

# Center for Teaching Old Models New Tricks (TOMNET)

## A USDOT Tier 1 University Transportation Center

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### PROJECT PROPOSAL

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#### **Title: Heterogeneity in the Relationship Between the Built Environment and Bicycling**

**Principal Investigator:** Deborah Salon, Assistant Professor, School of Geographical Sciences and Urban Planning, Arizona State University

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#### **1. Introduction/Problem Statement**

Bicycling offers a wide range of benefits to both individuals and society. Cycling is an environmentally friendly and affordable mode of transportation that is viable for short distance trips. Using bicycles instead of cars reduces fuel consumption and associated harmful emissions, provides exercise for the cyclists, and can improve quality of life overall. For these reasons, urban planners, public health advocates, and others are looking for strategies to promote more bicycling, including improvements to the built environment that make bicycling more attractive. An understanding of the relationship between the built environment and individual decisions to bicycle provides an important basis for the development of such strategies.

There are numerous studies in the current literature that focus on understanding the link between the built environment and bicycling from the perspectives of both health and transport. Pikora et al. (2003) and Handy et al. (2002) provide reviews of this literature through the early 2000's. Built environment characteristics included in these studies include various metrics of density, land use mix, street network connectivity, bicycle infrastructure availability, green space, and destination accessibility. For many of these built environment characteristics, the literature does not provide a clear message as to the extent to which they are related to the choice to bicycle. Indeed, despite theory and intuition to the contrary, the dominant finding for each of these land use characteristics is that they do not have a strong relationship with the choice to bicycle at all (e.g. Ewing, Schroeder, & Greene, 2004; Ducheyne et al., 2013; Carlson et al., 2015; Beenackers et al., 2012)!

#### **2. Project Objectives**

The present study adds to this existing literature by focusing on the heterogeneity in the association between built environment characteristics and bicycling behavior. Of existing studies, only a handful explicitly investigated heterogeneity in this relationship, and these are limited to heterogeneity across genders (Trapp et al., 2011; Mitra and Nash, 2018). A comparison of the larger universe of prior studies indicates that associations between bicycling and built environment characteristics are not always consistent, suggesting that heterogeneity is present. Because each study's sample, measure of the built environment, and estimation method was different, however, it is unclear whether the inconsistency in prior findings was due to different samples, measures, and methods, or due to heterogeneity in the underlying relationships. We use a single large survey together with measures of built environment characteristics and consistent statistical methods to estimate the association between bicycling frequency and built environment characteristics for different subpopulations.

### **3. Proposed Methodology and Data**

The data for this project will come from the California Household Travel Survey, conducted in 2012 and 2013. The CHTS sampled households throughout California, collecting household and individual demographic data, information about habitual commute trips, and a 24-hour travel diary. The survey included three questions related to bicycling:

1. How many bicycles in working condition are available to people in your household?
2. In the past week, how many times did you/this person ride a bicycle outside including bicycling for exercise?
3. How do/does you/this person normally get to this primary job/school?

We will use the answers to these questions, together with built environment information about respondents' home, work, and school locations, to investigate the relationship between bicycling and the built environment in this dataset, as well as heterogeneity in that relationship.

Built environment information will be derived from three sources: the 2012 Urban Footprint base variables, the American Community Survey from the U.S. Census Bureau, and the Longitudinal Employer-Household Dynamics (LEHD) data, also from the U.S. Census Bureau. The Urban Footprint variables include land cover, parcel, census, and transportation network information measured at the resolution of a 150-meter grid. These data are available for the San Francisco Bay Area, the Sacramento metropolitan area, the San Joaquin Valley, the Los Angeles metropolitan area, and San Diego County, representing all major urban and suburban areas in California.

The methodologies used transform these data into an answer to our research question will include data fusion (merging built environment data with travel survey data) and multivariate statistical analysis. In the statistical analysis, we will focus especially on exploring heterogeneity across genders, age groups, and worker status. To do so, we will employ a combination of subsampling of the data into categories and interacting specific built environment variables with respondent demographics in order to test the hypothesis that the relationship between bicycling and these variables may differ between demographic groups.

### **4. Work Plan (Project Tasks)**

#### **Task 1: Fuse CHTS data with built environment variables from multiple data sources**

The task is to use GIS to spatially merge multiple data sets that are available at different spatial resolutions. In addition, cleaning of the survey data may be necessary to insure robust results. This project is a continuation of work that had begun under a contract to the California Department of Transportation, so much of the data cleaning and merging is already complete. We will do a final check of these processes as a first step in this project.

#### **Task 2: Complete review of existing literature**

There is a large literature on the topic of bicycling and its relationship to various built environment characteristics. We have already reviewed a portion of this literature, but in order to successfully complete this project, a more comprehensive review of this literature will be necessary. Specifically, we will be documenting and comparing the findings of each study with regard to the relationships they found between different built environment characteristics and bicycling.

#### **Task 3: Statistical model development and testing**

Statistical modeling for this project will begin with the goal to estimate the overall average relationship between built environment characteristics and bicycling, and comparing these estimates with those in the literature reviewed in Task 2. Once we are satisfied that our model and data are performing adequately, we will work toward testing to see if we find different relationships for different demographic subpopulations within our dataset.

#### Task 4: Report results and publish in a peer-reviewed journal

The final task in this project is to write up the results and work toward publishing them in a peer-reviewed academic journal. As is evident in the project schedule, we do not expect that this task will be completed before the end of the project period, but we hope that we will complete the task by the end of 2018.

### 5. Project Schedule

	2017					2018						
Task	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July
1			■	■	■	■	■					
2			■	■	■	■	■	■				
3							■	■	■	■	■	■
4											■	■

Note that we do not expect this particular project to begin at the beginning of the academic year, which partly explains why we do expect that the last task of writing the final report and publication will extend beyond the funding period. Since TOMNET has multiple years of funding and the research team for this project consists of TOMNET core team members, we feel comfortable stretching this project across funding years.

### 6. Relevance to the Center Theme/Mission

This project's relevance to TOMNET's theme is in its combination of data fusion and statistical analysis that explicitly accounts for heterogeneity in *relationships*. Gaining a clearer understanding of heterogeneity in relationships is central to the TOMNET research mission. In this case, the heterogeneity being explored centers on demographic characteristics rather than attitudes, but the methods developed and used in this work are fundamentally similar to much attitudinal research.

### 7. Anticipated Outcomes and Deliverables

We anticipate that this research will contribute new insights to the literature on travel choices and the built environment by illustrating that the effect of the built environment on one's travel choices may actually be different depending on the person. In this case, we will be focusing particularly on the choice to bicycle, but this paper is part of a larger theme of heterogeneity in the literature that is relatively less explored. Heterogeneity in *outcomes* is commonly discussed, but heterogeneity in *relationships* is less so.

The main deliverable of this project will be a written report and published paper documenting the work and findings.

### 8. Research Team and Management Plan

The research team for this project will include Matthew Wigginton Conway and Deborah Salon. Conway is beginning his PhD studies in the School of Geographical Sciences and Urban Planning at ASU in August 2017, and Salon is both a faculty member in the School and Associate Director of TOMNET.

Conway has experience in transportation planning, accessibility modeling, and computer programming. Salon has experience in travel behavior research and analysis. Both team members have substantial experience working intensively with varied transportation-related datasets, including the assembly of fused datasets and statistical modeling.

Salon and Conway will meet regularly to ensure timely delivery of the project.

## 9. Technology Transfer Plan

We plan to publish this research in a peer-reviewed academic journal, as well as to present the work both with ASU as well as at academic conferences (e.g. Transportation Research Board Annual Meeting).

## 10. Workforce Development and Outreach Plan

One of the main team members on this project will be Conway, who will be a PhD student in the School of Geographical Sciences and Urban Planning at ASU. Conducting this project will provide useful training for him, and will give him experience in academic publishing as well. So that other graduate students in SGSUP may benefit from the project, we will share progress with a transportation research working group that meets weekly during the academic year. Once the data are analyzed, we plan to present findings at major transportation and geography conferences.

## 11. References

- Beenackers, M.A., Foster, S., Kamphuis, C.B.M., Titze, S., Divitini, M., Knuiman, M., van Lenthe, F., & Giles-Corti, B. (2012). Taking Up Cycling After Residential Relocation: Built Environment Factors. *American Journal of Preventive Medicine*, 42(6), 610-615. doi: 10.1016/j.amepre.2012.02.021
- Carlson, J.A., Saelens, B.E., Kerr, J., Schipperijn, J., Conway, T.L., Frank, L.D., Chapman, J.E., Glanz, K., Cain, K.L., & Sallis, J.F. (2015). Association between neighborhood walkability and GPS-measured walking, Bicycling and Vehicle Time in Adolescents. *Health & Place*, 32, 1–7. doi:10.1016/j.healthplace.2014.12.008
- Ducheyne, F., De Bourdeaudhuij, I., Lenoir, M., Spittaels, H., & Cardon, G. (2013). Children's cycling skills: Development of a test and determination of individual and environmental correlates. *Accident Analysis & Prevention* 50, 688–697. doi:10.1016/j.aap.2012.06.021
- Ewing, R., Schroeder, W. & Greene, W. (2004). School location and student travel: analysis of factors affecting mode choice. *Transportation Research Record: Journal of the Transportation Research Board*, 1895, 55-63. doi:10.3141/1895-08
- Handy S.L., Boarnet, M.G., Ewing, R., & Killingsworth, R.E. (2002). How the Built Environment Affects Physical Activity Views from Urban Planning. *American Journal of Preventive Medicine*, 23(2S), 64-73. doi:10.1016/S0749-3797(02)00475-0
- Mitra, R., & Nash, S. (2018). Can the built environment explain gender gap in cycling? An exploration of university students' travel behavior in Toronto, Canada. *International Journal of Sustainable Transportation*. doi:10.1080/15568318.2018.1449919
- Pikora, T., Giles-Corti, B., Bull, F., Jamrozik, K., & Donovan, R. (2003). Developing a framework for assessment of the environmental determinants of walking and cycling. *Social Science & Medicine*, 56, 1673-1703. doi:10.1016/S0277-9536(02)00163-6
- Trapp, G., Giles-Corti, B., Christian, H., Bulsara, M., Timperio, A., McCormack, G., & Villanueva, K. (2011). On your bike! a cross-sectional study of the individual, social and environmental correlates of cycling to school. *International Journal of Behavioral Nutrition and Physical Activity*, 8(1), 1–10. doi:10.1186/1479-5868-8-123

## 12. Qualifications of Investigators

### DEBORAH SALON, Ph.D.

Assistant Professor, School of Geographical Sciences and Urban Planning,  
Arizona State University, Tempe, AZ 85287-3005. Ph: (480) 965-7475; Email:  
deborah.salon@asu.edu

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#### EDUCATION

- University of California at Davis, Davis, CA, USA
  - Ph.D., Agricultural and Resource Economics, May 2006
- Carleton College, Northfield, MN
  - B.A., Physics, June 1994

#### PROFESSIONAL EXPERIENCE

- Arizona State University
  - Assistant Professor, School of Geographical Sciences and Urban Planning, 2014-present
  - Graduate Faculty, School of Sustainability, 2016-present
  - Senior Sustainability Scientist, Global Institute of Sustainability, 2014- present
- University of California, Davis, Institute of Transportation Studies
  - Professional Researcher, 2008-2014
- The Earth Institute at Columbia University
  - Post-Doctoral Fellow, 2006-2008

#### RELEVANT REFEREED PUBLICATIONS (Total: 17 Refereed Publications)

1. Salon, Deborah. (2015) Heterogeneity in the relationship between the built environment and driving: Focus on neighborhood type and travel purpose. *Research in Transportation Economics*, 52, 34-45.
2. Cook, Jonathan, James Sanchirico, Deborah Salon, and Jeffrey Williams. (2015) Empirical distributions of vehicle use and fuel efficiency across space: Implications of asymmetry for policy analysis. *Transportation Research Part A: Policy and Practice*, 78, 187-199.
3. Salon, Deborah, Marlon Boarnet, Susan Handy, Steven Spears, and Gil Tal. (2012) How do local actions affect VMT? A critical review of the empirical evidence. *Transportation Research Part D* 17(7): 495-508.
4. Salon, Deborah. (2009) Neighborhoods, cars, and commuting in New York City: A discrete choice approach. *Transportation Research Part A: Policy and Practice* 43(2): 180-196.

#### RELEVANT RESEARCH PROJECTS (Total Sponsored Research: ~ \$600,000)

- *A Spatial Analysis of Housing and Transportation Affordability in Los Angeles County*, University of California Transportation Center, 2012-2015
- *Quantifying the effect of local government actions on VMT*, California Air Resources Board, 2010-2014

#### JOURNAL EDITORIAL ACTIVITIES

- CO- EDITOR OF SPECIAL ISSUE, *RESEARCH IN TRANSPORTATION ECONOMICS* (ELSEVIER), 2015
- EDITORIAL BOARD, *JOURNAL OF TRANSPORTATION GEOGRAPHY* (ELSEVIER), 2016-present
- EDITORIAL BOARD, *TRANSPORTATION RESEARCH PART D* (ELSEVIER), 2017-present

#### EDUCATION AND STUDENT ADVISING

- Thesis/Dissertation Major Advisor/Chair: 3 MS (Thesis) students completed, 1 MS (Thesis) student in progress
- Thesis/Dissertation Committee Member: 2 PhD students completed; 5 MS (Thesis) students completed

### 13. Budget Including Non-Federal Matching Funds

Institution: ASU

Project Title: Heterogeneity in the relationship between the built environment and bicycling

Principal Investigator: Deborah Salon

Budget Period: 8/1/2017 - 07/31/2018

CATEGORY	Budgeted Amount from Federal Share	Budgeted Amount from Matching Funds	Explanatory Notes; Identify Source of Matching Funds
Faculty Salaries	\$4,379.50	\$8,319.50	0.5 month summer salary CS: Salon 5% AY effort + 0.5 month summer salary
Other Staff Salaries	\$-	\$-	
Student Salaries	\$8,000.00	\$6,250.00	SNR Fellowship, SGSUP
Fringe Benefits	\$1,577.47	\$2,683.77	
<b>Total Salaries &amp; Benefits</b>	\$13,956.97	\$17,253.27	
Student Tuition Remission	\$4,044.00	\$4,044.00	SNR Fellowship, SGSUP
Operating Services and Supplies	\$-	\$-	
Domestic Travel	\$2,000.00	\$-	
Other Direct Costs (StataSE Perpetual License)	\$400.00	\$-	
Other Direct Costs (specify)	\$-	\$-	
<b>Total Direct Costs</b>	\$20,400.97	\$21,297.27	
F&A (Indirect) Costs	\$9,323.47	\$9,834.36	
<b>TOTAL COSTS</b>	\$29,724.44	\$31,131.63	

**Grant Deliverables and Reporting Requirements for UTC Grants (November 2016)**  
**Exhibit F**

<b>UTC Project Information</b>	
Project Title	Heterogeneity in the relationship between the built environment and bicycling
University	Arizona State University
Principal Investigator	Deborah Salon
PI Contact Information	Deborah.Salon@asu.edu
Funding Source(s) and Amounts Provided (by each agency or organization)	TOMNET: \$29,724 ASU, SGSUP: \$31,132
Total Project Cost	\$ 60,856
Agency ID or Contract Number	
Start and End Dates	8/1/2017 - 7/31/2018
Brief Description of Research Project	<p>Bicycling is an environmentally friendly, healthy, and affordable mode of transportation that is viable for short distance trips. Urban planners, public health advocates, and others are therefore looking for strategies to promote more bicycling, including improvements to the built environment that make bicycling more attractive. This study presents an analysis of how key built environment characteristics relate to bicycling frequency based on a large sample from the 2012 California Household Travel Survey and detailed built environment data. The built environment characteristics we explore include residential and intersection density at anchor locations (home, work, school), green space, job access, land use mix, and bicycle infrastructure availability. Analyses are conducted separately for three distinct demographic groups: school-age children, employed adults, and adults who are not employed. The key conclusion from this work is that the relationship between bicycling and some built environment characteristics varies between types of people – most dramatically between adults and children. To develop targeted policies with scarce resources, local policymakers need specific guidance as to which investments and policy changes will be most effective for creating “bikeable” neighborhoods. Our work indicates that the answer depends – at least in part – on who these bikeable neighborhoods are meant to serve.</p>
Describe Implementation of Research Outcomes (or why not implemented)	n/a
Place Any Photos Here	

Impacts/Benefits of Implementation (actual, not anticipated)	n/a
Web Links <ul style="list-style-type: none"><li>• Reports</li><li>• Project Website</li></ul>	