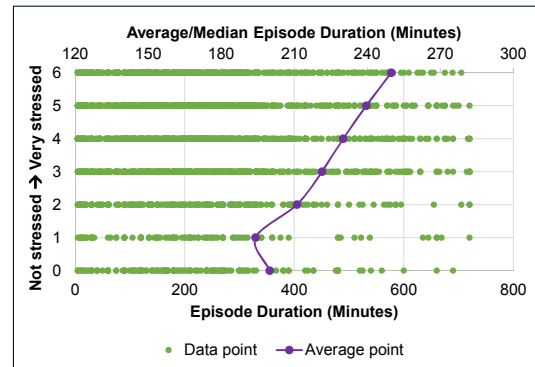
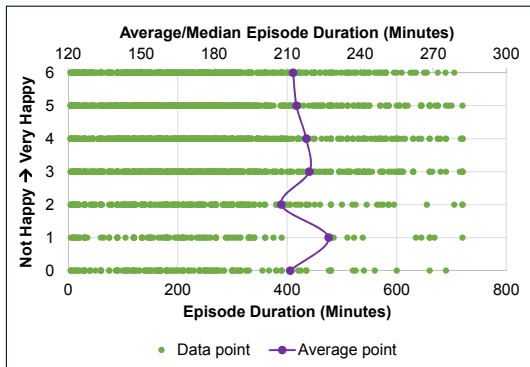
# Episode Duration vs Well-Being

## Personal Needs (n = 1,629)



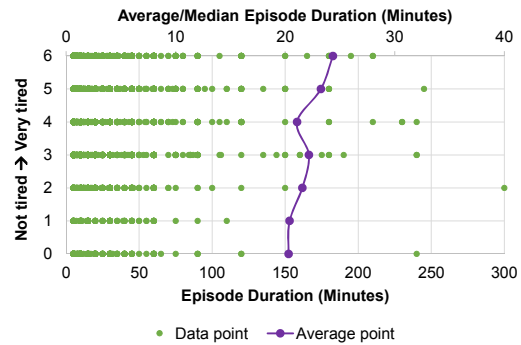
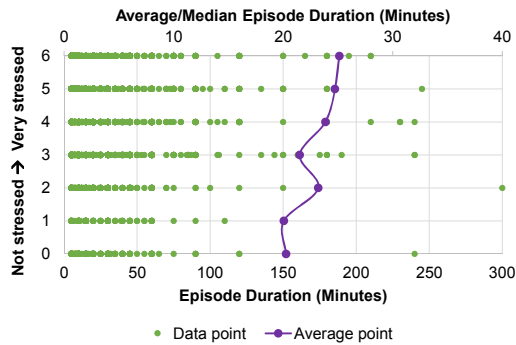
# Episode Duration vs Well-Being

## Work (n = 3,686)

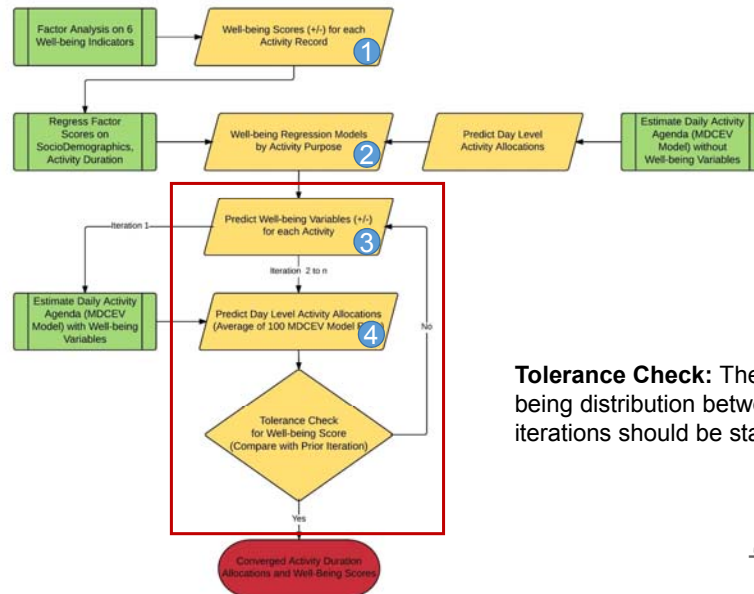


# Episode Duration vs Well-Being

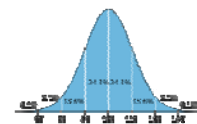
Travel (n = 6,316)



## Activity ↔ Well Being Model Framework



**Tolerance Check:** The 'Aggregate' well-being distribution between 2 consecutive iterations should be stable



## Factor Analysis

- Factor analysis performed on 'episode-level' data
- For each activity record, the respondent indicates well-being on six Likert-type scale variables
- Factor analysis parameters
  - Extraction method: Principal Axis Factoring
  - Rotation method: Varimax with Kaiser Normalization
  - Number of factors extracted: 2

15

## Factor Analysis

**Rotated Factor Matrix**

Well-being Response	Factor	
	Positive	Negative
Happy	0.75	-0.28
Meaningful	0.53	0.02
Painful	0.02	0.52
Sad	-0.15	0.61
Stressful	-0.19	0.65
Tired	-0.04	0.47

16



## Develop Well-being Equations

- Estimate factor score regression equations
- Models estimated at the episode level
- Separate regression models for each activity purpose

$$\text{Factor Score}_{(\text{positive/negative})} \sim f\{\text{sociodemographics, activity duration, } \varepsilon_{(\mu_0, \sigma_1)}\}$$

2 Well-being Scores (+ve and -ve) x 8 Activity Purposes = 16 Well-being Equations

17

## Sample Estimation Results: Regression

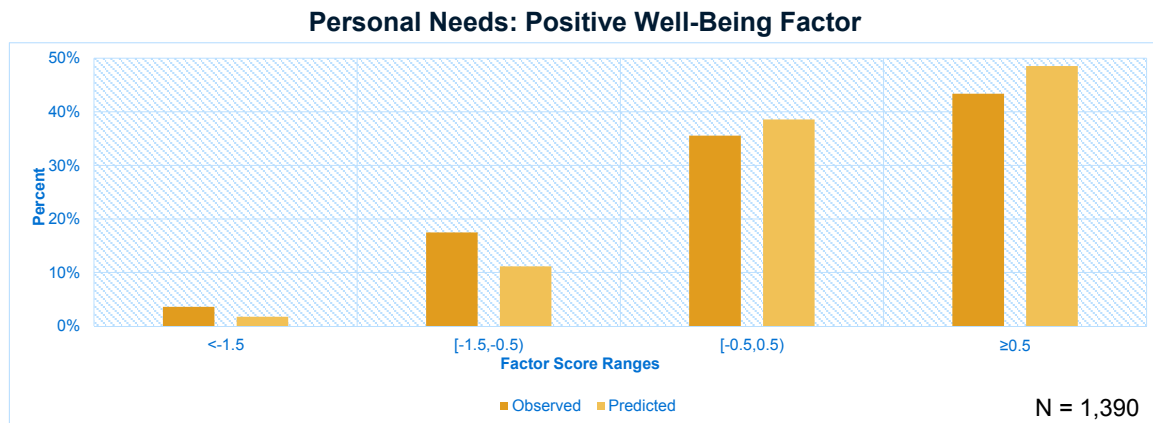
### Personal Needs: Positive Well-Being Factor

Variables	Coefficient	t-statistic
Constant	-0.46	-3.25
Rented House	0.22	4.03
Child Present in the Household	0.41	4.70
Individual from a Low Income Household ( $\leq$ \$35k)	0.27	3.78
Male Person	0.11	2.81
Ln(Activity Duration)	0.14	3.19
Individual in a Sales Job	-0.10	-2.24
Race (Asian)	-0.12	-1.50
Divorced or Separated Individual	-0.08	-1.47
Individual with a Full-time Job	0.06	1.40
Race (Black)	0.08	1.27
Own House x High Income Household ( $>$ \$75k)	0.16	1.92
Individual with College Education or More	-0.10	-1.90

Adjusted R<sup>2</sup>=0.07

18

## Replication Results



19

## Modeling Daily Activity Time Allocation

- Multiple Discrete-Continuous Extreme Value (MDCEV) model of daily activity time allocation (among 8 activity purposes)
- Two MDCEV models estimated for daily activity allocation
  - Without Well-being Variables: To produce initial activity durations
  - With Well-being Variables
- Model Specification
  - $\gamma$  profile model estimated
  - Outside good: Personal Needs (includes Sleep)

20

## Significant Parameters in the Baseline Utility: Illustrative Results

Activity	Explanatory Variables					
	Age (18-24)	Child Presence	Full Time Employee	Male	Low Income Person (≤ \$25K)	High Income Person (≥ \$75K)
Personal Business	↓					↓
Work			↑	↑		
Other		↓				
Meal					↓	
Social Recreation	↑	↓		↑		
Shopping						
Travel	↑				↓	

## Association Between Well-Being Variables and Activity Time Allocation

Activity	Well-Being Variables													
	PB <sub>P</sub>	PB <sub>N</sub>	W <sub>P</sub>	W <sub>N</sub>	O <sub>P</sub>	O <sub>N</sub>	M <sub>P</sub>	M <sub>N</sub>	SR <sub>P</sub>	SR <sub>N</sub>	S <sub>P</sub>	S <sub>N</sub>	T <sub>P</sub>	T <sub>N</sub>
Personal Business (PB)	↓	↑												
Work (W)			⊘	↑										
Other (O)					↓	↑								
Meal (M)						↑	↓							
Social Recreation (SR)								↑	↓					
Shopping (S)										↓	↑			
Travel (T)												⊘	↑	

Subscript 'P' refers to positive well-being variable  
 Subscript 'N' refers to positive well-being variable

⊘ Not Significant

## Baseline Constants and Translation Parameters

Activity	Baseline Constants		Translation Parameters	
	Coefficient	t-statistic	Coefficient	t-statistic
Personal Business	-5.75	-110.60	24.18	30.30
Work	-6.44	-117.15	215.96	18.31
Other	-6.62	-123.95	38.48	23.87
Meal	-4.44	-90.25	4.92	22.40
Social Recreation	-5.75	-112.97	19.44	20.14
Shopping	-7.47	-135.98	12.79	22.13
Travel	-4.52	-111.14	10.47	27.42

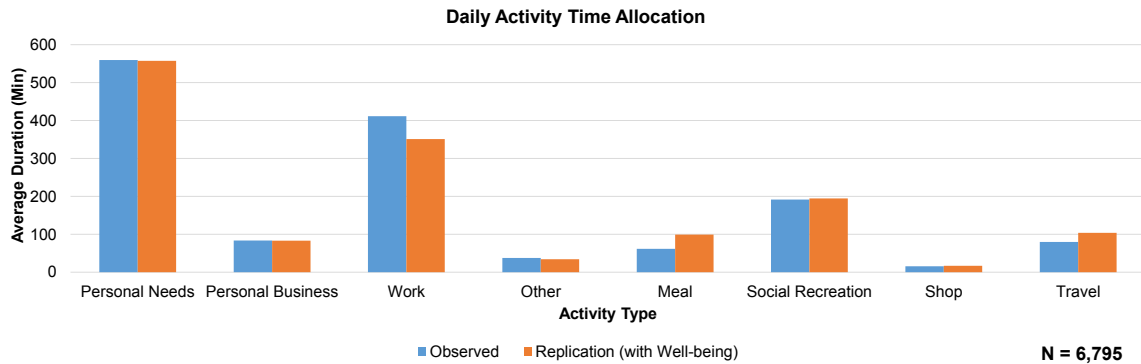
23

## Goodness of Fit Statistics

Model	Log-Likelihood	Degrees of freedom (df)	Likelihood Ratio	Critical $\chi^2_{(0.001,df)}$ Value
Constants Only (Base Model)	-229274.32	14	--	
MDCEV (No Well-being Variables)	-228603.0	39	1342.64 (Base)	52.62 <sub>(0.001,25)</sub>
MDCEV (With Well-being variables)	-225655.64	51	7237.36 (Base) 5894.80 (No Well-being)	61.66 <sub>(0.001,37)</sub> 32.91 <sub>(0.001,12)</sub>

24

## MDCEV: Replication of Observed Patterns



25

## Sensitivity of Time Allocation to Well-Being Score

- Sensitivity analysis exercises were carried out to test the impact of change in well-being scores on time allocation

### Scenarios

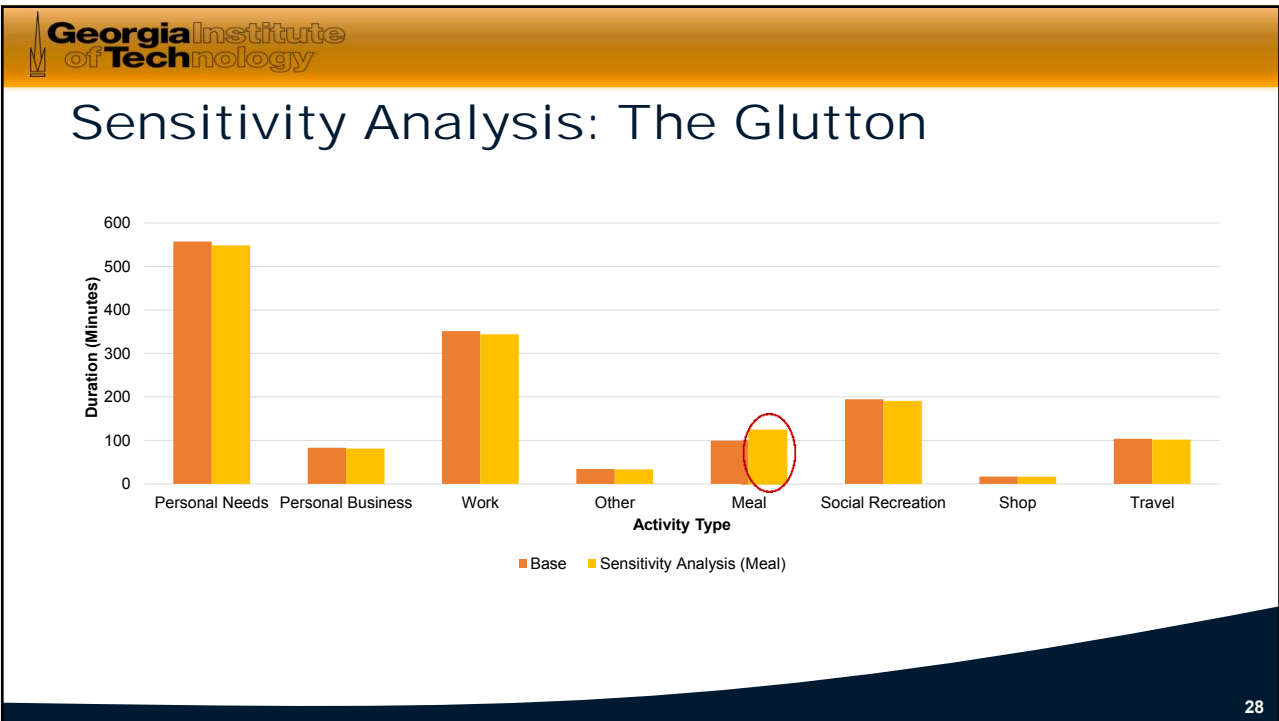
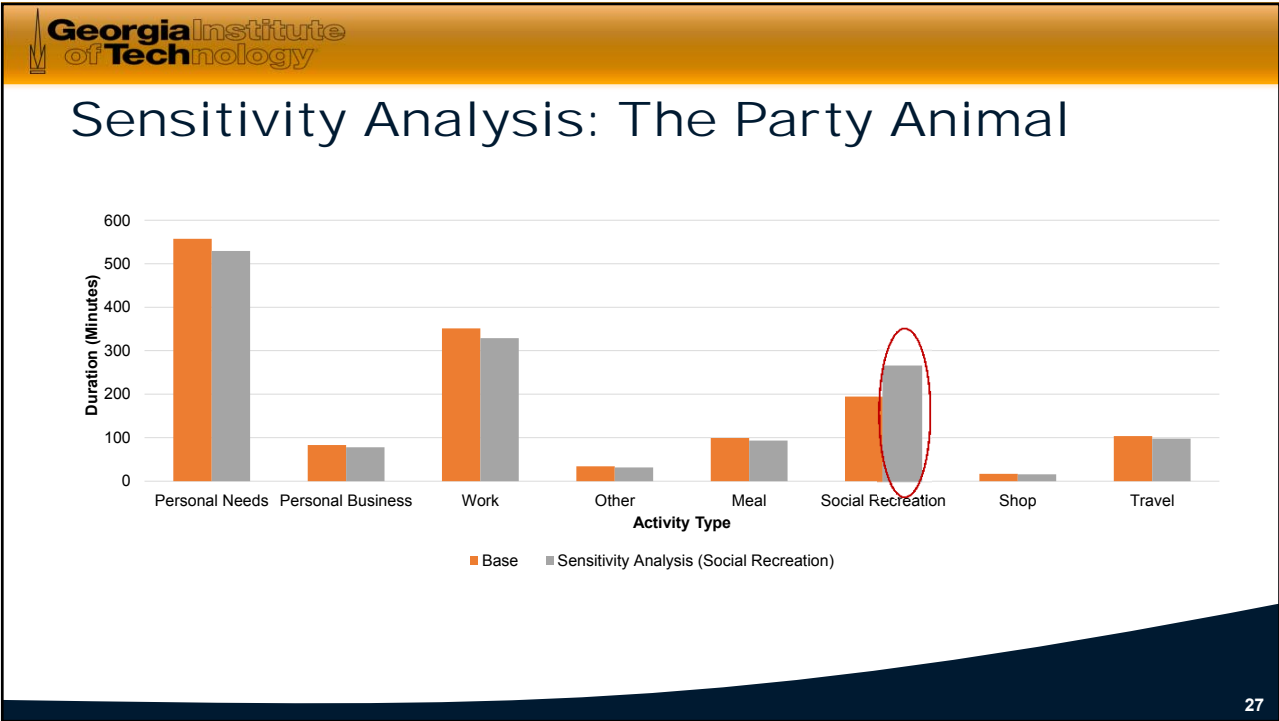


**The Party Animal:** Increase positive well-being score for social recreation (for all individuals) by 15%



**The Glutton:** Increase positive well-being score for meal (for all individuals) by 15%

26



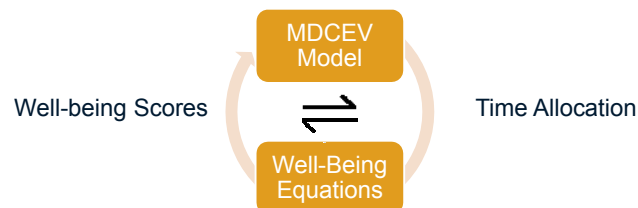
## Summary

- Developed framework to account for possible two-way relationship between activity-travel patterns and subjective well-being
- Modeled activity time allocation as a function of well-being scores
- Preliminary model results point to significant association between well-being scores and daily activity time allocation
- Estimated model performs very well in replicating observed activity allocation patterns

29

## Work in Progress

- Calibration/validation of individual model components
- Iterative process to reflect the balance between well-being and time allocation to activities that individuals try to achieve



30

To Conclude...



On a Scale of 0-6

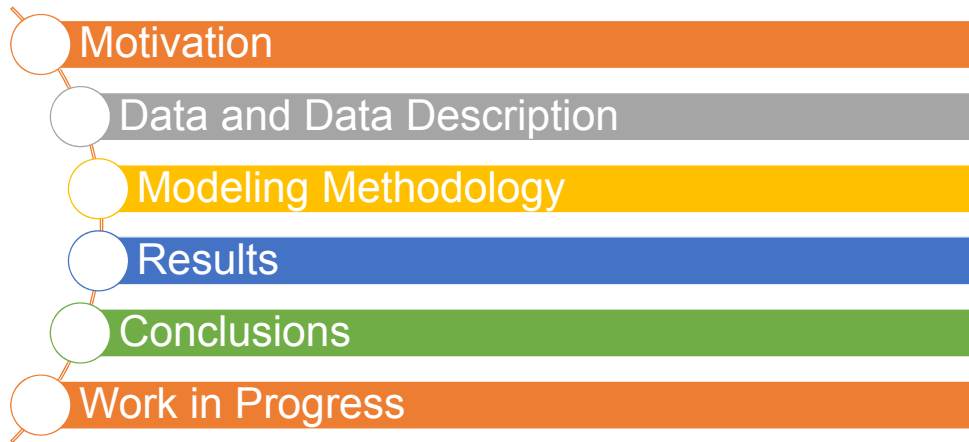
31

Questions/Comments

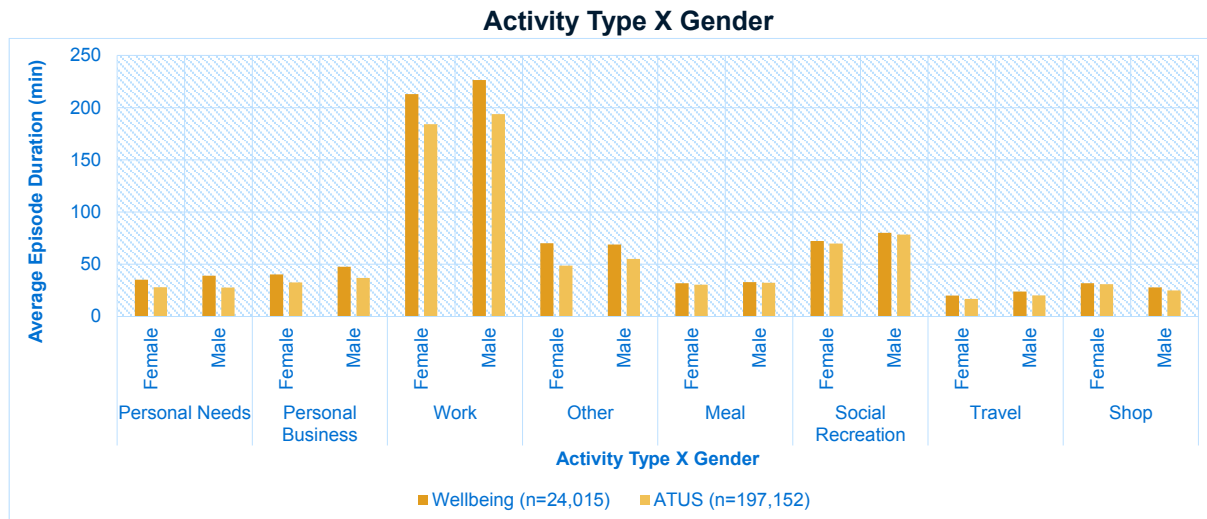




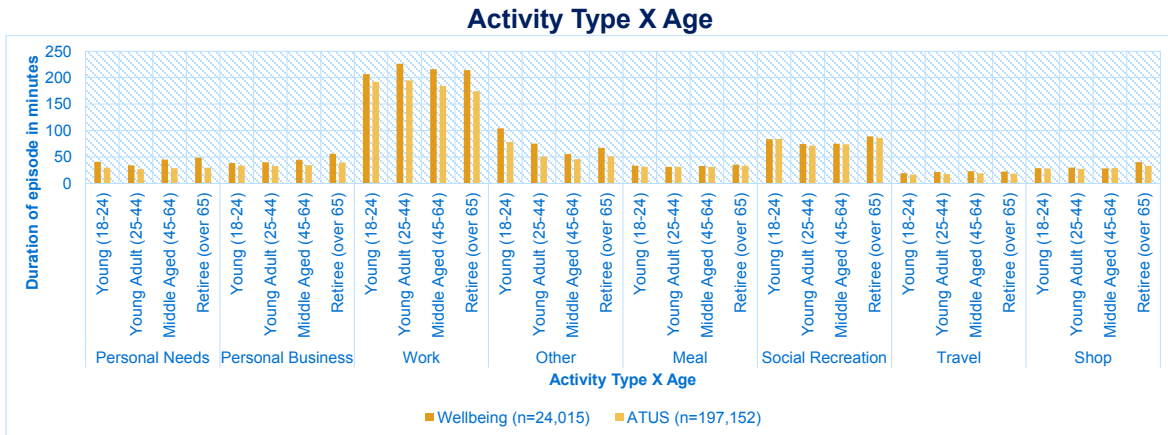
# Outline



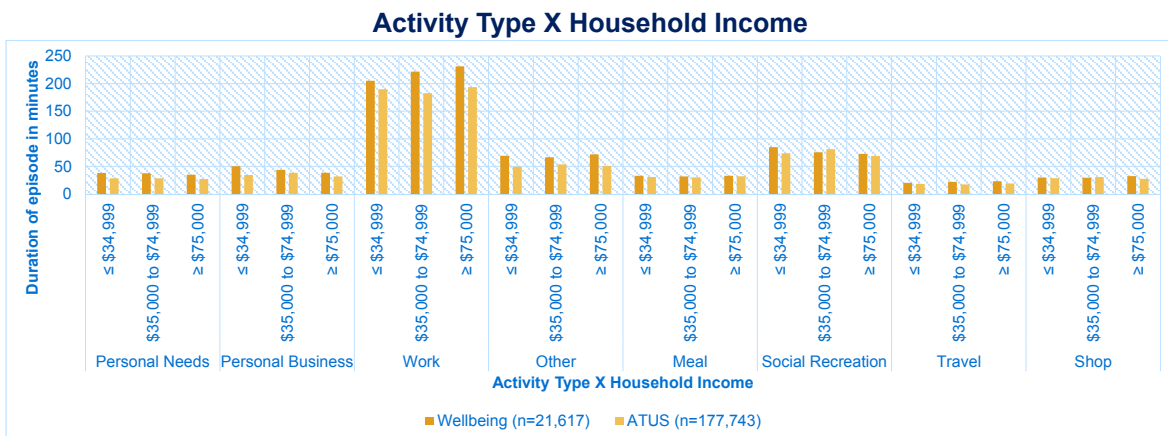
# Episode Durations (ATUS vs Well-Being Data)

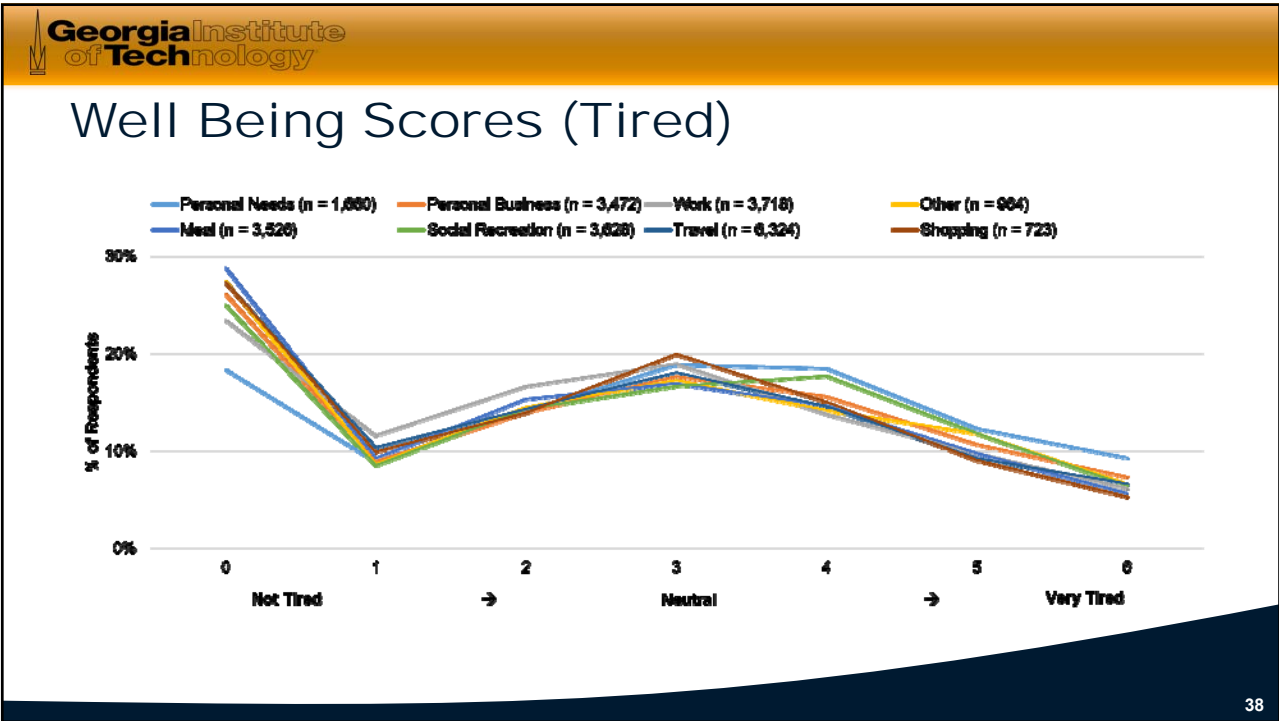
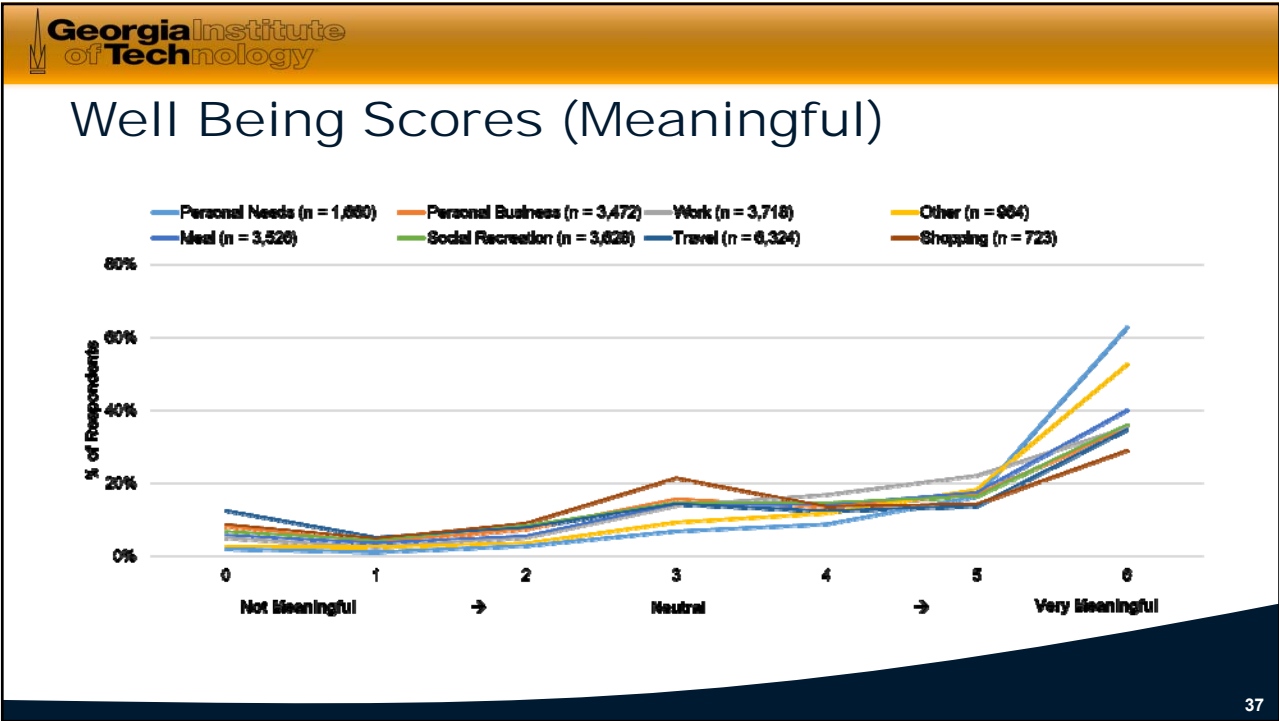


## Episode Durations (ATUS vs Well-Being Data)



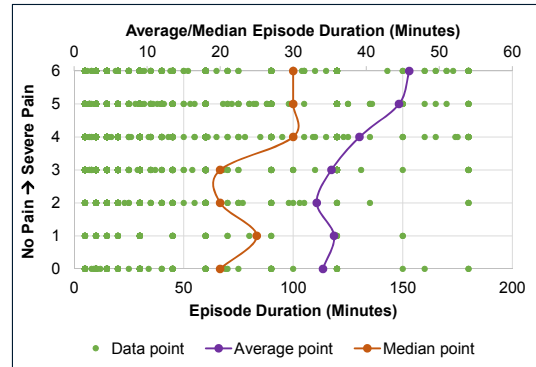
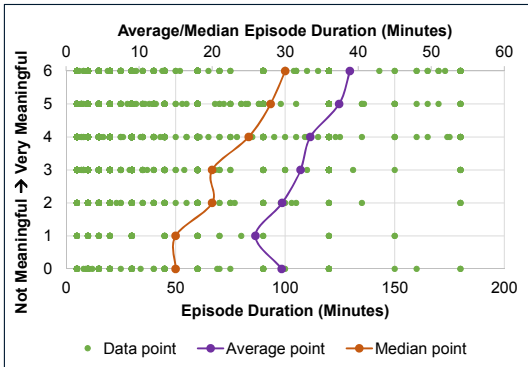
## Episode Durations (ATUS vs Well-Being Data)





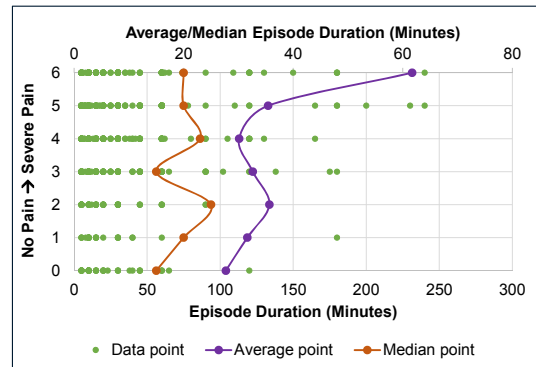
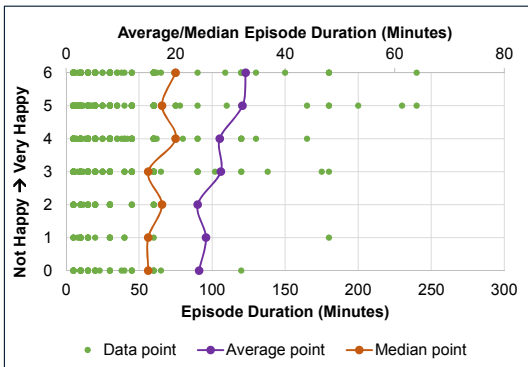
# Episode Duration vs Well-Being

## Personal Business (n = 3,370)



# Episode Duration vs Well-Being

## Shopping (n = 3,686)



# Sample Estimation Results: Regression

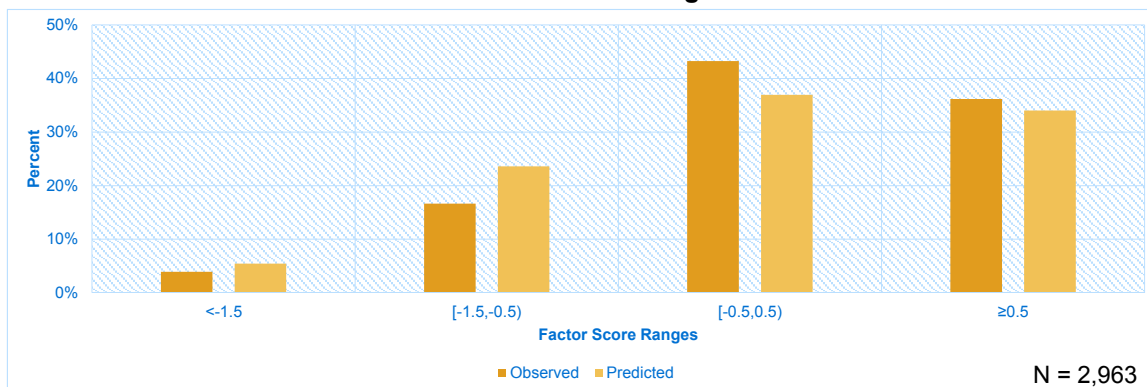
**Meal: Positive Well-Being Factor**

Variable	Coefficients	t-statistic
Activity Duration	2E-03	4.62
Individual with College Education or More	-0.16	-4.25
Married Individual	0.15	4.59
Individual from a Low Income Household ( $\leq$ \$35k)	0.19	4.19
Male Individual	-0.07	-2.34
Household size (3-5)	0.04	1.02
Race (African American)	0.10	2.26
Education (Some College but No Degree)	-0.08	-2.22
Construction Job	-0.07	-1.39
Individual from a Middle Income Household (\$35-75K)	0.16	3.46
Working in a Single Job	-0.18	-3.14
Own House x High Income Household ( $>$ \$75k)	0.14	2.58
Rented House	0.09	2.29
Age <sup>3</sup>	3.93E-07	2.35

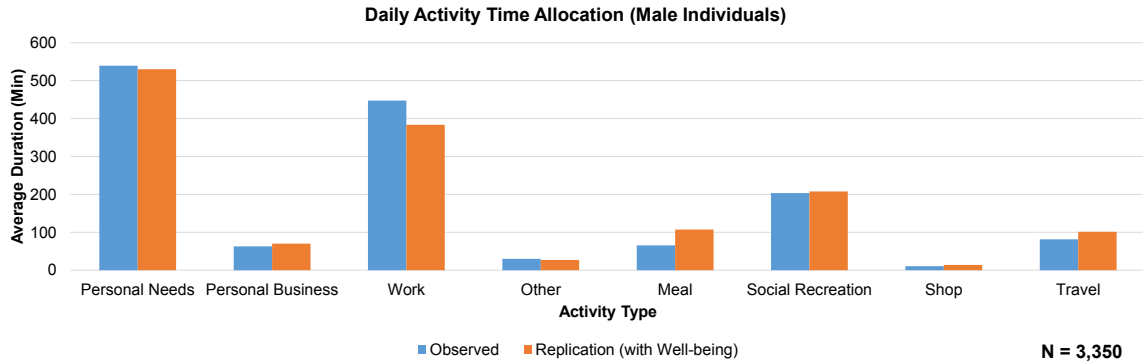
Adjusted R<sup>2</sup>=0.06

# Replication Results

**Meal: Positive Well-Being Factor**



# MDCEV: Replication of Observed Patterns



# MDCEV: Replication of Observed Patterns

