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Peak of the Day or the Daily Grind: Commuting and Subjective Well-Being

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by

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Abstract

To understand the impact of daily travel on personal and societal well-being, researchers are developing measurement techniques that go beyond satisfaction-based measures of travel. Metrics related Subjective Well-Being (SWB), defined as an evaluation of one's happiness or life satisfaction, are increasingly important for evaluating transportation and land-use policies. This dissertation examines commute well-being, a multi-item measure of how one feels about the commute to work, and how it is shaped. Data are from a web-based survey of workers (n=828) in Portland, Oregon, U.S.A., with three roughly equally sized groups based on mode: bike, transit and car users. Descriptive analysis shows that commute well-being varies widely across the sample. Those who bike and walk to work have significantly higher commute well-being than transit and car commuters. A multiple linear regression model shows that along with travel mode, traffic congestion, travel time, income, health, attitudes about travel, job satisfaction and residential satisfaction also play important individual roles in shaping commute well-being. A structural equation model reveals a significant correlation between commute well-being and overall happiness, controlling for other key happiness indicators. This research helps expand existing theory by demonstrating (1) how commute well-being can be measured and modeled; (2) how accessibility, distance and travel time impact commute well-being; (3) how individual mode choices interact with attitudes to impact commute satisfaction and (4) the relationship between commuting and overall well being.

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Chapter 1. Introduction

The term "subjective well-being" (SWB) is rooted in psychology and is defined as an evaluation of one's happiness or life satisfaction (Kahneman and Krueger, 2006). Researchers are applying measurements of SWB in studies of how different circumstances, policies, and choices affect quality of life, happiness, and life satisfaction. A growing body of research extends the study of SWB from overall life satisfaction to specific life domains, such as relationships and work. Travel behavior researchers have begun research to apply SWB metrics to travel (Abou Zeid and Ben-Akiva, 2011; Ettema, D. et al. 2010; Jakobsson Bergstad, C. et al., 2011). At this point, however, there is only a scattering of empirical research on how travel affects SWB, and most of it is was conducted outside the U.S.

Well-being studies complement a growing chorus that argues that policies should focus on well-being, rather than on economic indicators. Nobel Prize-winning psychologist Daniel Kahneman and others maintain that SWB measurements could complement conventional tools for measuring benefits and losses in policy analysis (Kahneman, 1999). Current transportation-related goals such as increasing accessibility and reducing vehicle miles traveled, single occupancy vehicle trips, and greenhouse gases do not account for well-being explicitly. They also may have limited appeal to the public (Gärling and Schuitema, 2001). Demonstrating increased SWB from modes of transportation consistent with transportation related goals could help policy makers to better market transportation policies.

Transportation research and planning has focused heavily on individuals' decisions about travel and less on the experiences resulting from their decisions. Travel mode choice models often fail to capture key factors, such as feelings of freedom or personal safety associated with travel experiences (Anable and Gatersleben, 2005; Ory and Mokhtarian, 2009). Accounting for SWB in travel experiences will improve predictions of future mode choices and how well-being is affected by these choices (Abou Zeid, 2009).

This dissertation focuses on "commute well-being" (CWB), a multi-item measure of the experience of commuting to work, and what influences it. Several empirical models are estimated that together build on work by other researchers and represent one of the first applications of this metric in the U.S. This research primarily uses data gathered in winter 2012 from commuters who travel to work in central Portland, Oregon via car, public transit, and bicycle. U.S. Census American Community Survey 2009 data show that commute mode shares for bike and transit (6 and 12 percent of commute trips, respectively) are relatively high in Portland, making it a good testing ground for evaluating the impact of modes on CWB.

Theoretical Model of Influences

Figure 1 shows a framework of the relationships between travel and subjective well-being that is adapted from Ettema et al., 2010a. This study focuses on only a portion of Ettema et al.'s model, measuring travel well-being from commuting as opposed to other trip purposes. The model integrates the following relationships:

- How sociodemographic characteristics, residential location, commute mode options and choices relate to well-being;
- How instrumental factors such as travel time, traffic congestion, and bus crowdedness affect commute well-being;
- How attitudes about travel and commuting interact with mode choice to affect commute well-being; and
- The presence and magnitude of the relationship between commute well-being and overall (or "Global") SWB.

The addition of measures of socio-demographics, travel preferences, accessibility, and mode choice (boxes shaded grey) offers a way to expand Ettema et al.'s (2010) conceptual model. In order to keep the focus on the above relationships, other relationships in the model will not be examined. For example, participation in activities accessed by travel and its relationship to overall SWB is outside the scope of this project. This study focuses on commuting to just one activity - work. Finally, it is acknowledged that the commute satisfaction may impact future mode choices; however, examining this relationship is beyond the scope of this project.

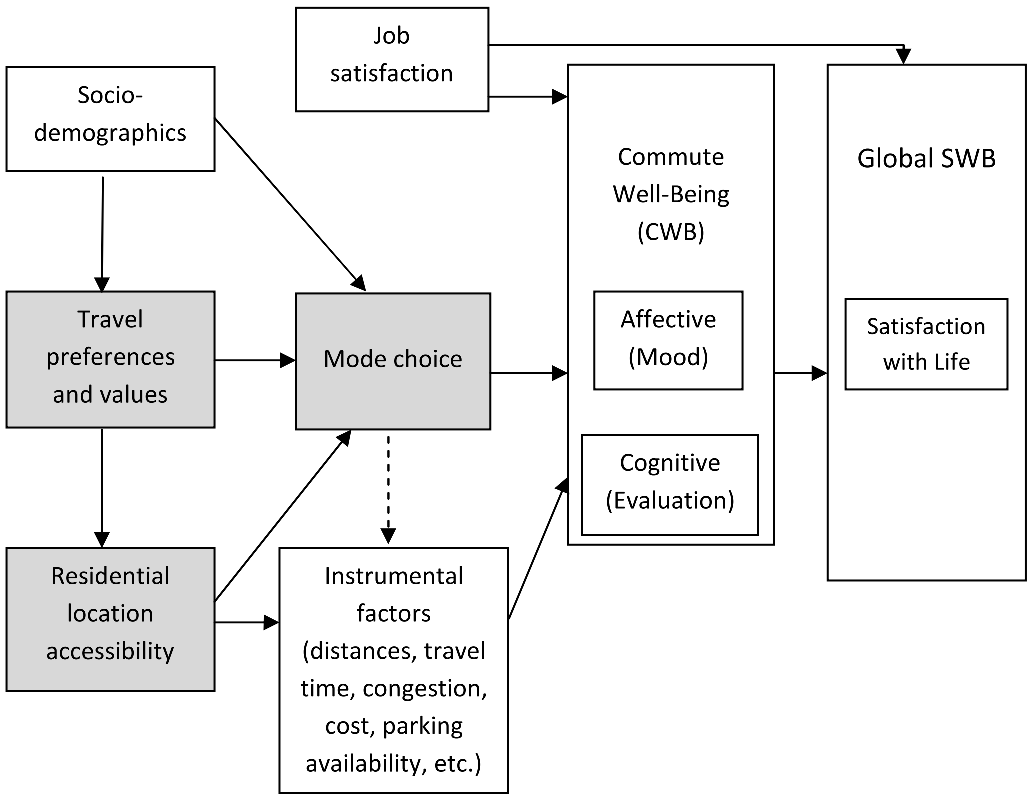


Figure 1. Theoretical model (adapted from Ettema et al., 2010a).

Project Goals

This project investigates factors influencing satisfaction with commute travel, or commute well-being. It gathers empirical evidence on people's commuting experiences, their values and preferences, and how these elements interact to shape their commute well-being. It measures commute well-being using reliable psychometric scales (Ettema et al., 2010). Quantitative methods are used to analyze relationships between travel preferences, travel experiences and commute well-being, controlling for transportation accessibility. Results are compared to previous findings on the affective factors of travel. Implications for transportation policy and planning, as well as future research, are discussed.

The following question: "*What factors contribute to well-being in the domain of commute travel?"* drives this research. Sub-questions address:

- How does commute well-being differ among the working population, between specific mode users, and residents with varying levels of accessibility?
    - *Hypothesis:* Commute well-being varies widely among the population.
    - *Hypothesis:* Active travelers (walk and bike commuters) have higher commute well-being than bus, rail or car commuters, controlling for other variables (i.e. age, income, gender, education, vehicle availability, job satisfaction, residential location satisfaction, and accessibility).

- How do trip context and affective factors affect CWB for each mode?
    - *Hypothesis:* For motorized modes, long distances, motor vehicle congestion, and commuting during peak-hours are each associated with lower commute well-being, while short and medium distances, a lack of congestion, and off-peak travel times are associated with greater commute well-being.
    - *Hypothesis:* For active modes, commute well-being will vary by distance, motor vehicle congestion, peak-hour travel and other contextual trip factors.
- Which travel preferences are associated with commute well-being and do they differ among mode users?
    - *Hypothesis:* People have different values and preferences regarding commuting.
    - *Hypothesis:* Travelers who commute using modes that align with their values and preferences have higher commute well-being.
    - *Hypothesis:* Travelers with values that are not in line with the modes they use have low commute well-being. For example, those who value sustainability, but require a car to meet their commute needs, will have

lower CWB. Similarly, those who value car travel but do not have access to a car will have low CWB.

- *Hypothesis:* Some features associated with greater commute well-being will differ depending on mode. For walking and bicycling, stress reduction, excitement, and pleasure will be common. For bus and rail, listening to music, reading, and working will be common. For driving, excitement, control, and status will be common.

- Does commute well-being have a direct effect on overall (global) well-being?
    - *Hypothesis:* There is a positive association between commute well-being and overall well-being, controlling for some key correlates of subjective well-being.

Research Contributions

This project contributes to the burgeoning literature on subjective well-being, its increasing use as a measure of utility, and how it is affected by the domain of travel. Previous literature suggests a need for greater incorporation of psychological factors in the study of travel behavior, and more sophisticated behavioral models. Well-being measures offer a way to supplement utility maximization models. Subjective well-being with respect to travel can be measured and modeled (e.g. Abou Zeid, 2009; Ettema et al, 2010; Jakobsson Bergstad, 2010) and this project adds evidence to this line of inquiry by further testing measures for evaluating well-being in travel contexts and using innovative modeling techniques such as structural equation modeling with a large dataset.

This study also contributes to the study of the psychology of commuting, particularly its positive aspects, through analysis of a unique dataset. Other studies have addressed positive aspects of commuting, but in European countries (e.g. Gatersleben and Uzzell, 2007), in a university setting (e.g. Anable and Gatersleben, 2005; Paez and Whalen, 2010), or using an incomplete list of values and preferences (Ory and Mokhtarian, 2005). This research offers a U.S. (Portland) based sample, using commuters from a non-university setting, and containing updated survey questions based on advances in commuting psychology theories.

This research helps expand existing theory by demonstrating (1) how commute well-being can be measured and modeled; (2) how accessibility, distance and travel time impact commute well-being; (3) how individual mode choices interact with attitudes to impact commute satisfaction and (4) the relationship between commuting and overall well being. Overall, the research contributes to an emerging dialogue about how travel behavior and transportation planning relate to happiness.

Policymakers are paying greater attention to research on influences on subjective well-being (Bennett 2009). Research showing a correlation between commute well-being and overall subjective well-being would offer a new way of viewing transportation investments, as ways to not only improve travel conditions, but increase happiness. Better understanding the connection between commute well-being and people's mode choices could help provide policymakers with options to help increase carpooling, transit, walking and bicycling. This research could thus offer insights that could help policymakers make transportation more sustainable.

This research identifies different factors that influence commute well-being. Knowing these factors is essential for identifying specific types of policies and plans that could increase commute well-being. Segmenting the population could help show where there is a mismatch between particular groups' values and preferences and their actual experiences. For groups with low commute well-being, there may be potential for policies to improve it (e.g. addressing bus stop safety to address people that have low well being and are concerned about safety). For groups with high commute well-being, transportation planners may be able to show how their policies have helped enable this higher commute well-being, whether through providing transit arrival time tracking, better bicycling infrastructure, improved traffic signal timing, or something else.

Chapter 2. Review of the Literature

This chapter introduces key concepts and influences of subjective well-being and how well-being could complement economic tools in policy analysis. Previous research is summarized on how commuting influences health – both negatively and positively. Finally, ways of measuring commute satisfaction and well-being are discussed, along with the gaps in knowledge that necessitate this research.

Subjective Well-Being and Life Satisfaction

In the past 25 years, a group of psychologists have turned from a classical focus on depression to "positive psychology" -- investigating the causes of happiness, in addition to sadness, and the large area in between. Ed Diener, a professor of Psychology at the University of Illinois, at Urbana-Champaign, has been responsible for much of the development of this research, having written approximately 200 papers on well-being, including two that have been cited more than 1000 times. Diener's research focuses on determinants of happiness, cultural differences in these determinants and on using and improving methodologies for empirical studies of subjective well-being (Larsen and Eid, 2008). Subjective well-being encompasses life satisfaction, satisfaction (or lack thereof) in particular life domains (e.g. relationships, work, health), and general happiness. Note that the terms "subjective well-being", "life satisfaction," and "happiness", as well as "commute well-being" and "commute happiness" are used interchangeably in this study.

Primary correlates of SWB include having more and closer social relationships and being more extroverted, but these factors do not solely lead to happiness (Larsen and Eid, 2008). Rather, they are important conditions for SWB. Longitudinal studies point to the importance of early family environment and employment as important factors influencing well-being (Larsen and Eid, 2008). Correlates of SWB vary among different demographic groups, such as teens and seniors, and among different cultures. Top-down theories of SWB posit that genetic factors largely determine SWB, which in turn, determines satisfaction in life domains such work and relationships with friends, etc. However, there is greater agreement that genetic factors are less important than cultural and situational factors (Larsen and Eid, 2008). Bottom-up theories maintain that satisfaction in life domains like one's employment and relationships cumulatively make up one's overall life satisfaction, sense of well-being, and happiness. Feeling better off than others and making progress towards goals is also associated with greater SWB.

Experiences in one life domain can also affect well-being in other domains, a concept known as "inter-domain transfer effects" (Novaco and Gonzales, 2009). For example, commuting stress negatively impacts moods after returning home in the evening, while having greater residential choices has been found to limit commuting stress (Novaco and Gonzales, 2009). Other elements of travel, such as the ability to drive, likely spill over into other life domains (work satisfaction, ability to maintain relationships, etc).

Levels of satisfaction and happiness can have important consequences for people's lives. Diener's research shows that people with higher SWB can be more creative, earn more money, are more effective leaders, and contribute to better workplaces (Larsen and Eid, 2008). These findings have significant policy implications. Theoretically, governments should value improving SWB because having more citizens with these qualities would improve the communities they govern. Some governments have adopted well-being related policies (Diener, 2009). However, more research is needed to better represent the dynamics of SWB in order to create policies that effectively increase SWB.

Well-Being and Policy

A growing chorus argues that policies should focus on well-being, rather than economic indicators. Nobel-prize winning psychologist Daniel Kahneman (1999) and others maintain that SWB measurements could complement conventional tools for measuring benefits and losses in a variety of domains, and in policy analysis.[1] For example, research on flows of money to underdeveloped countries shows that simple measures of economic growth, measured in terms of per capita income changes, do not provide good indicators of whether a country is actually improving standards of living. More comprehensive indicators that include infant mortality rates, water access, and education can better capture countries' development (Hicks and Streeten, 1979). In

[1] Kahneman won the Nobel Prize in Economics in 2002 for his work developing prospect theory and is also known for his contributions to the fields of behavioral economics and hedonic psychology.

many policy domains, such as transportation, researchers suggest that improving SWB should be a common standard for policies to meet (Diener, 2009).

Political leaders worldwide have paid more attention to well-being in recent years. The country of Bhutan has a Gross National Happiness ranking that its government claims is more important for policymaking than GDP. Western countries have paid less attention, however some recent examples are emerging. David Cameron, conservative Prime Minister of England, is being credited with asking the National Statistics Office to track well-being measures. Cameron said in November 2010 that:

> "Well-being can't be measured by money or traded in markets. It's about the beauty of our surroundings, the quality of our culture and, above all, the strength of our relationships. Improving our society's sense of wellbeing is, I believe, the central political challenge of our times" (Stratton, 2010).

It remains to be seen how Cameron and other leaders will adjust policies to influence greater well-being.

Transportation planning and policy relies heavily on benefit-cost analysis. However, benefit-cost analyses have often neglected impacts on people (or aspects of natural systems) that are difficult to measure or monetize. Dora (2000) argues that "Psychosocial variables should become an integral part of impact assessments. This can only happen once appropriate indicators have been identified and methods developed to measure and analyse them" (p. 29). Measurements of travel well-being could be important indicators for impact assessments. They could also provide a measure of livability, something that cities are increasingly interested in promoting. There are strong ideas developing about the role of pedestrian, bicycle and transit facilities in making communities more livable. However, a better understanding of this role in actual experiences (and decision-making processes) is needed in order to properly plan future facilities that enhance livability.

Decision Utility versus Experienced Utility

The behavioral foundations of utility maximization theory have been a constant source of debates. The theory posits that one will choose the option providing the greatest utility, or satisfaction. While it provides a basis for modeling in transportation and many other policy areas, it also suffers from drawbacks and is being improved regularly. For example, information and cognitive constraints prompt people to constantly make choices that are sub-optimal, resulting in less than maximum utility (Kahneman and Thaler, 2006). This has led researchers to better define “rationality.” Improving the representation of people’s behavior in models has been a core goal of travel demand (and other forms of) modeling.

One issue with utility maximization theory is the timing of the utility to be gained through a choice. Kahneman and Thaler (2006) distinguish between utility maximization and experienced utility. Decision utility refers to the benefit of the various options being considered in a choice. For commuting, a decision about mode is thought to rest on the attributes of trip (i.e. time and costs of travel) and the traveler (i.e. vehicle availability, value of time and money spent/saved). As mentioned, full information about a choice (e.g. the precise time it will take to drive to work) is usually not available. Decision utility is commonly used for a wide range of applications in policy decisions. Experienced utility, on the other hand, refers to the benefits accrued in the actual experience made after the decision. Experienced utility includes both what people feel during the moments of an experience (called moment utility, the affective component) and how they evaluate the experience (remembered utility, the cognitive component). Because of this sequence, measuring experienced utility is difficult (Ettema et al., 2010). People's memories of previous experiences are often distorted. However, there are ways of aggregating measurements of moment and remembered utility to represent experienced utility.

Cost-benefit analyses and many models generally do not account for well-being or experienced utility, being based instead on decision utility. Measuring decision utility is best for explaining choices with modeling, an important element of transportation planning and policy. Yet, experienced utility is what policies should often aim to improve (Ettema et al., 2010; Kahneman, 2000).

Commuting and Physical Health

Commuting has been demonstrated to significantly impact physical health. Commute distance, duration, mode and feelings of loss of control from exposure to traffic are associated with health related measures such as obesity and stress.

As commute distance increases, health deteriorates, according to many studies. A recent study of commuters in 4297 car commuters in Texas found that as commute distances increase, people exercise less and cardiorespiratory fitness decreases, while body mass index (BMI) scores, waist circumference, and blood pressure scores increase (Hoehner et al., 2012). Although commute mode was unknown, the authors note that their sample was likely private car commuters primarily. The authors note that commuting time likely displaces time that would otherwise be spent being physically active and reduces overall energy expenditures.

Commute mode also affects physical health. A study of 21,088 commuters in Scania, Sweden found, using logistic regression models, that car or public transit commuters had poorer self-rated health and greater stress, exhaustion, and missed work days relative to bike and walk commuters (Hansson, et al., 2011). With respect to commuting time, the authors note that one hour + car commutes are not as harmful to health as shorter car commutes, possibly because (1) car commutes do not necessarily involve driving in congested areas and could be relaxing and (2) healthier people may be more likely to engage in (and endure) long driving commutes. Transit commutes longer than one hour were more harmful than shorter transit commutes, presumably because they may involve transfers that can reduce travel time reliability.

A unique quality of active/non-motorized transportation is that it requires substantially more human power to move than other modes. Indeed, some people cycle primarily to exercise. One can control the level of physical exertion from cycling by adjusting his speed, acceleration, routes, and luggage. Dora (2000) shows that exercise, including walking and bicycling, does in fact boost people's moods. This presents a problem for the researcher interested in comparing how different modes affect well-being. Is it the exercise that may boost a cyclists mood or is it some other aspect of cycling? If it is the former, someone may commute by car and obtain the same mood boost at other times of the day through other exercise, such as running or basketball. Time saved by driving could be used for this exercise. If someone replaces other exercising with bicycle/walk commuting, there may be no net gain in exercise or happiness. However, there is evidence that people that cycle or walk to work have lower weights and levels of body mass than commuters that use motorized modes (Wagner et al., 2001).

In research on travel psychology, the commute trip and its associated stress have received the most attention. Early research on commuting stress by Raymond Novaco and others shows how perceptions of commuting impedance (both distance and time of the trip, as well as other aspects) increase commuting stress. Subsequent research showed that perceptions of control matter; in particular, commute predictability and variability affect stress, as found in tests using salivary cortisol and other measures (Novaco, 2010). Females, in particular, show higher stress impacts from commuting. Other studies show that driving stress decreases with age and driving experience (2010). Commute stress often carries over to work and home spheres (2010).

A Positive Utility of Travel

According to classic transportation planning theory, travel is a “derived demand”, in which the consumer travels solely to access goods or services in different locations. This theory has been supported in most cases (i.e. commute distance is something to be minimized for the negative health reasons previously mentioned). However, evidence suggests that there are a variety of situations in which travel is not just to access activities, but an activity itself. Mokhtarian and Salomon (2001) find that sometimes the destination is secondary to the trip itself. They examined evidence from a study of over 1900 San Francisco Bay Area residents and found a positive utility for travel, which goes against “derived demand” theory. Almost two-thirds of respondents reported traveling “by a longer route to experience more of your surroundings” sometimes or often and roughly three-quarters of the sampled group reported traveling “just for the fun of it” sometimes or often. (Mokhtarian and Salomon, 2001, 707) Over one-half of the group sometimes traveled “just to relax.” (Mokhtarian and Salomon, 2001, 707) They hypothesize that desired travel time differs according to demographic groups, mode, and other variables. (2001)

Further work enhanced this theory, providing determinants of “travel liking” (Ory and Mokhtarian, 2005) and the importance of perceptions (Ory and Mokhtarian, 2005 & 2009). They note that “…*Travel preferences* are important. It is unlikely that any two individuals who have seemingly the identical commutes (same travel route, time of day, mode, etc.) will perceive their commutes in exactly the same way (Ory and Mokhtarian, 2009, p. 26). For example, some people simply enjoy bicycling more than others. A recent study found that those who cycle longer distances on their commutes have more positive attitudes towards bicycling than those who cycle shorter distances on their commutes (Heinen et al., 2011). Schneider (2011), using a mixed logit model to analyze data from people traveling to, from, and within 20 San Francisco Bay Area shopping districts, also found that enjoyment of walking and biking significantly impacts people's choice of walking and bicycling.

Travel is enjoyable in certain contexts because of feelings that it engenders. Steg (2005) adds to a small but growing number of empirical findings on symbolic and affective functions of car use. She used factor analysis of data collected in 185 interviews of adults in Groningen and Rotterdam, the Netherlands and found that people, especially younger, male, and frequent drivers, significantly value non-instrumental aspects of car use. "People do not only drive their car because it is necessary to do so, but also because they love driving" (p. 160.) She also notes that cars engender "feelings of sensation, power, superiority and arousal." Steg stresses that policies to reduce driving must better recognize motivations to drive.

Commute Satisfaction

Findings on a positive utility of travel have prompted recent research that examines factors influencing travel satisfaction. Páez and Whalen (2010) examined the liking/disliking of commutes among students and faculty at a Canadian university. They used Mokhtarian and Solomon's (2001) survey questions, including attitudinal questions about travel and neighborhood preferences. They obtained ratios of ideal to actual commute times, and used these to represent commute satisfaction (and as the dependent variable in regression equations). They found that people using all modes would like to decrease their commute. This is important since it was suggested (Choo et al. 2005) that policies to reduce driving would not be effective for many people given the "positive utility of travel" found by Mokhtarian and colleagues. However, those who walk or bike to school were far less dissatisfied than those who drive or use transit. For those "active travelers", living in neighborhoods with many activities and strongly agreeing that their neighborhood is a community were significant. Socio-demographic variables were not significant (except Canadian citizenship). One weakness in this and many of these other studies is the use of university students as subjects. The authors note that future research should focus on non-student commuters and also why students switch from active travel to the car upon graduating and entering the workforce. This study also groups bicycling and walking together even though there are important differences between these modes. In addition, more control of land-use attributes and residential location could help this type of analysis.

The importance of instrumental and affective factors associated with travel differs by trip purpose. Anable and Gatersleben (2005) conducted a survey of university students, faculty, and city government members and found that for leisure trips, affective factors (notably flexibility, convenience, relaxation, a sense of freedom and “no stress”) were as important as instrumental factors (convenience, distance, and time).

For commuting, instrumental factors were more important - particularly convenience. They note that bicyclists are most satisfied with their mode, but the researchers do not take land-use factors (distance) or route-related factors into account.

Gatersleben and Uzzell (2007) continue research on affective components of commuting and mode use in a study of university employees at the University of Surrey in the UK. Danger, delays, and inconveniences other than delays were associated with unpleasant travel experiences for all modes, while "scenery, listening to music or reading, flexibility (not being stuck in traffic), the presence and behavior of others, and the mere enjoyment of the travel" were associated with pleasant experiences (pp. 423-4). Primary sources of pleasure and displeasure for each mode were also reported. For drivers, delays and traffic; for public transport, delays; for cyclists, other road users; for pedestrians, poor infrastructure and "noise, pollution, and danger" from vehicle traffic. They note that all mode users received pleasure from "beautiful scenery;" music and literature were more cited for drivers and public transport users, and enjoying the travel itself for cyclists and pedestrians. Ease of use was the strongest predictor of people's attitudes towards their usual modes. Lower cognitive and physical effort involved in using a mode was associated with better attitudes towards their modes. Their authors summarize that, for commuting, "Driving is relatively unpleasant and arousing (i.e. stressful and exciting), public transport is unpleasant and not arousing, cycling is pleasant and arousing, and walking is pleasant and not arousing" (Gatersleben and Uzzell, 2007, p. 427) The study does not control for accessibility or represent the population and the authors recommend addressing these shortcomings in future studies.

People develop cumulative evaluations of commuting and other travel contexts as they experience such trips over time (Jakobsson Bergstad et al., 2011). As mentioned above, predictability of commuting conditions affects travel satisfaction (Novaco and Gonzales, 2010). Table 1 presents affective (i.e. related to feelings) and instrumental (i.e. contextual) elements found to increase the utility of travel for different modes.

Table 1. Elements shown to increase the utility of travel

Element	**Mode**	**Source**
Affective		
Relaxation	Walking	Gatersleben and Uzzell, 2007; Anable and Gatersleben, 2005
Fun	Car	Steg, 2005
Freedom	Overall, car	Ory and Mokhtarian, 2005; Steg, 2005; Anable and Gatersleben, 2005
Status	Overall, car	Ory and Mokhtarian, 2005; Steg, 2005
Control	Overall	Ory and Mokhtarian, 2005; Anable and Gatersleben, 2005
Pleasure	Walking, Cycling, car	Gatersleben and Uzzell, 2007; Steg, 2005
Stress reduction	Car (-), bus (-)	Gatersleben and Uzzell, 2007; Anable and Gatersleben, 2005
Transition time	Bus, Car, Rail	Paez and Whalen, 2010; Ory and Mokhtarian, 2005; Mokhtarian and

		Solomon, 2001
Time alone	Car, bus	Paez and Whalen, 2010;
Using trip productively	Car	Paez and Whalen, 2010; Ory and Mokhtarian, 2005
Good quality shelters and other bus facilities	Bus	Paez and Whalen, 2010;
Excitement	Walking, cycling	Gatersleben and Uzzell, 2007; Anable and Gatersleben, 2005
Enjoying the scenery/exposure	Car, Walk	Gatersleben and Uzzell, 2007; Ory and Mokhtarian, 2005
Escape/Therapy	Walk, Car	Ory and Mokhtarian, 2005
Curiosity	Walk, Overall	Ory and Mokhtarian, 2005
Independence	Overall, Car	Ory and Mokhtarian, 2005; Steg, 2005
Reading/Listening to music	Car, transit	Gatersleben and Uzzell, 2007
Instrumental		
Flexibility	Overall	Anable and Gatersleben, 2005; Gatersleben and Uzzell, 2007
Convenience	Overall	Anable and Gatersleben, 2005
Cost	Overall	Anable and Gatersleben, 2005
Predictability	Overall	Anable and Gatersleben, 2005
Environmental quality	Overall	Anable and Gatersleben, 2005
Health quality	Overall	Anable and Gatersleben, 2005

Most research on affective factors of travel has focused on stress, usually from car and public transport commuting contexts. Recent studies, however, hone in on positive feelings experienced during travel, including relaxation, excitement, and control. Experienced utility, satisfaction, and other measures of well-being have been applied in other life domains, but have not been used widely in the commute context.

Previous research, however, suffers from several weaknesses. First, many studies use university students and faculty as subjects. This group, unlike larger segments of commuters, has more flexible working hours or often travels during off-peak hours. Secondly, most studies on affective factors of commuting were performed in several European countries and only a handful of studies were performed in the United States. There are, in general, large gaps between European countries and the U.S. with respect to fuel prices, land-use patterns, and social norms surrounding transportation and the environment. Findings from the European studies are not necessarily generalizable for American commuters. Much of the research from Mokhtarian and her colleagues uses data collected in the San Francisco Bay Area in 1998 and in Northern California in 2003. Changes in environmental awareness, in-vehicle technologies, and provisions for cyclists in road design since then suggest that current data is needed.

Measuring Well-Being and Travel Satisfaction

Measuring subjective well-being is a challenge and previous studies use a large mix of methods. Scales have emerged that have high degrees of reliability. For overall (global) life satisfaction, the Satisfaction with Life Scale (Diener et al. 1985) is the most widely used measure in subjective well-being research. In surveys with this scale, respondents rank their agreement on a seven-point scale with five statements:

1. "In most ways my life is close to my ideal;
2. The conditions of my life are excellent;
3. I am satisfied with my life.
4. So far I have gotten the important things I want in life.
5. If I could live my life over, I would change almost nothing."

The scores for each item are totaled to show life satisfaction, from "extremely dissatisfied" to "highly satisfied." (Diener et al., 1985) For those with an average score (20-24), Diener offers the following explanation:

> The average of life satisfaction in economically developed nations is in this range – the majority of people are generally satisfied, but have some areas where they very much would like some improvement. Some individuals score in this range because they are mostly satisfied with most areas of their lives but see the need for some improvement in each area. Other respondents score in this range because they are satisfied with most domains of their lives, but have one or two areas where they would like to see large improvements. A person scoring in this range is normal in that they have areas of their lives that need improvement. However, an individual in this range would usually like to move to a higher level by making some life changes. (Diener, 2006, p. 1)

Measuring satisfaction with specific domains and activities performed during the day, such as travel, has proved more difficult. While studies show people can classify whether an experience was positive or negative, their memories often distort feelings experienced during events (Kahneman and Krueger, 2006). Measures of perceptions of experiences capture feelings more accurately when “they are reported closer to the time of, and in direct reference to, the actual experience” (Kahneman and Kruger, 2006, p. 4). To avoid memory distortion, the Experience Sampling Method (ESM) asks participants for real-time evaluations of experiences, often using cell phones or other handheld devices. This method can be complex to implement, and most measurements rely on memory using reference points. The Day Reconstruction Method was “designed specifically to facilitate accurate emotional recall” using diaries of activities performed throughout the day and questions about feelings during the activities (Kahneman and Kruger, 2006, p. 10). Its results were found to correlate closely with results obtained through ESM (2006).

Other scales such as the Positive and Negative Affect Scale and the Swedish Core Affect Scale (Västfjäll and Gärling, 2007) measure moods and emotions related to past events. The Swedish Core Affect Scale is a six-item scale developed by Västfjäll and Gärling (2007) to measure the relative pleasure/displeasure (happy–sad, satisfied–dissatisfied, joyful–depressed) and level of activation (active–passive, alert–sleepy, awake–dull) experienced during the day. These retrospective scales have shown high degrees of reliability (e.g. Cronbach's alpha of .89 in Ettema et al.'s (2010b) study, meaning that the individual items do a good job at measuring the same thing).

Jakobsson Bergstad et al. (2011) developed a Satisfaction with Daily Travel (STS) scale. It is quite similar to the Satisfaction with Life Scale and includes statements such as "I am completely satisfied with my daily travel" and "When I think of my daily travel the positive aspects outweigh the negative" and asked respondents to use Likert scale rankings. The scale is reliable, with a Cronbach's alpha of .77. Ettema et al. (2011) help enhance the STS scale by adding specific items related to affective responses to travel, including scales of affect (i.e. relaxed versus time-pressed, calm versus stressed, alert versus tired, enthusiastic versus bored, and engaged versus unengaged). The multi-item scale showed high statistical reliability, as Cronbach's alpha was .91. Even with the latter refinements, the STS scale still does not include any specific measures of enjoyment in its affective response questions. Feelings of pleasure, escape, thrill, and other feelings would not fall clearly into this scale.

The STS scale is different from other methods of measuring satisfaction. Consumer satisfaction research is well-developed and published in marketing and business-related academic journals. These studies distinguish between satisfaction with particular transactions (encounter satisfaction) and accumulated satisfaction with a service (cumulative satisfaction). Customer satisfaction research often relies on recall of "critical incidents," specific events that a person attributes with the service. These can be positive or negative, and their frequency affects cumulative satisfaction. Customer satisfaction questionnaires gather information on these incidents, as well as perceptions and attitudes (Hayes, 2008). Friman et al. (2001) show that satisfaction with transit depends largely on previous critical incidents using transit that deviate from expectations (e.g. late buses). Negative critical incidents affect predicted satisfaction more than positive critical incidents (Pedersen et al., 2011).

Customer satisfaction research also uses stated preference questions, which present various scenarios (having different attributes) and ask respondents to say how satisfied they would be in these scenarios. Analysis of the data allows the researchers to identify what attributes are most important and whether these vary among respondents with different personal characteristics. These studies can be criticized as the scenarios are hypothetical and, thus responses are not necessarily representative of how people would respond in the real world. However, they are more flexible because they can gather opinions about scenarios that would otherwise hard or expensive to access. They can sometimes be combined with revealed preference data. For example, Ahern and Taply (2008) compare preferences for intercity bus and rail in Ireland. Passengers were asked to rank and choose different scenarios that varied on cost, trip length, service frequency, reliability, and presence of on-board toilets. In addition, the researchers were able to record their actual mode choices. Rank-ordered logistic regression (for the ranking data) and conditional logit models (for the choice data) showed that travel time and cost are the most important factors influencing the choice of bus or rail for intercity trips.

Abou Zeid and Ben-Akiva (2011) focus on how social comparisons affect commute satisfaction, and the effect of commute satisfaction on work well-being. Survey questions of commuters asked about the mode, stress level, and commute time of another person whose commute is familiar to them. The stress level question, in which the respondent is asked to mark on a five-point scale the stress level of their commute relative to the other person's commute, is used to indicate comparative happiness. Using structural equation models, the authors find that favorable comparisons with others' commutes (social comparative happiness) *and* with previous personal commutes (intrapersonal comparative happiness) are significantly associated with higher commute satisfaction. Having a shorter commute increases social comparative happiness. Active mode-using commuters have favorable comparisons when others commute by car, while car commuters have favorable comparisons when others also commute by car and negative comparisons when others commute by active modes. In addition to comparative happiness, commute satisfaction is also significantly increased by commute enjoyment and decreased by commute stress. Commute stress is found to be increased by longer travel times, higher travel time variability, frequent congestion (for car and bus users), and traveling alongside car traffic (for nonmotorized commuters). The study also finds that work well-being is positively influenced by commute satisfaction (Abou Zeid and Ben-Akiva, 2011).

Recent studies on relationships between travel and subjective well being are summarized in Table 2.

Table 2. Empirical studies of travel and subjective well being

Study	Data	Methodology	Main Findings
Ettema, D., et al. (2011)	Survey of 155 undergraduates at Karlstad University, Sweden	Tested measures of satisfaction with travel (STS), mood, and life (SWB). Used mixed factorial ANOVA and *t*-tests	STS measure is highly reliable. Travel mode, travel times, bus stop access, and activity agendas all influence STS. Satisfaction with travel is correlated with SWB, but activity participation is likely more important than travel in influencing overall SWB.
Jakobsson Bergstad, C. et al. (2011)	Survey of 1,330 Swedish citizens	Measured car access and use, satisfaction with daily travel, satisfaction with activities, and SWB (mood, affective, and cognitive). Means, standard deviations, and product moment correlations between factors are reported. OLS multiple linear regression is used, where STS is the dependant variable.	Satisfaction with travel affects SWB directly and indirectly (through satisfaction with activities accessed). Weekly car use had a slight impact on STS, but no impact on SWB. STS is higher in households without children and in households with older adults than in households with children and younger adults. The STS scale is reliable but should be refined.

Páez A, Whalen K (2010)	Survey responses from 1251 students at McMaster University, Hamilton, Ontario, Canada	Analysis of ratio of ideal commute time to actual commute time by mode, socio-demographic attributes, and attitudes using multiple regression analysis.	Effect of attitudes differs by mode; Bike/walk commuters are least dissatisfied with their commute. Car, and to a greater extent, transit commuters are more dissatisfied; Those who walk/bike and strongly agree that "getting there is half the fun" would like to commute longer distances; Active commuters that prefer living in lively neighborhoods want longer commutes; Car commuters largely do not value their commutes.
Abou-Zeid, Maya (2009)	Pre- and post-surveys of commuters in Switzerland and at MIT in Cambridge, MA.	New measurement techniques for activity and travel happiness are developed and discrete choice analysis is used to analyze data. Structural equation models are used to analyze commute satisfaction.	Greater activity participation is associated with greater activity and travel happiness. Transportation happiness is evaluated differently in routine and non-routine contexts. After an intervention (temporary free bus pass), people were more positive about their travel happiness.

Abou-Zeid, M. and Ben-Akiva, M. (2011)	Commuters recruited via emails, from several countries. Most were from the U.S. There are 594 total observations.	Survey question asks about commute stress relative to another person's commute that is familiar. Structural equation modeling is used to test influences of commute satisfaction and work well-being.	Favorable comparisons with others' commutes and with previous personal commutes are associated with higher commute satisfaction. Non-motorized mode-using commuters have favorable comparisons when others commute by car, while car commuters have favorable comparisons when others also commute by car and negative comparisons when others commute by non-motorized modes. Work well-being is positively influenced by commute satisfaction.
Spinney, J.E.L. et al. (2009)	Statistic Canada's Time-Use data for 1998; 1558 elderly respondents which, in the analysis, are organized by life situation (i.e. age groups, gender, living arrangement, activity limitation)	They determine the psychological, exercise, and community benefits of transportation among different life situations through activity participation rates. Spearman's correlation coefficients measure associations between mobility benefits, life situation, and subjective well-being.	Transport mobility and activity participation varies among sub-groups. The authors develop "contextually-derived" time-budgets for the sub-groups and find significant variation in subjective well-being associated with transportation mobility. Exercise benefits contribute most to SWB.

Chapter 3. Data and Methodology

This chapter describes how the data used in this study was gathered and many of the decisions involved during this process. It provides a summary of the sample in terms of their demographic, home location, and commuting characteristics.

Survey development

The survey instrument was developed during fall 2011. Survey questions were developed independently and borrowed from other researchers. Borrowed measures included questions on travel well-being (Ettema, D., et al., 2011), attitudes and preferences about travel (Ory and Mokhtarian, 2005; Dill, 2011) and satisfaction with life (Diener, E., 2011).

Commute well-being is a composite measure adapted from Ettema, D., et al. (2011). It is based on seven questions that measure both affective responses to the commute (i.e. feelings during the commute) and cognitive responses (i.e. evaluations of the commute afterwards). Questions are structured according to the following statement: "Please select the box that best corresponds to your experience during the [most recent commute] trip. For example, if you were very tense, select the box for -3. If you were neither tense nor relaxed, select the box for 0." Differences between Ettema et al.'s travel well-being measure and the commute well-being measure in this study are shown in Table 3. Three questions from Ettema et al. were removed in order to simplify the measure and reduce respondent burden. The wording on four questions was slightly changed to fit the American context better, as the original scale items were translated from Swedish. One question related to enjoyment was added based on its theorized relevance to well-being and mode choice (Schneider, 2011). These changes were made following pre-testing of the survey instrument. Finally, while Ettema et al. distinguish between two types of affect (positive activation and positive deactivation) as well as a cognitive evaluation of travel, this study distinguishes only affective and cognitive evaluation items. This also was done to simplify the commute well-being measure while retaining its two main theoretical factors.

Table 3 Comparison of Travel Well-being Measures Items between Ettema et al., 2010 and This Study

Ettema et al. (2011)		This study	
Grouping	**Item**	**Item**	**Grouping**
Positive Deactivation	Time pressed (-4) – relaxed (4)	Tense (-3) to relaxed (3)	Affective Evaluation
	Worried I would not be in time (-4) – confident I would be in time (4)	Worried that you would arrive on time (-3) to confident that you would arrive on time (3)	
	Stressed (-4) – calm (4)	*Not included*	
Positive Activation	Tired (-4) – alert (4)	Tired (-3) to excited (3)	
	Bored (-4) – enthusiastic (4)	Bored (-3) to enthusiastic (3)	
	Fed up (-4) – engaged (4)	*Not included*	
	Not included	Not enjoyable (-3) to enjoyable (3)	
Cognitive Evaluation	Travel was worst (-4) – best I can think of (4)	My trip was the worst I can imagine (-3) to my trip was the best I can imagine (3)	Cognitive Evaluation
	Travel was low (-4) – high standard (4)	*Not included*	
	Travel worked well (-4) – worked poorly	My trip went poorly (-3) to my trip went smoothly (3)	

Eligible participants must have commuted outside of the home to central Portland at least two days per week.

Nineteen people, including all dissertation committee members, pretested the survey. Their feedback ranged from a simple comment to two pages of comments and suggestions and was used to revise the survey. Appendix C contains the full survey instrument. The online survey was administered using Qualtrics survey software, which is free to the PSU community. Figure 2 shows a screenshot of the survey's first page.

Figure 2 Screenshot of survey

Study Area

The study area for workplaces includes organizations located in central Portland, including the Downtown district and the nearby Lloyd District, Central Eastside, South Waterfront and Northwest/Pearl/Old Town. Figure 3 displays a heat map of workplaces of respondents. Darker blue areas represent locations where higher numbers of respondents work. The primary reason for choosing central Portland was to provide some measure of control. All respondents commute to a common location in an urban area. No one commutes to a rural or suburban workplace, which would likely result in different experiences. A second important reason is that central Portland has relatively high quality transit, bicycle, and car access. TriMet, the primary transit provider for the Portland region, is by and large a "spoke and wheel" transit system that serves peak-hour trips to central Portland best. The network of streets with bicycle treatments is well suited for travel to downtown. Almost all streets and eight bridges crossing the Willamette River serve cars in central Portland. Therefore, most commuters have reasonable mode options for commuting. A third reason is that these neighborhoods almost all have metered or paid off-street parking, except for the central eastside and parts of the Pearl District. (To more fully account for parking costs and constraints, respondents were also asked whether or not they would have to pay for parking if they drove to work). Finally, this area has the highest overall employment density in the region and is thus an ideal location to study commuting experiences.

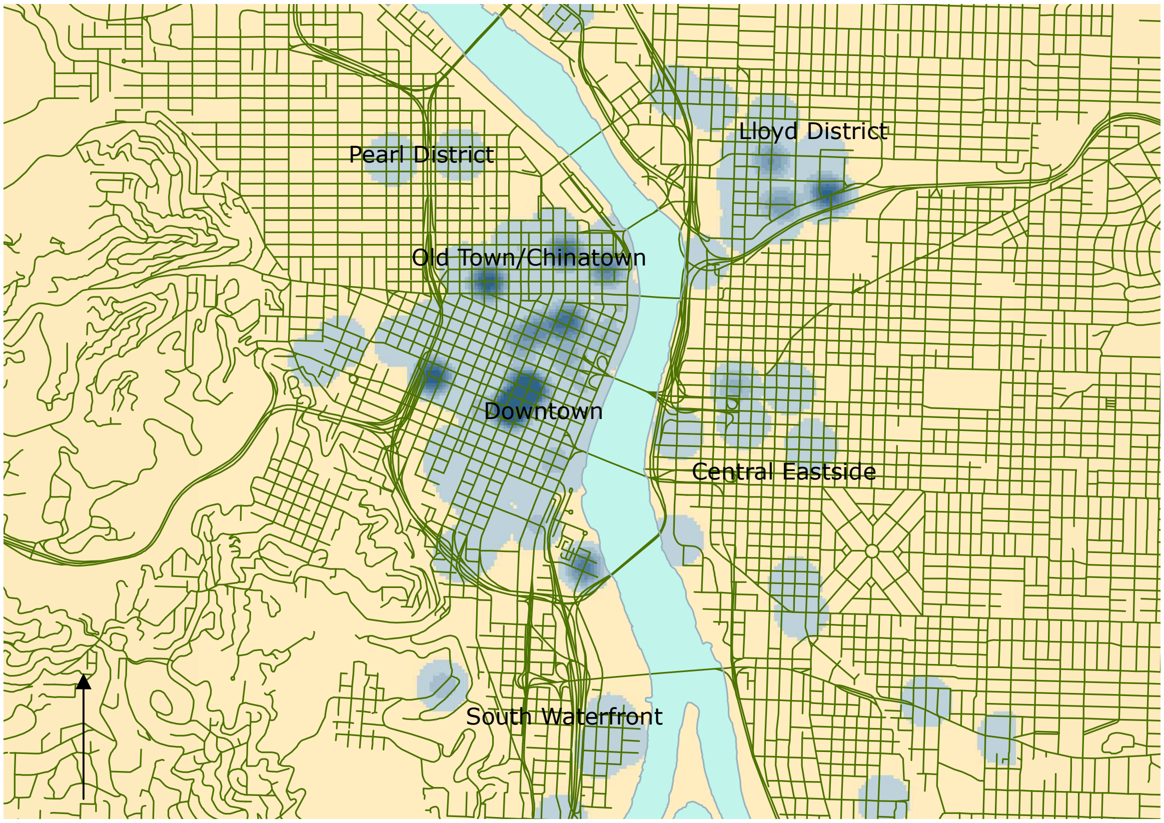


Figure 3 Workplace study area and locations

While the study focuses on commuters to destinations (i.e. workplaces) in central Portland, the study area includes commute trip origins (i.e. homes) located throughout the metropolitan region and beyond.

Survey distribution

The survey was distributed primarily to white-collar workers. This helped control for several factors, including workplace conditions and work hours. For example, respondents most likely worked at desk jobs in climate controlled offices. They also likely worked during normal business hours (8am to 5pm).

The survey was initially distributed to 14 businesses on December 15, 2011. The 14 businesses were:

Name	Industry
Standard Insurance	Insurance
Cambia Health Solutions	Insurance
CareOregon	Insurance
Sera Architects	Architecture
CH2MHill	Engineering & Planning
Harland Financial	Financial
Stoel Rives	Law
David Evans and Associates	Planning
Parsons Brinckerhoff	Planning
Wells Fargo	Banking
Boora Architects	Architecture
Robert Duncan Plaza	Building management
Tonkon Torp	Law
Portland Energy Conservation Inc.	Energy

These businesses have established relationships with the Portland Bureau of Transportation (PBOT). Scott Cohen, SmartTrips Business Coordinator at PBOT, sent the email to contacts at the fourteen businesses. Scott's email is shown in Appendix B. Only one survey response was received following the initial email, likely due to the holiday season rush. On January 17, 2012, Scott sent a follow-up email to the same organizations, as well as the Lloyd District Transportation Management Association, where a contact further distributed the email to a Transportation Coordinators mailing list with list with 96 recipients at organizations in the Lloyd District. Together, this generated a large initial response (~330 responses within four days of the follow-up email).

The next week, I contacted approximately 25 other businesses via email and phone using the Portland Business Alliance directory. An email (see Appendix C) to office managers at medium-sized companies (staff of 40-80) was often successful. Within another week, I had almost 500 responses. I continued to phone and email companies and although many did not respond, responses continued to come in. More than 50 organizations were eventually contacted. Table 4 lists the organizations in which the survey was distributed. In early February, more than 270 responses had been obtained for both car and transit commuters. This would likely provide enough full responses to fill the quotas (i.e. 250) for these groups, although I still only had just over 100 responses from bicycle commuters.

To fill the remaining quota, I targeted bike commuters with an intercept method. In three different locations on three separate mornings, I handed out cards with information on the survey printed on bright orange 65 lb. paper. The cards showed provided instructions to take the survey, a web link to take it, and my contact information (see Figure 4). The dates, times, locations, weather, and number of cards distributed to bike commuters are shown in Table 5.

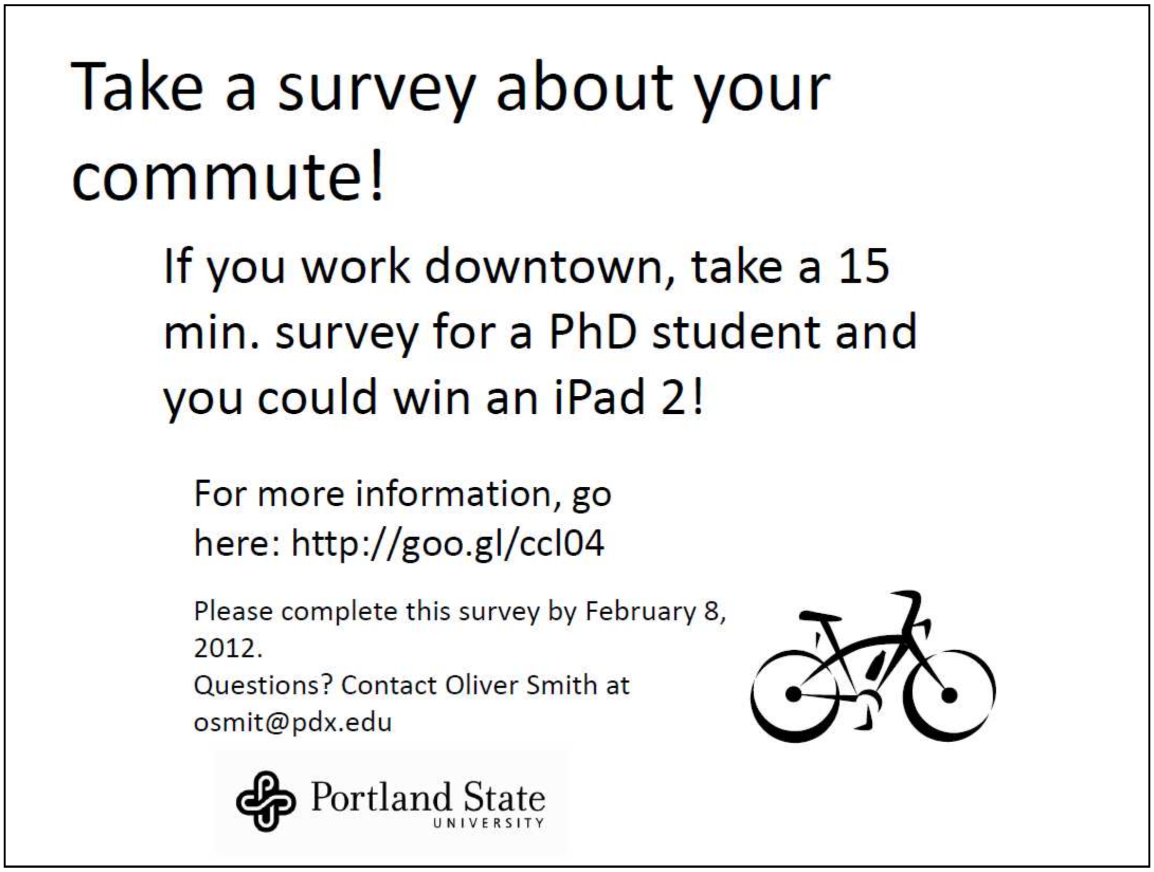


Figure 4 Card distributed to bike commuters

Cards were distributed near or on the Hawthorne, Steel and Broadway bridges. These locations were chosen specifically because they have large numbers of cyclists during commuting hours. They also each had stoplights. At red lights, I asked cyclists that were slowing down or had stopped whether they would take a card about a survey on their commute. I often added that I was a graduate student at Portland State University. An estimated majority of cyclists took the card although many declined it. For safety reasons, cyclists that did not need to stop at the stoplight (due to a green light) were never asked to take a card. Table 5 shows the weather conditions on the three mornings in which cards were handed out varied.

Table 4 Number of responses and response rate by organization

Organization	Distribution	Responses	Rate	Industry
The Standard	2998	141	5%	Insurance
Northwest Natural	200	31	16%	Energy
David Evans and Associates	200	34	17%	Planning
Chrome Systems	130	22	17%	Technology
Outside In	120	53	44%	Social Service
SERA Architects	105	40	38%	Architecture
Energy Trust	100	34	34%	Energy
Parsons Brinckerhoff	80	19	24%	Planning
Portland Center Stage	75	39	52%	Arts
Boora Architects	66	14	21%	Architecture
U.S. Forest Service	50	9	18%	Government
GBD Architects	50	10	20%	Architecture
Watershed Sciences	41	10	24%	Technology
Oregon Historical Society	41	10	24%	Non-profit
Alta Planning + Design	37	15	41%	Planning
Regional Arts & Cultural Council	31	6	19%	Arts
Walker Macy	30	7	23%	Architecture
Glumac	20	7	35%	Architecture

Vestas	11	8	73%	Energy
McDonald Jacobs	5	3	60%	Accounting
TOTAL	4390	512	26% (avg.)	

Table 5 Summary of distribution of card handouts to bicycle commuters

Location	Date	Time	Duration	Weather	Cards Distributed
SW 1st and Main	2/3/2012	7:40-9:10	1 hr 30 min	Sunny, high 30s	71
Steel Bridge approach (N. Interstate Ave and Multnomah)	2/7/2012	7:15-10:00	2hrs 45 min	Sunny, high 40s	147
Broadway Bridge (West side at split between NW Broadway Ave and NW Lovejoy St)	2/14/2012	7:30-8:45	1 hr 15 min	Rainy, low 40s	118
Total					336

Responses from all methods of distribution are shown in Table 6. A total of 865 initial responses were obtained and the average response rate was 26%. This response rate is fairly normal for web-based surveys with no follow-up or personalized contact (Cook et al., 2000). Note that only 75% of surveys received were from respondents at a workplace or intercept site in which a known number of surveys were distributed. The other 25% of surveys came from workplaces where an unknown number of surveys were distributed (due partly to company representatives not responding to inquiries about survey distribution and respondents emailing the survey info to contacts outside of their organization). After filtering out partial responses and responses from people working outside central Portland (i.e. invalid responses), 828 valid responses remained.

Table 6 Summary of responses

Metric	#
Number of organizations in which survey was directly distributed	21
Responses from email distribution	675
Bike handout responses	190
Average response rate for both distribution methods	26%
Invalid responses	37
Total valid responses	828

Respondent Profile

As hoped for, a sample was obtained that represented transit (33.1%, n=271), bicycle (31.9%, n=261) and car (31.9%, n=261) commuters. A small number of respondents walked for their most recent commute (3.2%, n=26). Some of the analysis in this study includes findings related to walk commutes. However, the low sample size of this group precludes inclusion of walk commuters in all analyses. Bike and walk commuters are generally not combined because (1) the bike/walk ratio would be 9:1, making specific findings mostly related to bikes, and (2) there are differences in speeds and sensations felt between the two modes.

The demographic profile of the sample is somewhat different than of the population of commuters to Portland based on Census Transportation Planning Products (CTTP) data (2006-2008). This was expected because the study focuses on commuters to central Portland, a primarily white-collar population compared with commuters to all of Portland. Sociodemographic data for respondents is summarized in Table 7. Data for commuters to central Portland was unavailable.

Table 7 Sociodemographic Description of Respondents

	Study Respondents				Commuters to Portland (CTTP)			
	Car	Bike	Transit	Total	Car	Bike	Transit	Total
Age 25 to 44	60.7%	82.4%	58.8%	67.0%	45.4%	47.3%	48.8%	48.0%
Age 60 or more	7.0%	1.1%	9.4%	6.3%	8.7%	7.2%	4.2%	8.9%
Income (% less than $35K)	12.3%	12.6%	11.1%	12.1%	13.2%	24.4%	24.6%	16.1%
Income (% 75K or more)	55.3%	46.6%	47.0%	49.2%	51.9%	37.4%	37.9%	48.9%
Vehicle Availability (1 or more)	99.2%	87.7%	94.1%	93.2%	98.7%	77.2%	79.4%	94.6%
Gender (% Female)	60.5%	37.1%	59.8%	52.3%	-	-	-	44.9%
Race/ethnicity (% white)	87.0%	90.9%	81.9%	86.8%	-	-	-	76.4%
Education (% 4-yr college)	73.3%	90.8%	80.1%	81.2%	-	-	-	-
Education (% graduate degree)	23.8%	42.3%	31.4%	32.8%	-	-	-	-
Children (% with children in hh)	34.4%	40.8%	41.1%	37.8%	-	-	-	-
One-adult, no children	14.5%	12.8%	17.3%	15.6%	-	-	-	-
Zipcar member	19.8%	31.0%	17.0%	22.3%	-	-	-	-
n	257	261	241	828	314,060	12,720	48,410	409,330

The majority of respondents fall into the 25 to 44 year age group, while the age distribution is more spread out for the population of commuters in Portland. Bike commuters aged 25 to 44 are particularly overrepresented but there are relatively few bike commuters at least 60 years old (1.1%) in the sample compared to Census data for this group (7.2%).

Household incomes of survey participants are somewhat higher than incomes of commuters to Portland overall although this is expected since jobs in central Portland provide higher wages than in other parts of the city. Note that the distributions of incomes by mode are similar (see Figure 5). There are relatively fewer car commuters (16.7%) in the $35,000 to $49,999 category compared to bike (39.2%) and transit (39.2%) commuters in this category. Household income information was not provided by 6.0% of respondents.

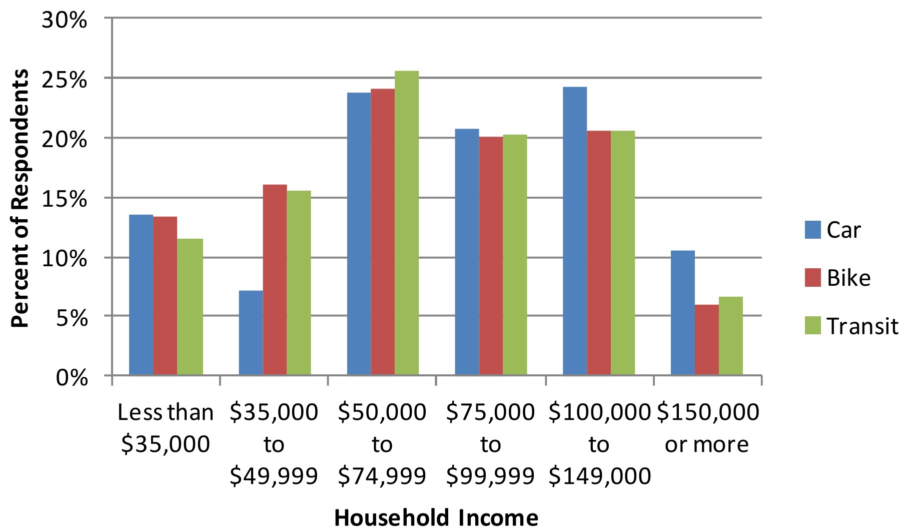


Figure 5 Income Distribution by Mode

The percentages of female (52.3%) and white respondents (86.8%) in this study are slightly higher than for commuters to Portland overall. However, the percentage of female respondents that bike to work is low (37.1%) compared to the percentage of female respondents using car (60.5%) or transit (59.8%).

Although education and household structure data cannot be obtained from the CTTP, it is likely that respondents in the sample have higher education levels, particularly among bike commuters (42% of whom have a graduate degree), compared to the commuters to Portland overall and workers in central Portland. Most (81.2%) of the sample holds a four year college degree.

At least one vehicle was available to 93.2% of the sample, slightly lower than vehicle ownership for commuters to Portland overall. Vehicle ownership in the sample is higher among bike and transit users, and lower than car users compared to CTTP data. Figure 6 displays additional information on vehicle availability by most recent mode. Among those with two or more cars, driving to work was the most common mode while biking was least common. Less than one-quarter of respondents (23%) with access to at least two cars biked to work.

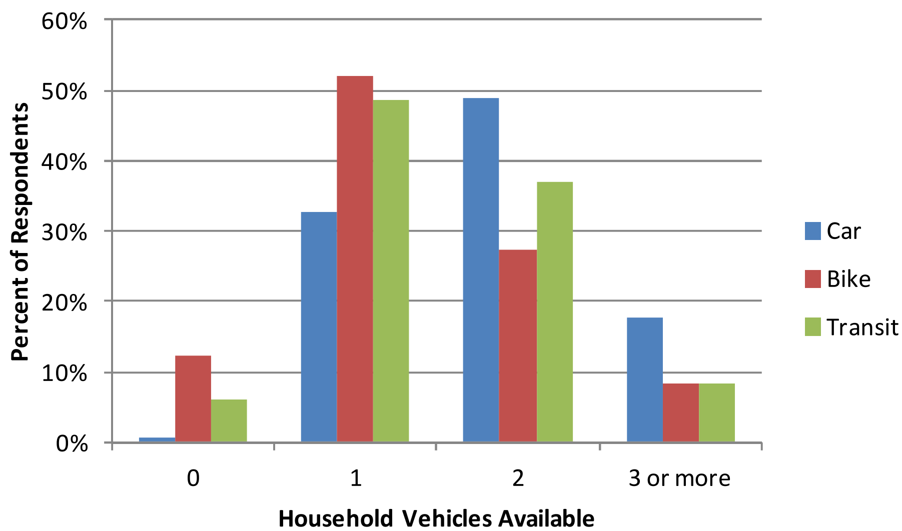


Figure 6 Household Vehicles Available by Mode

Related to vehicle ownership is Zipcar, a carsharing service that allows members to temporarily access a car for commuting or other trips and thereby avoid owning a car (or an additional car). Although membership data is unavailable for the population, Zipcar membership among the sample is likely higher (particularly for bike commuters) than for the population of commuters to central Portland.

Job and residential (i.e. home and neighborhood) satisfaction among the sample are particularly high (see Figure 7 and Figure 8). Eighty-two percent of respondents are somewhat or very satisfied with their job while 92% are somewhat or very satisfied with their home and neighborhood. It is common, however, to find high job satisfaction using single item measures like the one used in this study (Oshagbemi, 1999). There are no significant differences in job or residential satisfaction between modes.

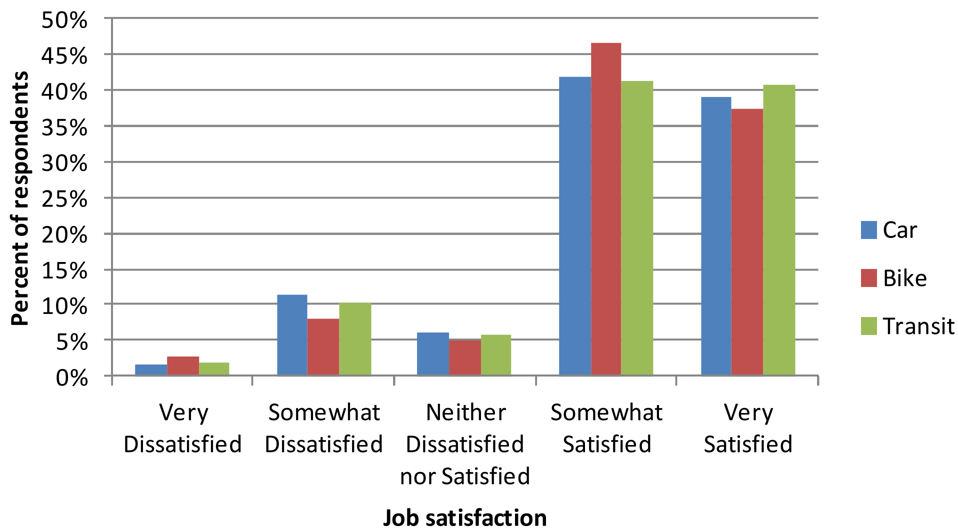


Figure 7 Job Satisfaction by Mode

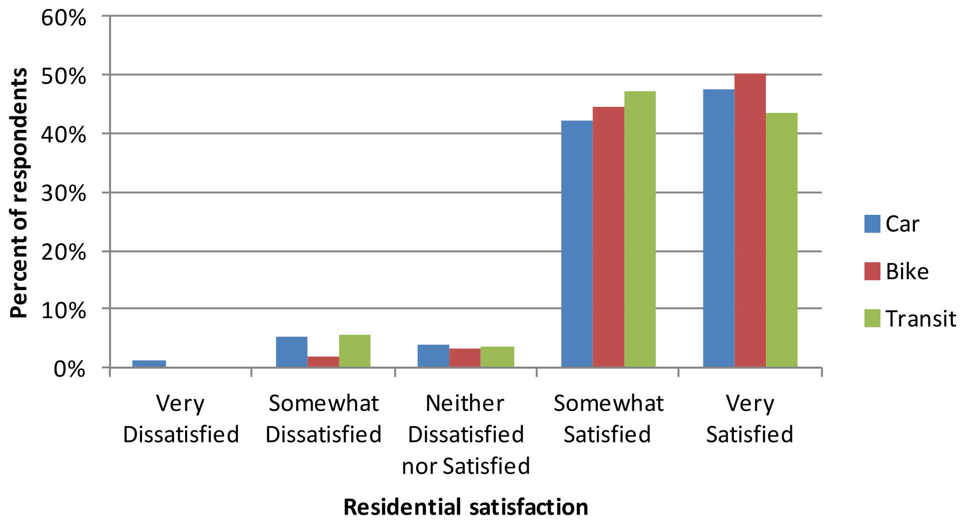


Figure 8 Satisfaction with Residence (Home and Neighborhood) by Mode

The general heath (self-reported) of respondents is good, as shown is shown in Figure 9. Approximately 85% of respondents reported somewhat (44%, n = 359) or very good (42%, n = 344) health. Because only 0.2% (n = 2) of respondents indicated that their health was “very bad”, this category was combined with the 4.6% (n = 38) of respondents that reported “somewhat bad” health for descriptive analyses. Almost twice as many bike commuters (59%, n = 153) reported having “very good” health compared to car (32%, n = 83) and transit commuters (33%, n = 90).

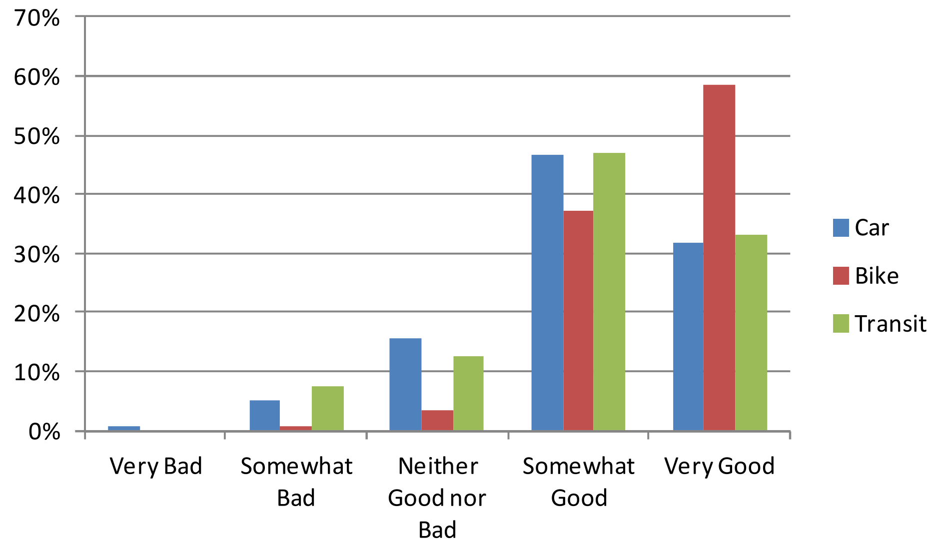


Figure 9 Self-Reported General Health by Mode

Home Location

Respondents' residential location was geocoded using ArcGIS software. Street network data was drawn from Metro's Regional Land Information System (RLIS) database, which contains detailed layers of information on the Portland region's (including Vancouver, WA) transportation and land-use network. Note that the street network for the Portland region needed to be connected the network for the Vancouver region by editing vertices in ArcMap.

Data from February 2012 was used as it was the most recent data at the time of analysis. For addresses with only the street name, the street and city were entered in Google Maps and its Street View function was used to return the closest address. For example, Google returns "16982 Southeast Mill Plain Boulevard" when "Mill Plain Blvd, Vancouver, WA" is entered. This was done for roughly 37 respondents. If no street was given, only the city and state were entered in Google Maps and a point was selected in the middle of downtown. This was done for seven respondents. For small towns like Mulino, OR this should be a good estimate of home location. However, for larger cities, this is a rough estimate. In cases in which the zip code but no city, street name, or street number was provided, the centroid of zip code areas was obtained using ArcGIS. The address for the home closest to the centroid was selected. This process was done for an additional 22 respondents. Because there at least 15 zip codes within the City of Portland, the location of the zip code centroid is likely reasonably close to the actual home location. Table 8 summarizes home location data availability for respondents.

Table 8 Home location data availability

	n	Percent
All Info	762	92%
Street Only	37	4%
Zip Only	22	3%
City Only	7	1%
Total	828	100%

Using ArcGIS, the Vancouver street network was merged with the Portland street network to create one layer. ArcMap's Geocoding tool was used to geocode home addresses. Work addresses were cleaned and geocoded in ArcMap as well. The Streets_NoZone layer from RLIS (February 2012) was used as an address locator. Using the home and work point data and the Route function of Network Analyst, 799 (96.5%

of respondents) shortest path routes were calculated, representing the shortest path on the street network between respondents' home and work addresses. ArcMap also calculated the distance of these routes. The routes are shown in Figure 10.

Locations of homes are well-distributed throughout the Portland metro region and are shown by quadrant in Figure 11 and by suburban region in Table 9. As expected, the majority of respondents live in NE (31.8%, n = 193) and SE (31.2%, n = 189) Portland, where over 80% of Portland's population resides. However, substantial numbers of responses came from N Portland (19.8%, n = 120), and to a lesser extent, SW (10.6%, n = 64) and NW (6.6%, n = 40) residents. Intercepting cyclists on both the Broadway and Steel Bridges likely contributed to the high share of bike commuters from North and Northeast Portland. Southeast had the highest share of transit commuters, while both car and transit were the dominant modes among SW and NW commuters

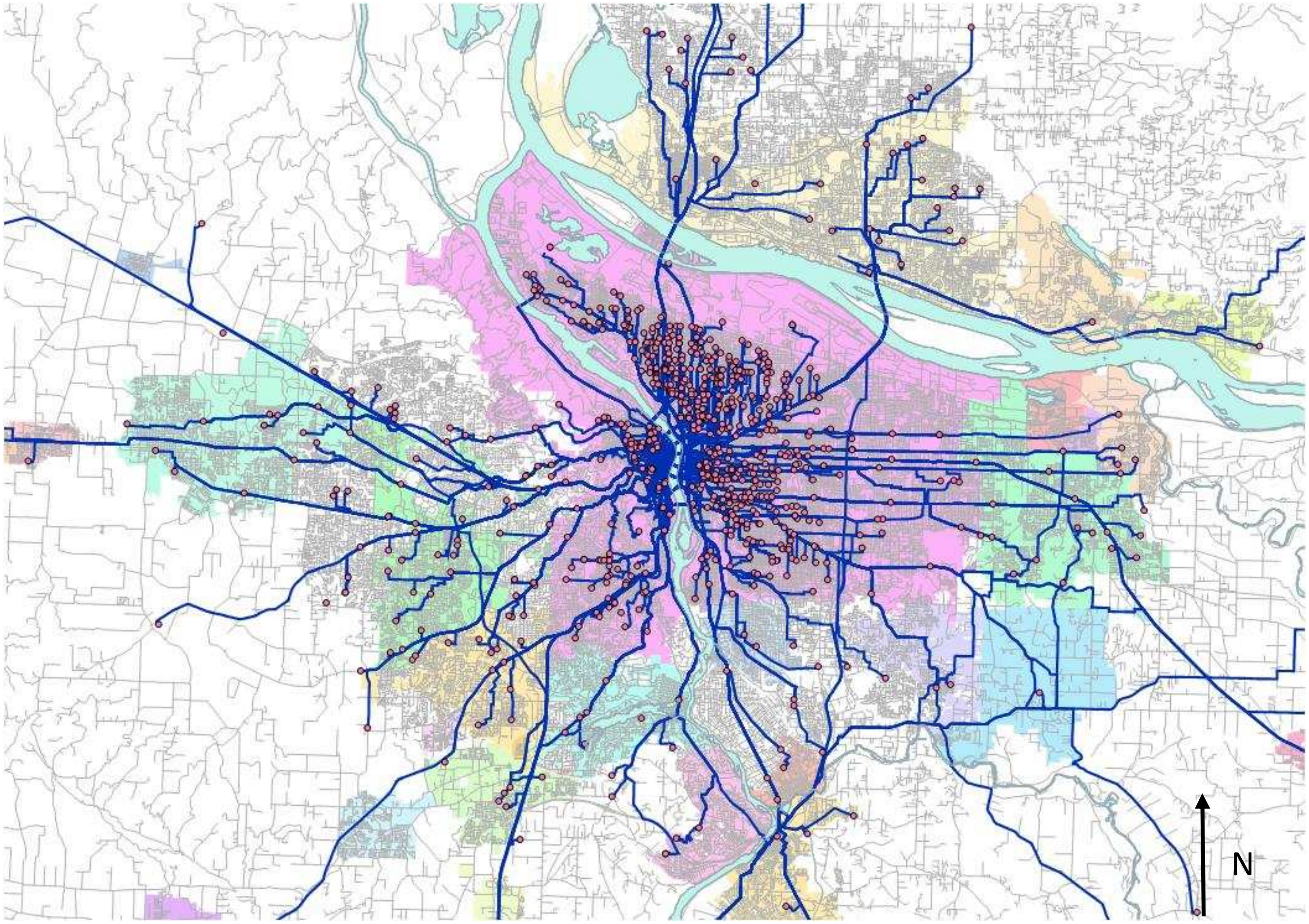


Figure 10 Map of shortest paths between respondents' home and work locations

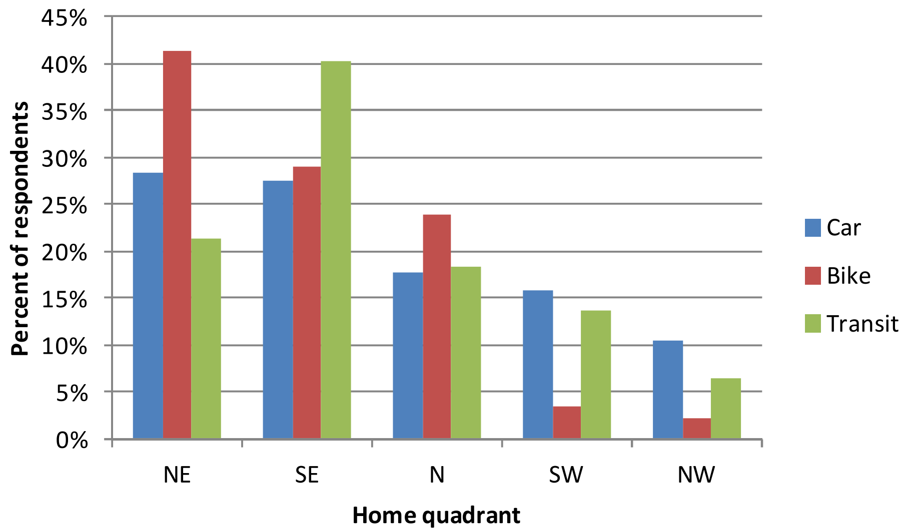


Figure 11 Percent of Respondents by Portland Home Quadrant and Mode (n=614)

Commuters living outside Portland (n=214) are fairly well-represented. Table 9 shows the names of the 50 towns and cities where these respondents live and commute from. In addition, it shows the direction of the town/city in relation to central Portland, ascertained visually using Google Maps. The largest share of these respondents travel from towns and cities south (32%), followed by west (29%), north (21%), and south (17%) of Portland.

Table 9 Home locations for respondents living outside Portland by region (n=214)

East (n = 37)	North (n = 46)	South (n = 68)	West (n = 63)
Boring	Battleground	Albany	Aloha
Clackamas	Brush Prairie	Aumsville	Banks
Damascus	Camas	Colton	Beaverton**
Estacada	La Center	Donald	Cornelius
Fairview	Longview	Gladstone	Deer Island
Gresham*	Vancouver**	Lake Oswego*	Forest Grove
Happy Valley	Washougal	Milwaukie	Hillsboro*
Rhododendron	Woodland	Mulino	McMinnville
Sandy		Newberg	North Plains
Sunnyside		Oregon City	Rock Creek
Troutdale		Salem	St. Helens
Welches		Sherwood	
		Sublimity	
		Tigard	
		Tualatin	
		West Linn	
		Wilsonville	

* 10 or more respondents

** 35 or more respondents

Data Limitations

While this sample has many advantages, it has several limitations, including: (a) it is not generalizable to the population of Portland commuters; (b) commute routes are estimates, not necessarily actual routes; (c) subjective responses are subject to measurement error; and (d) several monetary costs of commuting that may affect well-being are ignored. Each of these is discussed below.

The sample is not random and therefore is not generalizable to the Portland regions' population of commuters. The sample was convenience-based, largely based on organizations and individuals that were willing to participate in the study. In addition, the sample of commute trip destinations is drawn from "Central Portland." This helped to control for some factors (i.e. respondents were mostly white collar workers going to a common destination) and it may come close to representing the population of commuters to this area. However the sample is not large enough to generalize to all different groups of commuters to this area. It also neglects the large percentage of commute trips to other destinations within the region.

Limited route choice data for the sample was obtained. The commute routes estimated using ArcGIS represent the shortest path on the street network between respondents' home and work addresses. In reality, drivers are known to divert from the shortest path to streets with higher speed limits, fewer stops, etc. Bus lines use certain routes to serve passengers that differ from the shortest path routes. Cyclists are known to go out of their way to bike on separated facilities and low-volume streets (see Broach et al., 2012, for example). In addition, many commuters make stops that force them to divert from the shortest path between work and home. So the actual paths taken (for most respondents) are almost certainly longer than the distances estimated in this study. The lack of route choice information also precludes the inclusion of route-level variables that could affect commute well-being, such as the quality of bicycle infrastructure and actual congestion. Respondents were asked about congestion levels and the ease of biking from home but were asked few details about the actual route.

Much of the data in this study uses subjective data, which may suffer from measurement error. Statistical tests (i.e. Cronbach's Alpha, confirmatory factor analysis) help describe the reliability of measures using subjective data. For example, the reliability of the Satisfaction with Life Scale, a five-item measure, is tested using Cronbach's Alpha and results are compared to other studies that use this measure. Single item measures were also used (e.g. for home and job satisfaction) that are known to be less reliable than multi-item measures in an attempt to limit the survey length. Self-reported travel time is another variable that is known to be subject to round-off error in surveys (Mokhtarian and Chen, 2004).

Finally, monetary costs of commuting, such as fuel, bus passes, or rain gear, were not obtained. In addition, many companies may offer incentives to employees that commute by bike (e.g. gift certificates to bicycle shops), by transit (e.g. free or discounted transit passes), or by car (e.g. free parking). Some companies may offer non-monetary incentives for carpooling or using non-auto modes. Financial costs of commuting and incentives offered by employers could affect CWB and not accounting for these factors could bias results.

Summary

Data was collected via web-based surveys that were completed between January 16 and March 7, 2012. Participating organizations were recruited via phone calls and emails to personal contacts and employers (often HR managers) in central Portland. In this study, central Portland includes downtown Portland and a roughly one-mile perimeter that includes the adjacent Lloyd District, Pearl District, Old Town Chinatown, and Central Eastside areas. Respondents were recruited via emails containing information on the study forwarded by contacts within their organizations. Over 20 organizations, mostly private companies, distributed survey information. In addition, roughly 58% of bike commuters in the sample were recruited by intercepting them during the morning commute. Eligible participants must have commuted outside of the home to central Portland at least two days per week. Valid responses were collected from 828 respondents. The overall response rate was 26%, although only 75% of surveys received were from respondents at a workplace or intercept site in which a known number of surveys were distributed.

Chapter 4. Components of Commute Well-Being and Its Influences

This chapter describes the development and testing of the commute well-being measure adapted from Ettema et al. (2011). Possible correlates of commute well-being are tested using descriptive statistics and their significance is discussed. Finally, two multiple linear regression equations are tested to examine which variables best predict commute well-being (and which variables have insignificant effects).

Reliability of the Commute Well-Being Measure

The distributions of responses to the seven commute well-being questions by mode are shown in Figure 12 through Figure 18.

Respondents that bike and walk to work express more positive responses to their commutes overall compared to those who drive and use public transit, particularly for affective measures of enthusiasm, excitement, and enjoyment. The majority of car and transit commuters are neutral about items related to enthusiasm and excitement felt during the commute. Bike and walk commuters are the most likely to be highly confident that they would arrive at work on time (40%), followed by transit commuters (36%) and car commuters (28%). Results are generally consistent with findings in similar studies described in Table 1 about differences in affective elements of travel between modes. All individual items suffer from non-normal distributions to some degree, with the exception of one item, "My trip was the worst I can imagine (-3) to my trip was the best I can imagine (3)," shown in Figure 16. The non-normal distributions are generally consistent with those found in Friman et al. (2013).

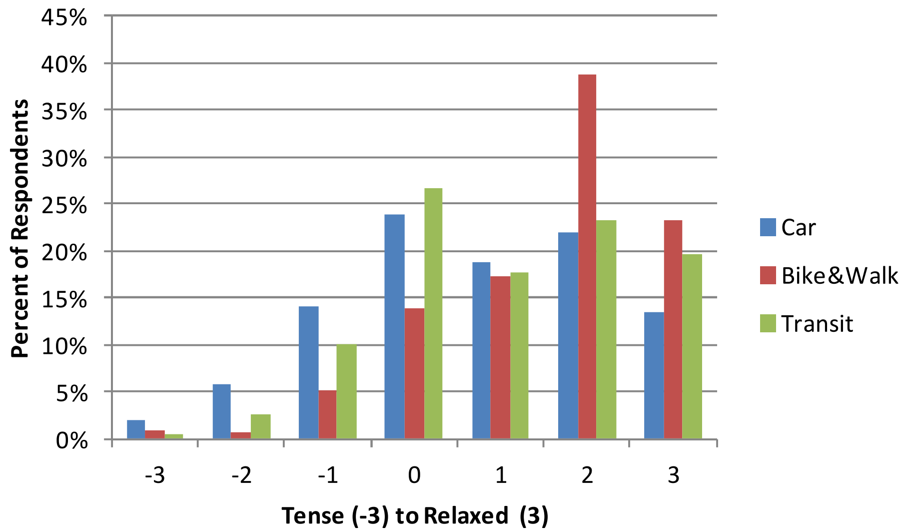


Figure 12 Distribution of commute stress by mode

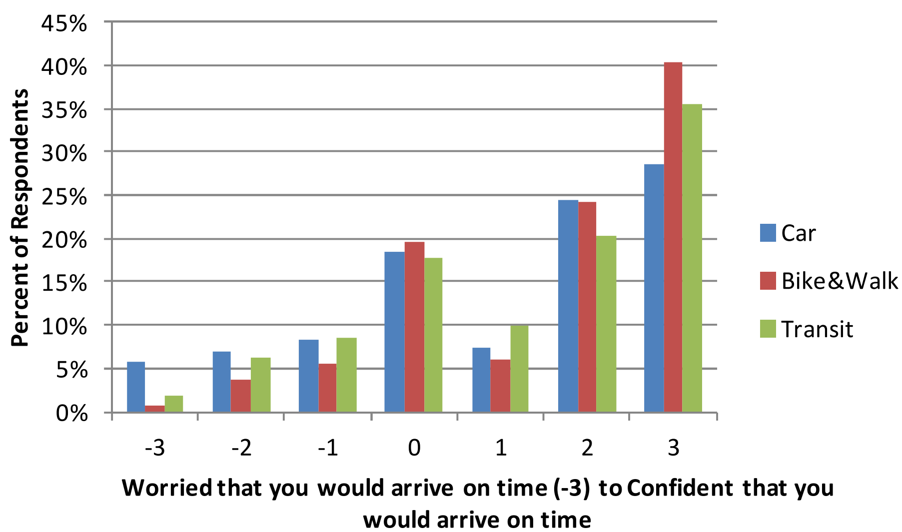


Figure 13 Distribution of arrival time confidence by mode

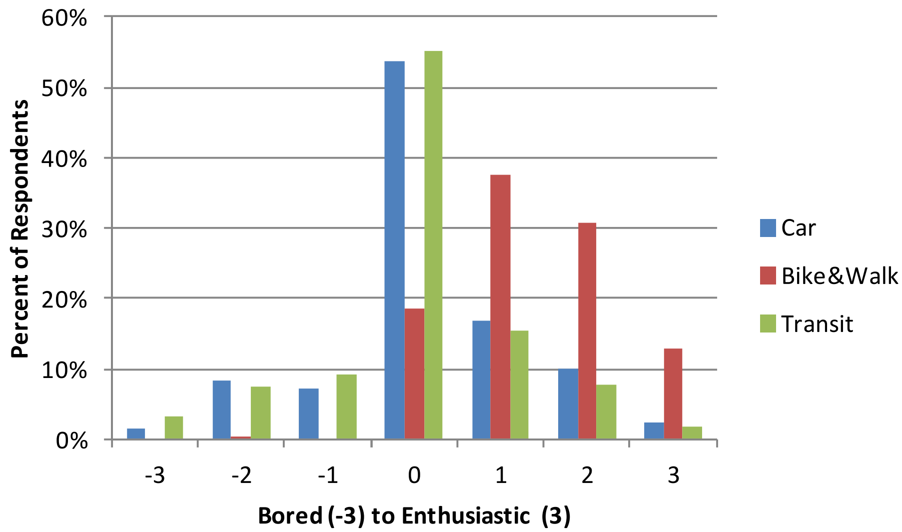


Figure 14 Distribution of enthusiasm by mode

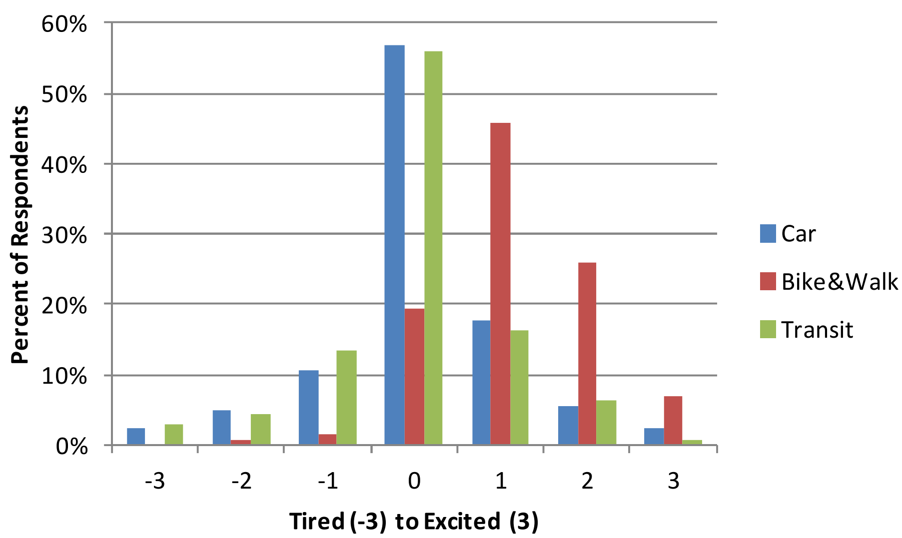


Figure 15 Distribution of excitement by mode

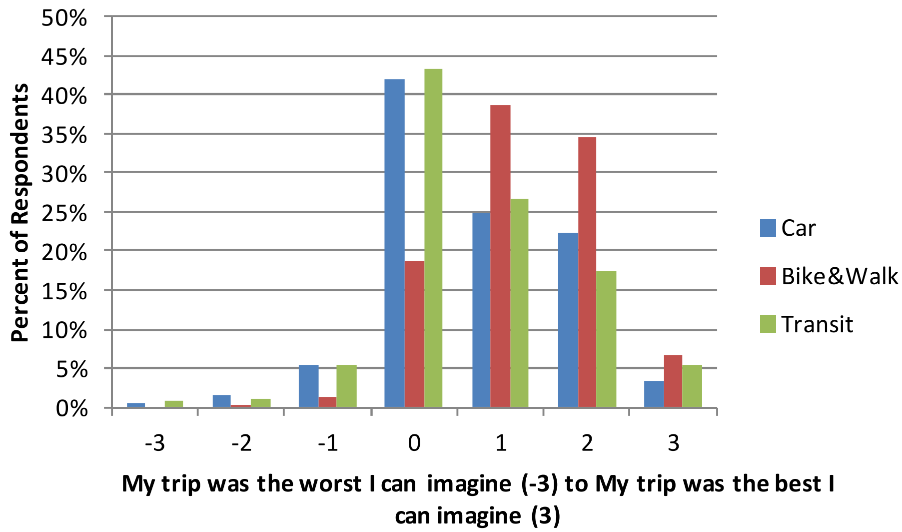


Figure 16 Distribution of comparison of commute by mode

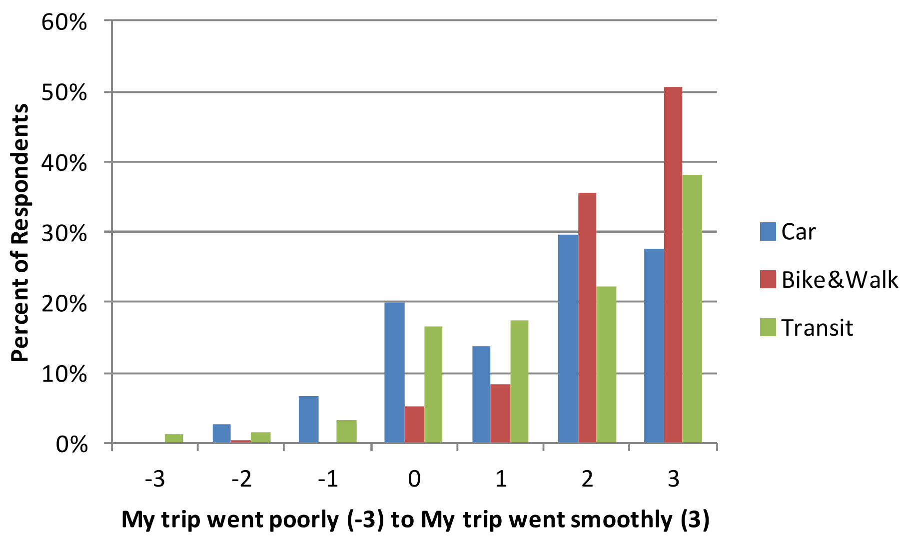


Figure 17 Distribution of commute evaluation by mode

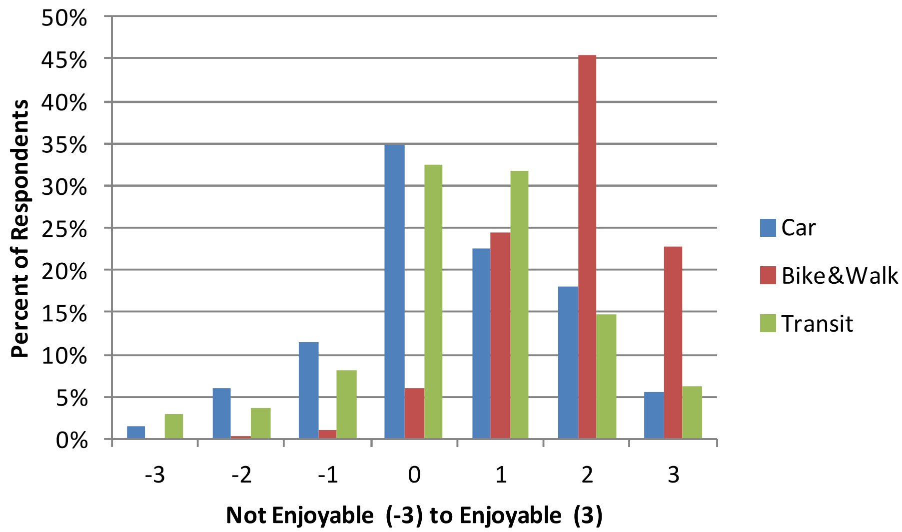
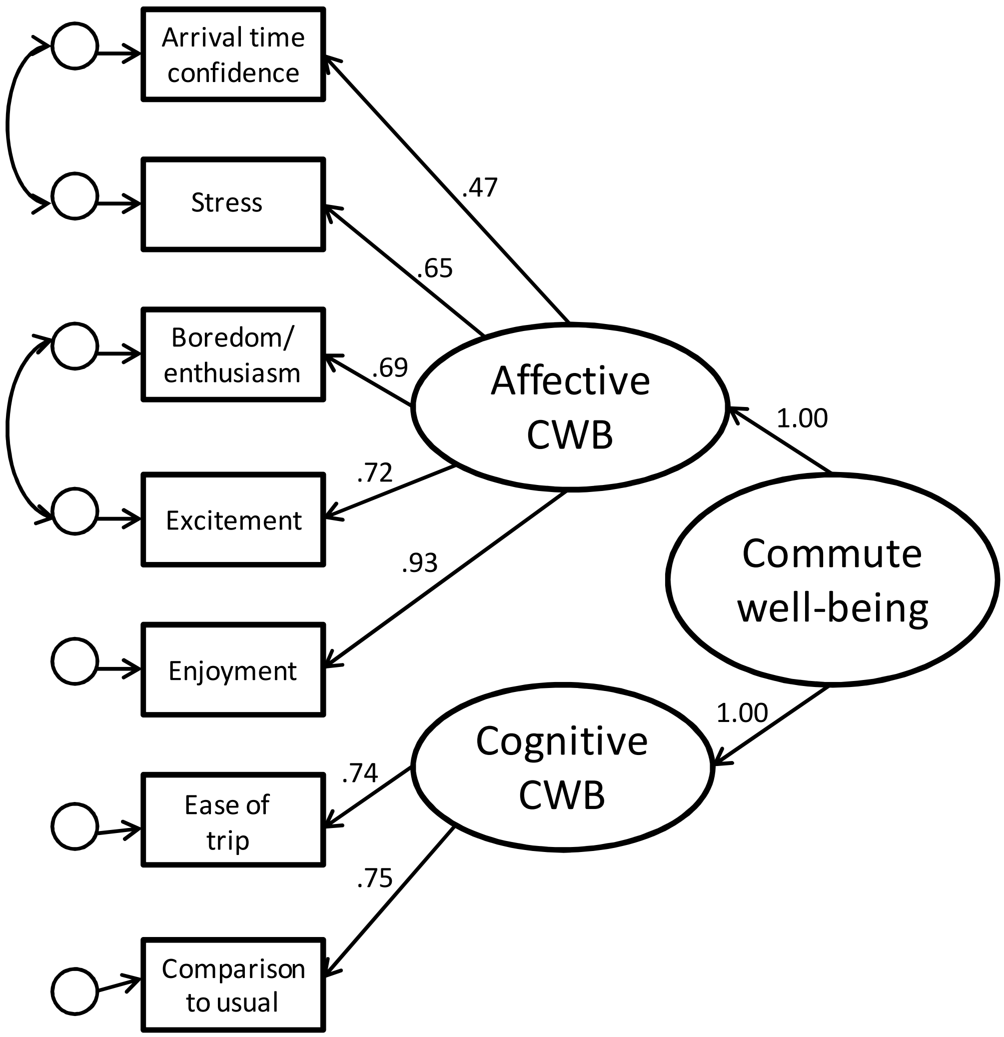


Figure 18 Distribution of commute enjoyment by mode

Cronbach's alpha is a common statistic used to show the reliability (i.e. internal consistency) of a measure. In other words, it shows how different items in a scale "measure the same thing." It is calculated using the number of test items and the average inter-correlation among the items. Values range between 0 and 1, with values closer to 1 indicting greater internal consistency. The Commute Well-Being scale shows acceptable internal consistency based on a Cronbach's alpha of 0.87 (Tavakol and Dennick, 2011).

To further assess the reliability and validity of the commute well-being measure, a two factor structural equation model of commute well-being was performed based on confirmatory factor analysis using AMOS Version 19.0, as shown in Figure 19. At first, fit statistics indicate a marginally unacceptable fit ($\chi^2(9) = 220.7$, CFI = 0.923, RMSEA = .169) because the CFI is slightly less than the cutoff value of .95 recommended by Hu and

Bentler (1999) for a good fitting model. When co-variances between error terms for two pairs of items -- (1) Arrival time confidence and Stress and (2) Boredom/enthusiasm and Excitement items are estimated, as suggested by the modification indices, model fit improves substantially ($\chi^2(12) = 121.7$, CFI = 0.963, RMSEA = .105). These changes to the model are minor and theoretically plausible because the questions in each pair have similar meanings. Variable loadings change very little from the modifications.



Fit information
$\chi 2 = 121.7$ (12)
CFI = .963
RMSEA = .105

Figure 19 Confirmatory Factor Analysis of the Commute Well-Being Measure

Most of the variables load highly (i.e. greater than .6) on the affective and cognitive constructs. One item, Arrival Time Confidence (assessing "Worried that you would arrive on time *to* Confident that you would arrive on time") has a marginally acceptable standardized loading (λ = .47). Since arrival time confidence theoretically represents part of commute well-being and was used successfully in Ettema et al. (2011) and Friman et al. (2013), this item was retained.

The path coefficients between latent variables show that both affective and cognitive components have significant and positive effects on overall commute well-being, as expected.

Based on the theoretical relevance of these items, their use in other studies of commute well-being, and the statistical tests described in this section, the seven-item, two-factor measure of CWB is deemed to be reliable and valid.

Distribution of Overall CWB

Scores from the seven commute well-being questions were averaged to obtain a CWB score for each respondent. The sample showed a wide distribution of CWB. Average CWB scores range from -2.6 (indicating low CWB) to 3.0 (indicating high CWB). Mean CWB is 1.01 (S.D. = .995) and the distribution of CWB is somewhat skewed to the right (skewness = -0.490, as shown in Figure 20, meaning that the sample expresses positive commute experiences overall. Using the guidelines of West, Finch and Curren (1995), the distribution of CWB does not substantially depart from normality as the Skewness is less than two and Kurtosis (0.193) is less than seven.

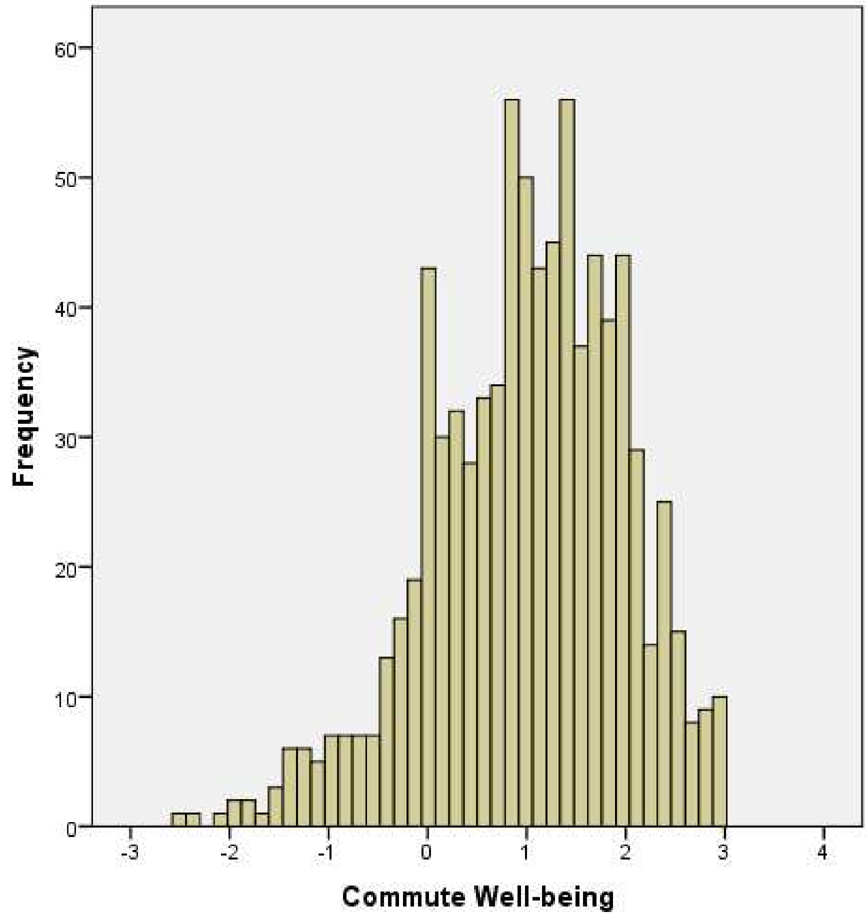


Figure 20 Distribution of commute well-being among respondents (n = 828).

Note that 21 respondents (2.5%) indicated a neutral response for each of the seven CWB items. These respondents may not have considered their responses carefully. Given the low number of these responses, their roughly even distribution among mode groups, and the possibility that the responses are valid, they were retained for the analysis.

Mode

Mean CWB among modes used by sample respondents are shown in Figure 21. Commuters that bicycle to work have the highest CWB (mean = 1.59; S.D. = 0.70, n =

261), while those who drive alone have the lowest CWB (mean = 0.59; S.D. = 1.01; n = 176). These results are in line with findings from similar research showing high commute satisfaction among active modes (i.e. Abou-Zeid and Ben-Akiva, 2011, Gatersleben and Uzzell, 2007, Páez and Whalen, 2010).

Among car commuters, those who carpool to work have higher CWB (mean = 0.77; S.D. = 1.01, n = 79) than those who drive alone (mean = 0.59; S.D. = 1.01, n = 176), however the difference is not statistically significant. The standard deviation for those that drive alone is relatively high, indicating high variability in CWB among this group. Travel time and the degree of congestion experienced likely explain much of this variability, as explained later in this chapter.

Among transit users, express bus (CTRAN) users (mean = 1.14; S.D. = 1.05, n = 19) have higher CWB than light rail (mean = 0.84; S.D. = 0.88, n = 100) and local (TriMet) bus users (mean = 0.65; S.D. = 0.98, n = 100) and the differences were significant using t-tests ($p<.05$). Express bus users likely use the express services from Vancouver, Washington to downtown Portland and Lloyd Center, both within central Portland. Along with having very few stops, most CTRAN buses are equipped with more comfortable seating than TriMet buses. TriMet is the transit service for the Portland metro area in Oregon only. Light rail (TriMet MAX) users have significantly higher CWB than TriMet bus users. This may reflect that light rail has greater comfort than TriMet buses in terms of space, noise and ride smoothness. Light rail also uses dedicated right of way that is not impacted by congestion.

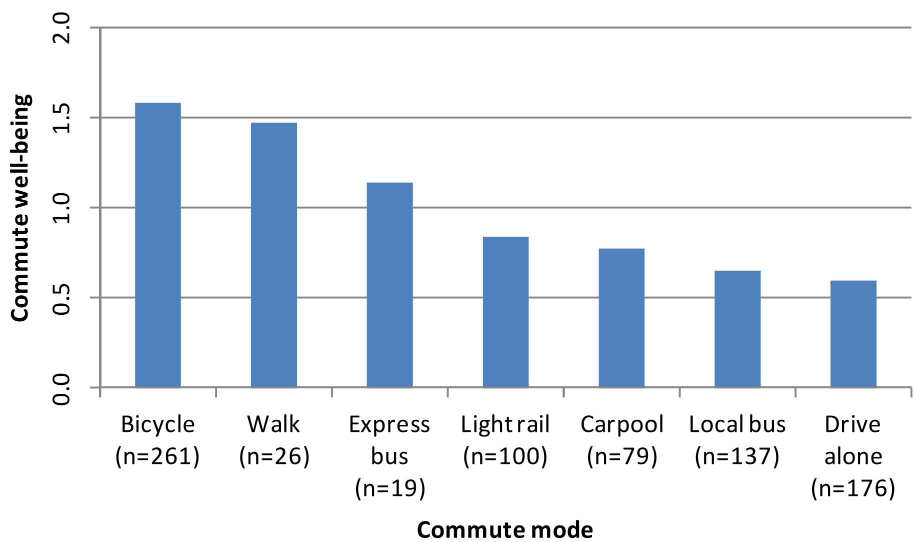


Figure 21 Commute well-being by mode (n = 828).

Users of active modes exhibit higher CWB than transit and car users. In Figure 22, modes are grouped together by car (drive alone and carpool), transit (light rail, TriMet bus, and CTRAN) and active modes (bike and walk). Commuters using active modes have significantly greater CWB ($p < .001$) than transit and car commuters. Differences in CWB among transit and car commuters are not statistically significant, based on an unpaired *t* test.

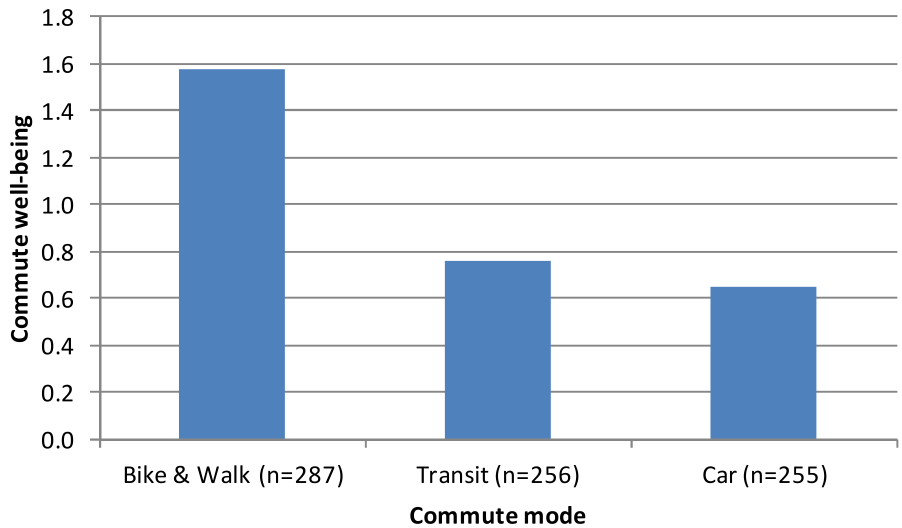


Figure 22 Commute well-being by grouped mode (n = 828).

The majority of respondents (71.4%) use the same commute mode nearly every day. For the remaining 28.6% respondents that use another mode at least two days per week, CWB was calculated for the alternative modes as well. As shown in Figure 23, CWB is highest for bike commutes (mean = 1.45, n = 52, S.D. = 0.81) and lowest for TriMet bus commutes (mean = 0.32, n = 65, S.D. = 1.15). When modes are grouped together, CWB highest for bike and walk modes (mean = 1.38, n = 83) and lowest for transit modes (mean = 0.43, n = 124), as shown in Figure 24. These results suggest among people that commute using different modes on different days, bike and walk commutes are the best, while transit commutes are the worst. The results generally confirm the differences in CWB by mode for the most recent commute (see Figure 21). It is surprising, however, that light rail (MAX) commutes on other days (mean = 0.50, n =

53, S.D. = 1.18) are significantly lower ($p < .05$) compared to the group that used light rail for the most recent commute (mean = 0.84, n= 100, S.D. = 0.88).

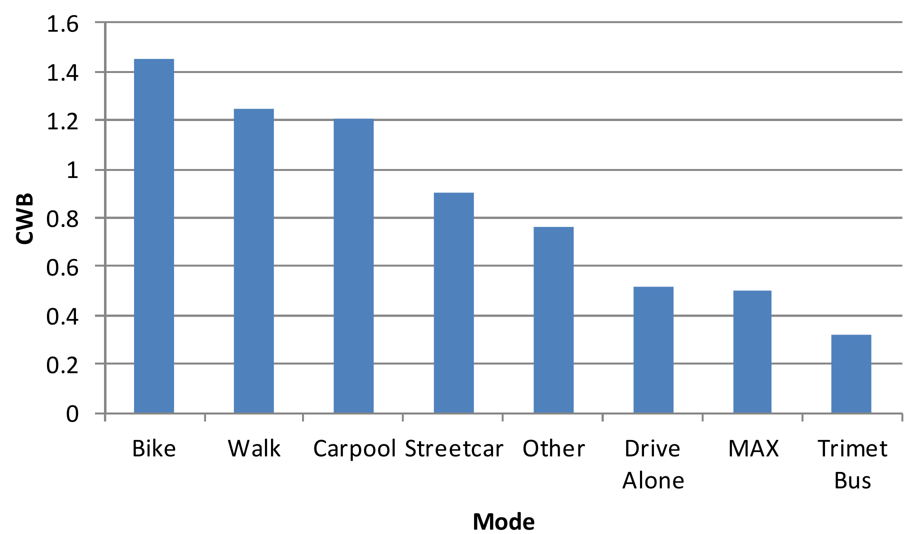


Figure 23 CWB for Secondary and Tertiary Modes

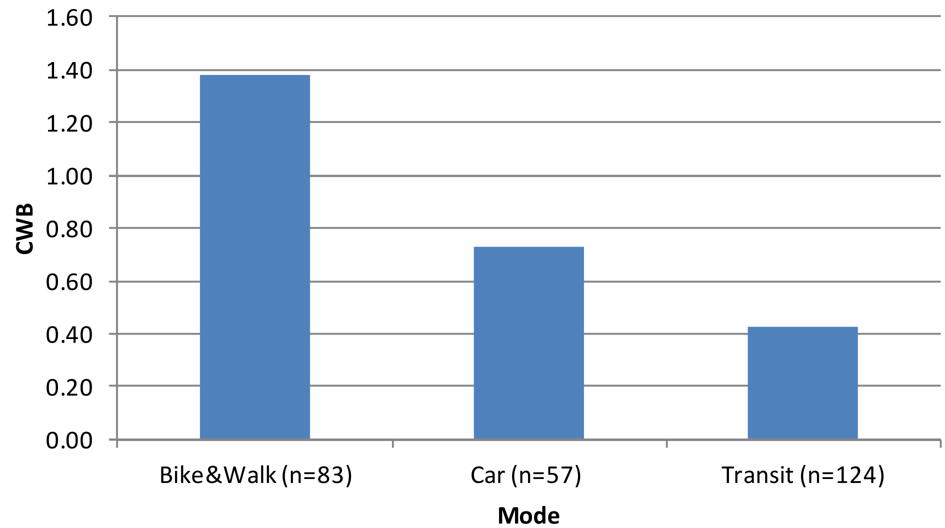


Figure 24 CWB for Grouped Secondary and Tertiary Modes

Travel time and distance

In this study, commute times are self-reported responses to the question: *"How long did the total trip take, from the time you left home to the time you arrived at work?"* Average commute times for the whole sample are just over one-half hour (31.2 min.), as shown in Figure 25. Transit commuters have the longest average commute times (41 min) while bike and walk commuters have the shortest commute times (25 min.). Figure 25 also shows average trip times by mode using American Community Survey data for commuters to Portland. Times in the study are slightly longer overall, especially for bike and walk commuters (25 min in the study versus 18 min in the ACS), possibly due to the workplace study area. Travel times for car and transit commuters are similar to times for these modes as reported in the ACS for Portland commuters (Census CTTP 2006-2008 data). It should be noted that average travel times for the Portland region (27.9

minutes) are 2.5 minutes longer than average commute times for the United States (25.4 minutes) but may be shorter than commute times for other medium and large-sized metropolitan regions (U.S. Census, 2012).

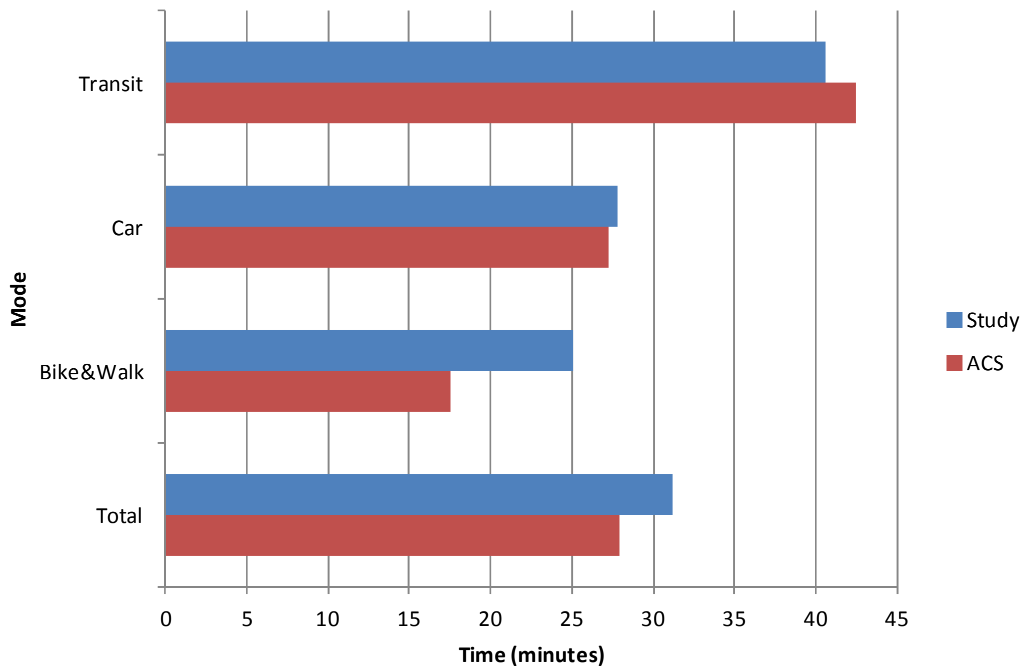


Figure 25 Mean Commute Time by Mode for Study Compared to American Community Survey

The distribution of travel times to work is shown in Figure 26. For bike and car modes, the distribution is similar. The highest percentage of respondents for bike and car commuters have commutes between 20 and 30 minutes. Transit commuters tend to have longer commutes. Thirteen percent of transit commuters had commutes longer that were at least one hour long, compared to six percent of car commuters and one percent of bike commuters.

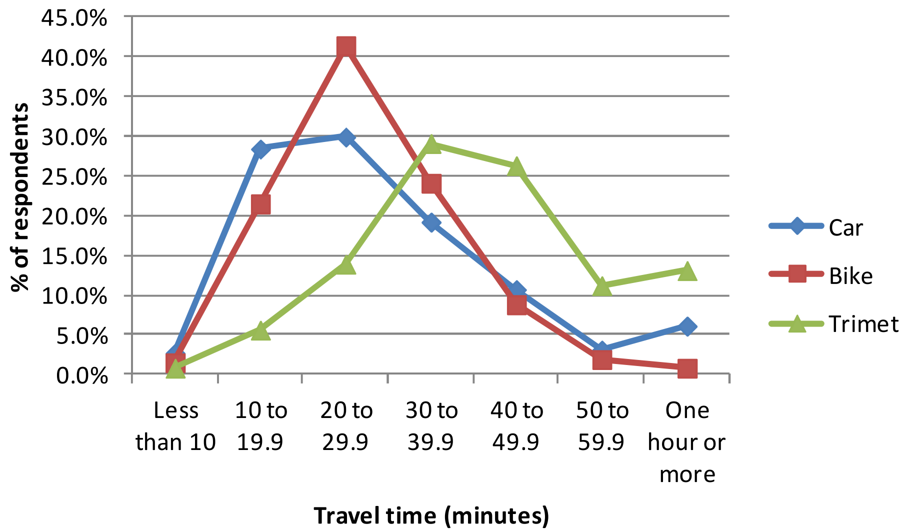


Figure 26 Percent of respondents by travel time categories and mode

Travel time is weakly negatively correlated with CWB, with a Pearson Correlation coefficient of -0.17 ($p < .001$). Its association differs by mode, however. As shown in Figure 27, car commuters' CWB declines as travel time increases (Pearson Correlation coefficient = -.258, $p < .01$), although not in a linear way. Car commuters with (one-way) commutes in excess of one hour have the lowest CWB of all mode and travel time categories. For TriMet commuters, CWB stays relatively flat as travel time increases (Pearson Correlation coefficient = -.051, ns). For those who bike to work, CWB increases as travel time increases (Pearson Correlation coefficient = .065, ns), but drops off after one hour. Bike and car commuters with short commutes (less than 10 minutes) have lower CWB than those with commutes of 10 to 20 and 30 to 40 minutes. These results are consistent with findings in other literature that note the importance of having some transition time between home and work (i.e. Paez and Whalen, 2010; Ory and Mokhtarian, 2005; Mokhtarian and Solomon, 2001).

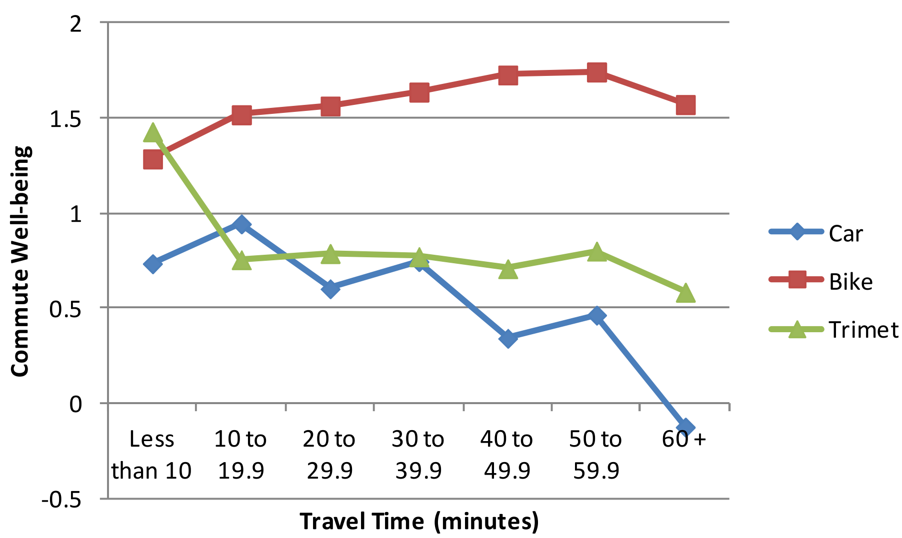


Figure 27 Mean CWB by commute travel time and mode

Estimated commute distances (i.e. shortest path distances between home and work along the road network obtained using ArcGIS) between modes show greater variation than the differences in travel times (see Figure 28). Express bus (CTRAN) commuters have the longest commutes followed by car, TriMet (light rail and local bus), and bike commuters. Aside from CTRAN, whose Portland-bound passengers live in Washington, commute distance decreases as modal speed decreases. Those who walk to work have the shortest commutes (mean = 1.5 mi.). Note that while two-thirds (n=16) of walk trips were less than one mile, these distances are long compared to those assumed for pedestrians in most travel demand models.

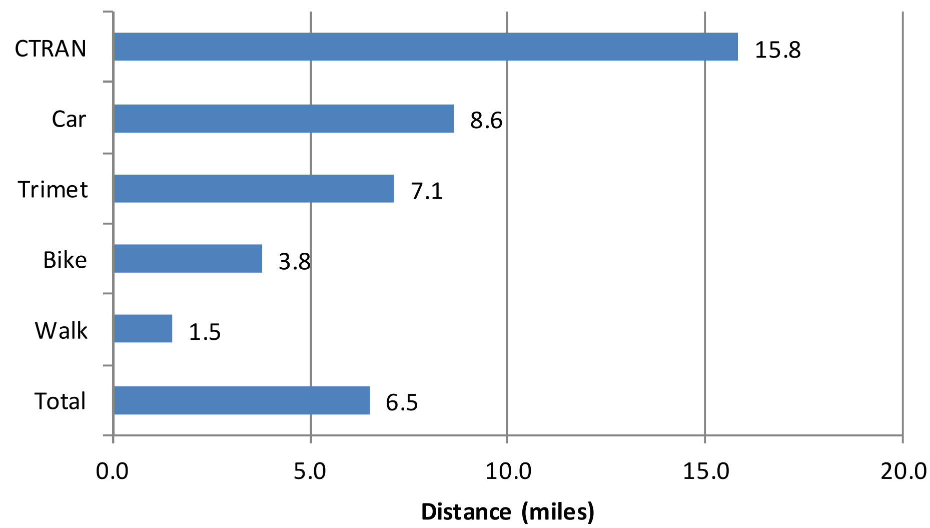


Figure 28 Mean commute distance by mode

The distributions of commute distances for car and TriMet commuters are remarkably similar, as shown in Figure 29. These distributions are also quite different than the distribution of distribution of commute distances for bike commuters. The share of respondents living between 2.5 and 4.9 miles from work is twice as high for bike commuters as for car and TriMet commuters. In addition, only two percent of bike commuters in the sample live further than 7.5 miles from work, compared to 43% and 34% of car and TriMet commuters, respectively.

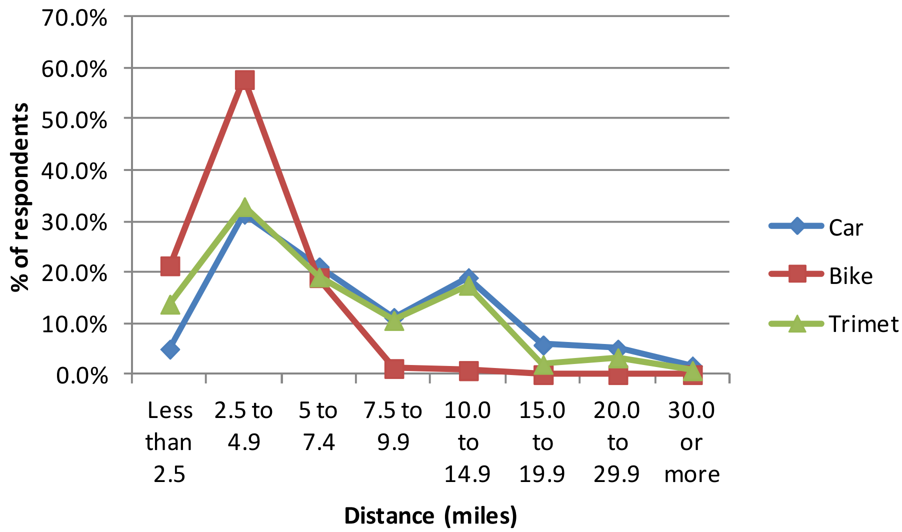


Figure 29 Percent of respondents by distance categories and mode

The effect of distance on commute well-being is somewhat unclear. Figure 30 shows that for people that bike to work, CWB increases slightly for commute distances up to 9.9 miles and then drops off (although the drop-off is negligible since there were only two respondents in this category). Another interesting result is that CWB among TriMet commuters is highest among those who live 7.5 to 9.9 miles. Among those who drive, CWB declines as distance increases but rises, counterintuitively, among those commuting between 7.5 and 9.9 miles. CWB is higher for those living at least 10 miles from their workplace than for those living between 5.0 and 7.4 miles from their workplace. Overall, the correlation between commute distance and CWB is insignificant. Results do not square with other studies that demonstrate a decrease in satisfaction as commute distance increases. Accounting for other factors, such as residential and job satisfaction, with a multivariate model could shed light on how distance affects well-being.

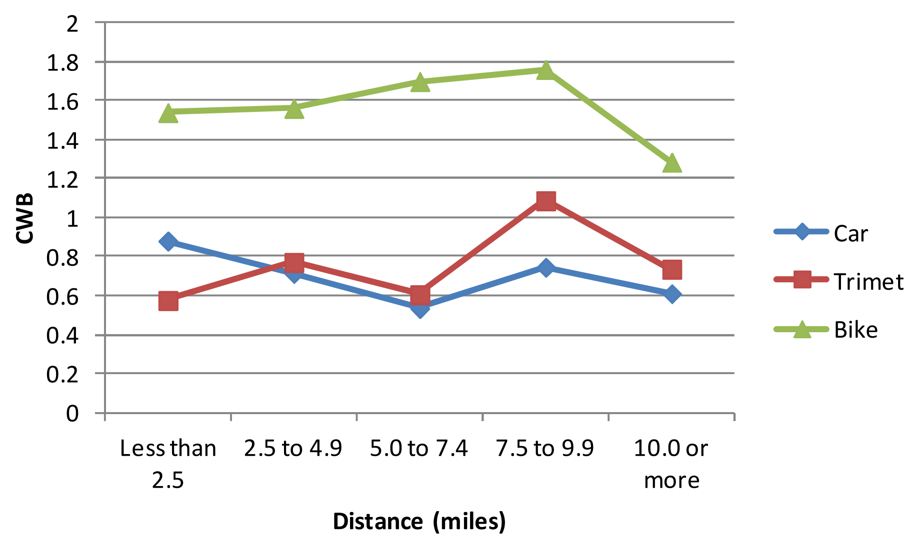


Figure 30 Commute well-being by commute distance categories

Distances to transit stops were also obtained using ArcGIS Network Analyst. The correlations between distances to transit stops (for both bus and light rail) and CWB were negative, as expected, but were not statistically significant. Even for the 57.2% (n=155) of transit users that walk from home to transit stops, there was no significant correlation between distance to transit stops and commute well-being.

Congestion

Respondents were asked about the level of traffic congestion encountered during the commute (i.e. “not at all congested”, “somewhat congested” or “very congested”). For both car and bus commuters CWB decreases substantially as the level of traffic congestion increases, as expected. This is not the case for bike commuters. ANOVA tests confirmed significant differences in means for different congestion levels among car and bus commuters (both $p < .01$), but no significant differences among bike commuters. These findings are consistant with some other research (Abou-Zeid and Ben-Akiva, 2011; Gatersleben and Uzzell, 2007), but are not necessarily consistent with Sener et al. (2009), who found cyclists are sensitive to moderate and heavy traffic volumes.

Several possible reasons could explain the lack of significant change in CWB among bicyclists facing increasing traffic congestion. First, bicycle commuters may be able to navigate congested streets, often through using bike lanes or separated paths, while avoiding much delay. Second, it could be that cyclists in this study are more experienced than in the Sener et al. study and are more comfortable riding along congested roadways. Third, there could be some measurement error. Respondents may have reported that their commute was heavily congested but only experienced traffic congestion at the very end of the ride (entering downtown, for example). Respondents that used light rail were not asked questions about congestion as light rail primarily uses dedicated rights-of-way that are not subject to traffic congestion.

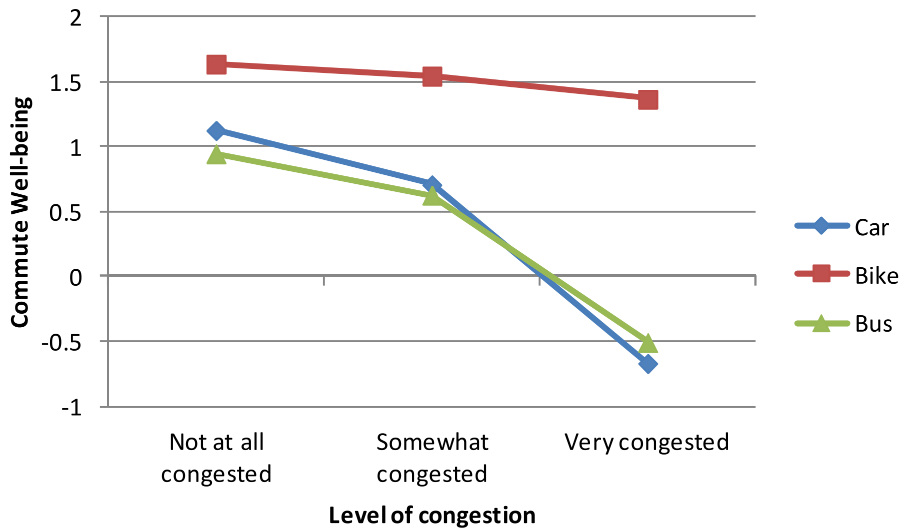


Figure 31 Mean CWB by level of congestion and mode

Crowdedness of Public Transport

Survey respondents that used public transportation on their most recent trip were asked about how crowded their vehicle was. Responses indicate that crowdedness negatively affects CWB for both local bus and light rail commuters, as shown in Figure 32. Respondents with more crowded vehicles expressed lower CWB relative to those expressing that their vehicle was “not at all crowded.” The effect appears to be similar for both light rail and bus. While the jump from “not at all crowded” to “somewhat crowded” does not significantly decrease CWB, the jump from “somewhat crowded” to “very crowded” results in a significant reduction in CWB for both light rail ($p < .05$) and local bus ($p < .001$) users, based on independent samples t-tests. An ANOVA test also indicates that the differences in CWB among different levels of crowdedness are significant ($p < .001$) for both bus and light rail commuters.

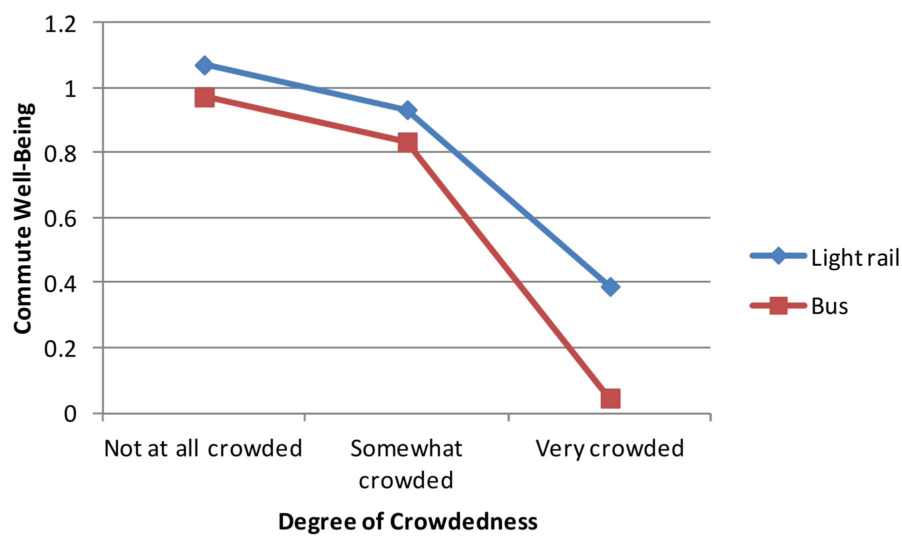


Figure 32 CWB by Level of Crowdedness on Public Transportation

Vehicle Availability

Use of a car for commuting is found to increase feelings of status and control in other studies (Ory and Mokhtarian, 2005; Steg, 2005). While it was assumed that greater vehicle availability would have a positive effect on CWB, increasing vehicle availability is negatively associated with CWB (Pearson's Correlation = -.115, $p < .05$), although the correlation is weak. Those with zero vehicles (mean = 1.40, n = 55, S.D. = .83) available have significantly higher ($p < .001$) CWB than respondents with three or more vehicles available (mean = 0.87, n = 90, S.D. = .84). Figure 33 shows mean CWB by the number of household vehicles available. Associations between CWB and vehicles per adult, vehicles per worker, and vehicles per household member were tested, but no significant associations were found. Among those that commute by car, surprisingly there were not significant associations between vehicle availability and CWB.

Taken together, these results suggest that vehicle availability may not affect commute well-being directly. Higher commute well-being among zero car households is likely due to the greater propensity of these households to bike to work (56.4% of zero-car households bike to work) compared to those with at least one vehicle available (in which 27.4% bike to work).

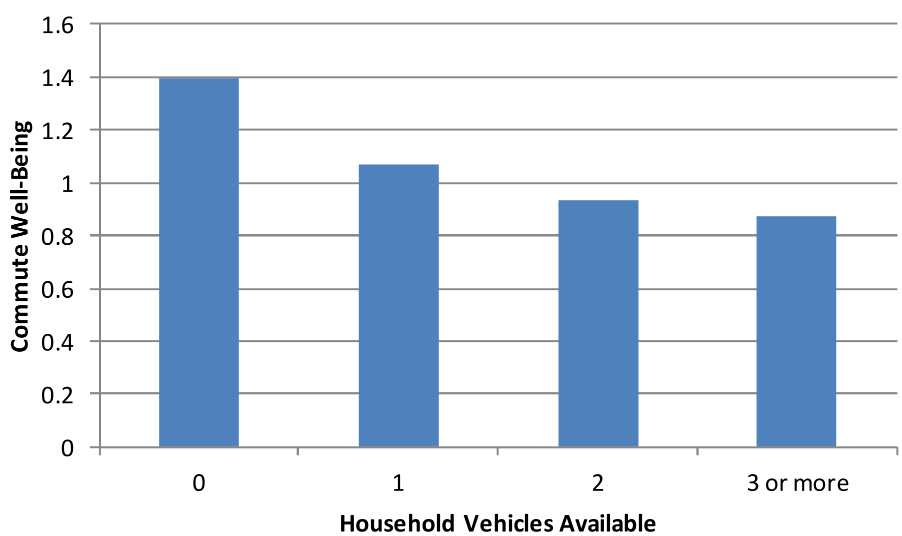


Figure 33 CWB by Vehicle Availability

Ease of Getting to Work by Different Modes

First, respondents were asked to rate the ease of commuting using different modes. It was hypothesized that having a greater number of mode options would increase CWB, as respondents would be able to better optimize their mode according to their preferences and daily needs. While it was not specified, respondents presumably answered the questions with the perspective of their current home location, work location, daily activities, and needs (e.g. dropping family members off at school, work dress codes, etc.).

A cross-tabulation of the “easy” dummy variables with most recent mode shows how respondents feel about the ease of using other modes and the ease of the modes they actually use (see Figure 34). Among those who use a car, 86.6% say that it is easy to drive while only 22.2% say that it is easy to bike to work. Among those who take transit, 95.9% say that it’s easy to take transit and 29.9% say that it is easy to bike. Among those who bike, 98.9% say that it is easy to bike and 51.0% said it is easy to drive. These results suggest slightly more transit and bike commuters say that it is easy to use their chosen modes than car users. In addition, commuting by transit would be/is “easy” for the largest share of respondents (74.9%). Driving would be easy for 63.9% of respondents and bicycling would only be easy for half of respondents (50.7%).

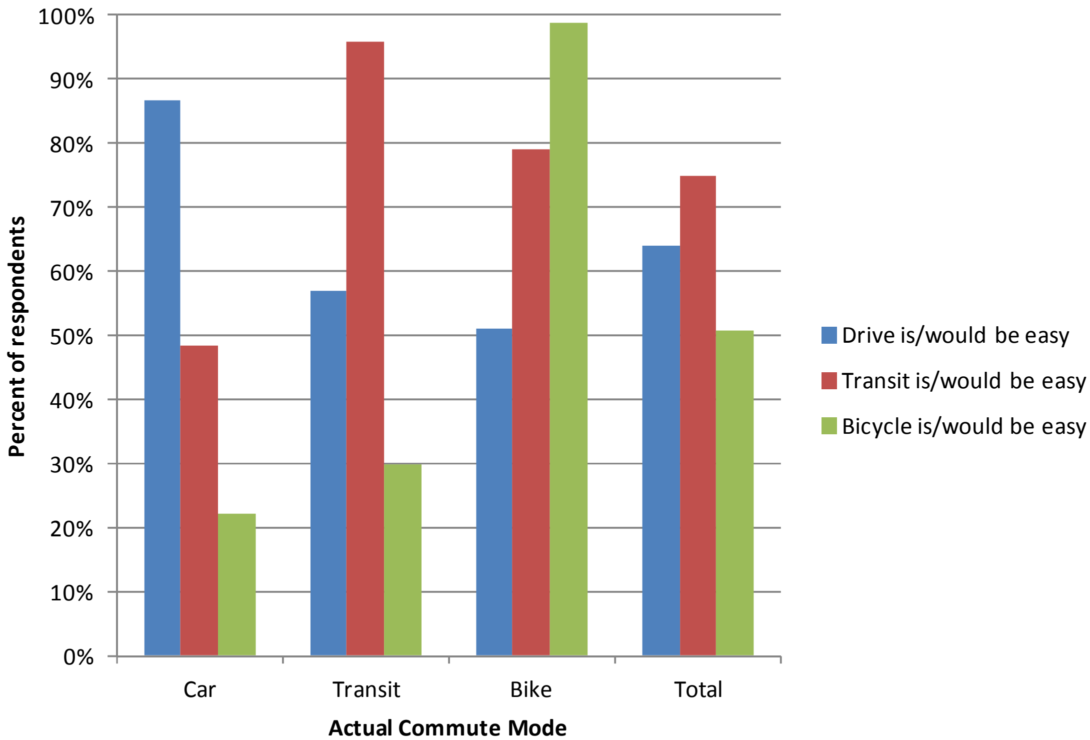


Figure 34 Ease of Using Different Modes by Actual Commute Mode

To measure the number of mode options for respondents, the sum of "easy modes" was calculated. It shows how many modes are "somewhat" or "very" easy to commute by among the following: transit, drive alone, carpool, bicycle and walking. The average number of easy modes for respondents is 2.3. The distribution of responses is shown in Figure 35. A small percentage (1.6%) of respondents has no easy options while the largest percentage (41.3%) has two easy mode options for commuting. A larger percentage of bike commuters have three or more easy modes compared to car and transit commuters. While most respondents have multiple options for commute modes, bike commuters have slightly greater mode options, on average. This could be partially because bike commuters live closer to work than transit and car commuters. Commute distance is moderately and negatively correlated (-.36, p < .001) with the sum of easy mode options.

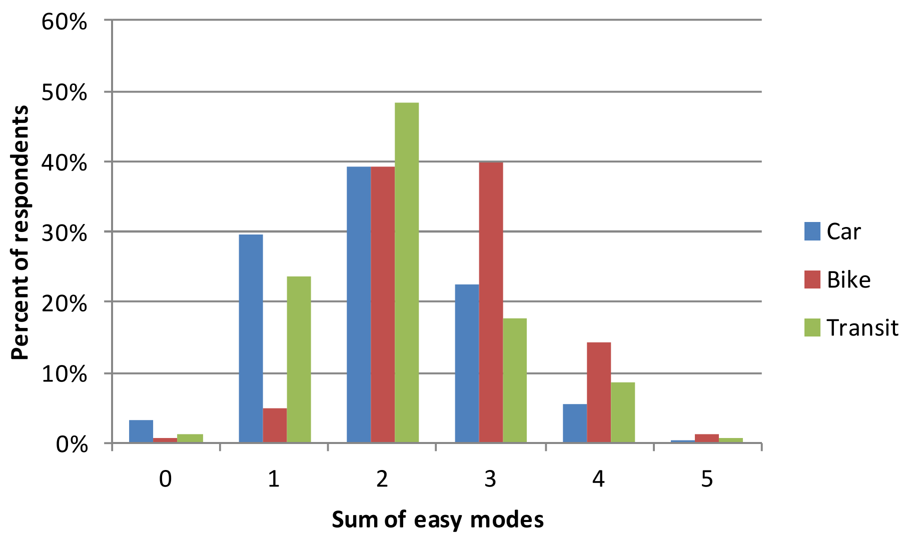


Figure 35 Distribution of Sum of "Easy" Modes

As expected, results indicate a link between mode options and well-being. There is a significant weak positive correlation between the number of mode options and CWB (Pearson Correlation = 0.208, p < .001). Figure 36 shows average CWB by the number of easy commute modes available. Those with no easy options have the lowest CWB (mean = -0.68, n = 13) while those with four or more easy options have the highest CWB (mean = 1.26, n = 89).

CWB by mode options and chosen mode are shown in Figure 37. For all modes together, CWB was higher among respondents with at least two easy mode options (mean = 1.09, n = 657, S.D. = 0.96) than those with zero or one easy modes (mean = 0.71, n = 171, S.D. = 1.08) and the difference was highly significant ($p < .001$). Among mode groups, no significant differences were found between those with zero or one easy mode options and those with at least two easy mode options. This suggests that use of particular modes for commuting is more closely related to commute well-being than having other mode options. Put another way, “captive” car, bike and transit users appear to have similar commute well-being as their “choice” car, bike and transit-riding counterparts.

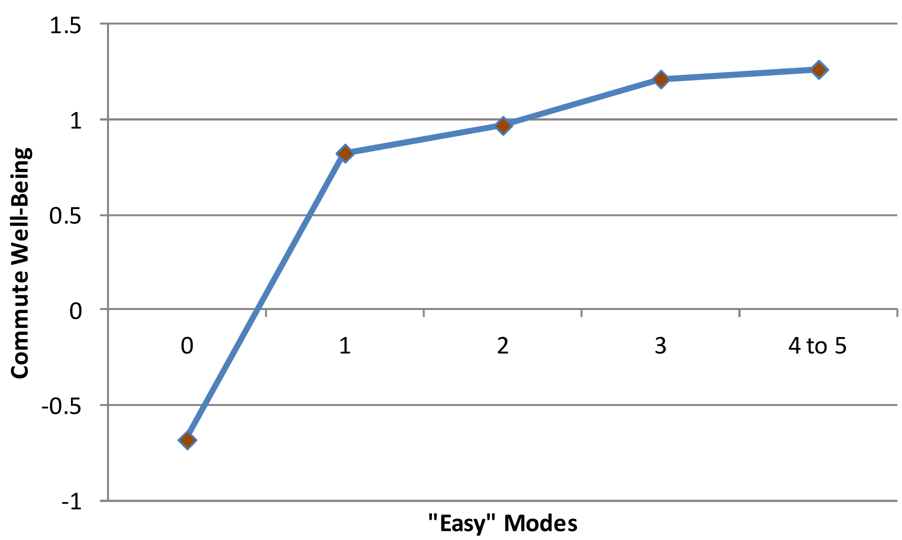


Figure 36 Commute Well-Being by Number of Easy Commute Modes

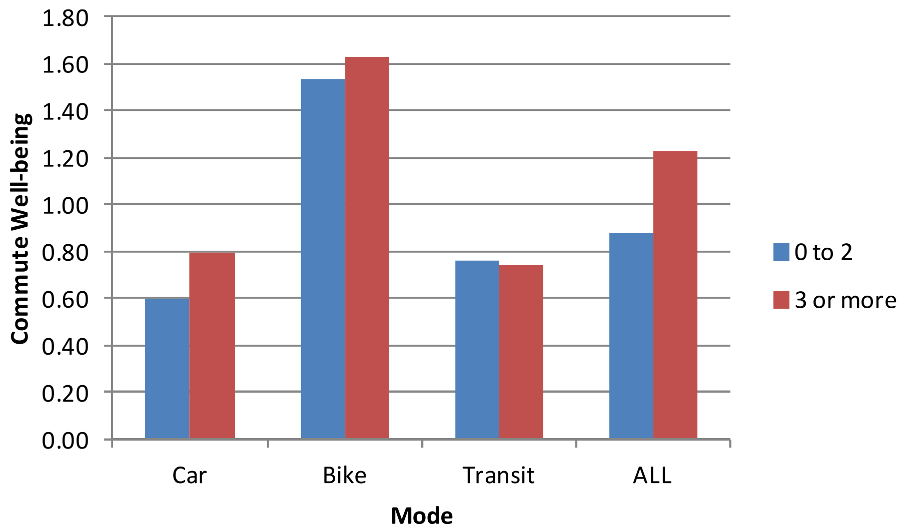


Figure 37 CWB by Easy Mode Options and Mode

Job Satisfaction, Home Satisfaction, Health and Life Satisfaction

Bivariate correlations show highly significant weak positive associations between CWB and job satisfaction (Pearson Correlation coefficient = 0.154, $p < .001$) and home and neighborhood satisfaction (Pearson Correlation coefficient = 0.220, $p < .001$). These results are intuitive and consistent with previous studies. Research shows that health and job satisfaction are common correlates of happiness or overall well-being (Kahneman, 1999).

The association between job satisfaction and CWB is more concave than linear, as shown in Figure 38. Those that are very dissatisfied with their jobs (mean = 0.91, n = 16, S.D. 1.21) are happier with their commutes than those with neutral job satisfaction (mean = 0.72, n = 53, S.D. 1.10), however the difference is not statistically significant. The association between satisfaction with residential living environment (including home and neighborhood) and CWB is similar to that of job satisfaction and CWB.

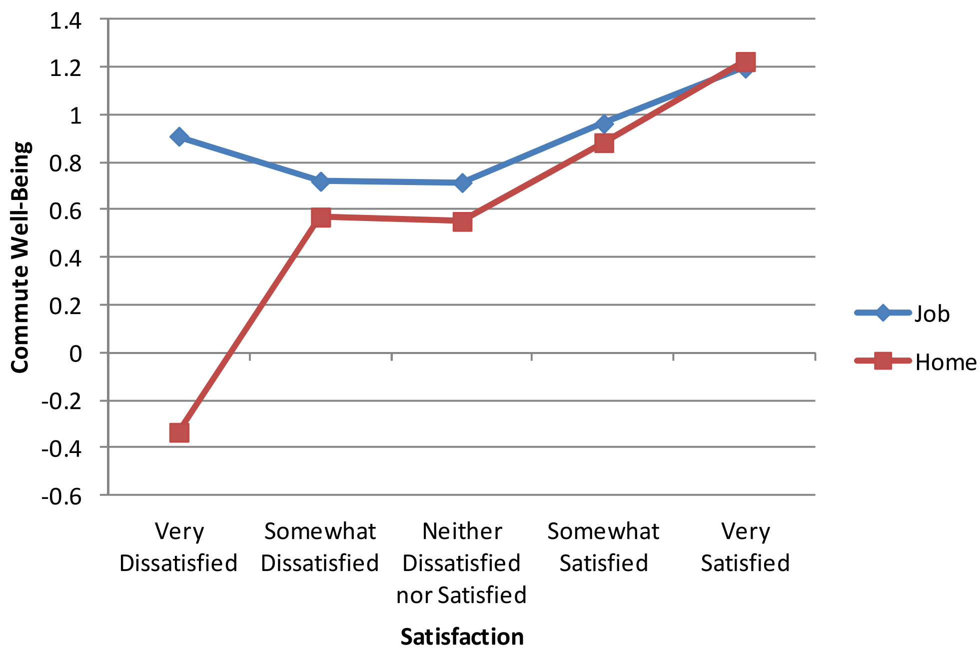


Figure 38 CWB by Home and Job Satisfaction

Health is also significantly and weakly correlated with CWB (Pearson Correlation coefficient = 0.259, $p < .001$). Because the modes differ with respect to physical activity required, differences in relationships between health and CWB were examined among the three modes, as shown in Figure 39. The relationships is strongest for respondents that bike (Pearson Correlation coefficient = 0.235, $p < .001$), followed by those that drive (Pearson Correlation coefficient = 0.195, $p < .01$), while for transit commuters there is no correlation between health and CWB. Transit commuters with very good health (mean = 0.96, n = 90, S.D. = 0.98) did not have significantly greater CWB than transit commuters with bad health (mean = 0.56, n = 20, S.D. = 1.07). For people that take a car to work, better health may increase CWB because the time savings and sedentary nature of the car allows them be physically active during non-commute activities, such as running during lunchtime or after work. Use of transit, which generally requires more time, may not leave open as much time for recreation before or after work.

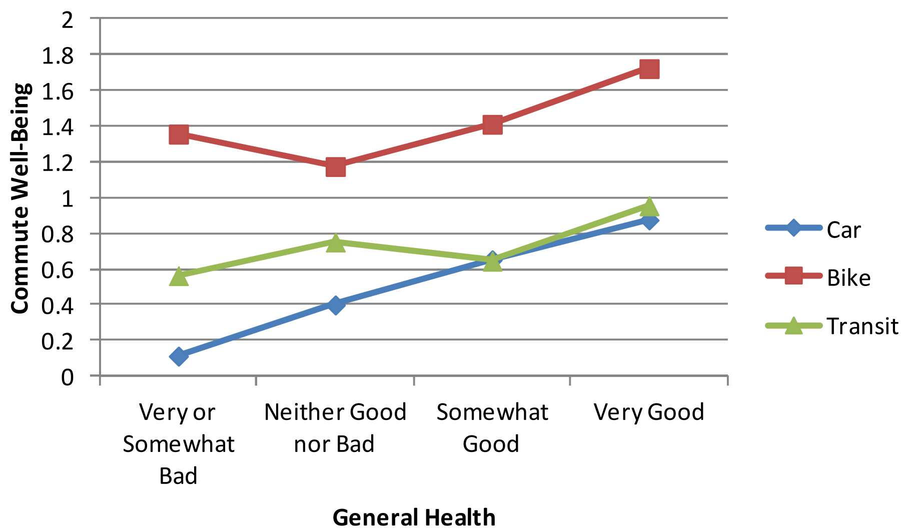


Figure 39 CWB by General Health and Mode

Overall subjective well-being (or life satisfaction) is also positively correlated with CWB (Pearson Correlation coefficient = 0.226, $p < .001$) and although the correlation is weak, it is highly significant. The correlation between CWB and SWB is also positive and significant among each of the mode groups. Taken together, these results suggest that factors influencing life satisfaction (i.e. satisfaction with job and home; health) may carry over to commute experiences. A structural equation model, presented in Chapter 5, helps explain the pathways of influences among these and other factors.

Sociodemographic variables

CWB varies by several key sociodemographic variables, including education, income and race. Differences in mean CWB among different sociodemographic groups were calculated and T-tests (for two groups) and ANOVA tests (for more than two groups) were performed to examine whether the differences in means are statistically significant. Results are summarized in Table 10.

Significantly higher levels of CWB were found among commuters:

- With household incomes of least $75K per year compared to households with less than $75K per year;
- Living in Portland city limits compared to those living outside Portland city limits;
- With four year college degrees compared to those without four year college degrees; and
- Identifying as white compared to those identifying with non-white race/ethnicity categories.

In addition, a bivariate correlation shows that CWB increases as household income category increases (Pearson Correlation coefficient =0.089, $p < .05$). However, the differences in mean CWB between all income categories were not significantly different based on an ANOVA test.

Those with four year college degrees may have higher CWB than those without four year college degrees because higher education levels are associated with higher income jobs and higher incomes may allow commuters to locate closer to work. Similarly, white workers generally have higher incomes and may be able to optimize their home location.

No significant differences in CWB were found among groups organized by gender, age or household structure categories. Despite the lack of statistical significance, women in the sample have slightly lower CWB than males, consistent with Novaco's (2010) findings. Regarding age categories, 30 to 39 year olds, which have the highest CWB, are also the group that biked to work more than any other age group; 40.1 percent of respondents aged 30 to 39 biked to work, which may explain their higher CWB. Only 10.4% of 50 to 59 year olds, the group with the lowest CWB, biked to work. The lack of significant differences in CWB among household structure categories was not unexpected and could be due to many factors. For example, while those with children were expected to be more time pressed in their commutes, roughly the same percentage of respondents with children expressed that saving time was important when choosing a travel mode as those without children (87.2% versus 86.4%, respectively). In addition, the commute experience is largely a personal experience that is not likely affected by household members.

Table 10 Variation in CWB by Demographic Group

Variable	Category	Mean CWB	n	Std. Dev.	Sig.
Four year college degree	No	0.82	155	1.05	<.01
	Yes	1.06	669	0.98	
Race	White	1.04	684	0.99	<.05
	Non-white	0.81	104	1.06	
Income	Less than $15,000	0.73	7	0.85	NS
	$15,000-$24,999	0.89	24	0.91	
	$25,000-$34,999	0.79	68	1.22	
	$35,000-$49,999	1.11	102	1.00	
	$50,000-$74,999	0.91	195	1.00	
	$75,000-$99,999	1.08	156	0.93	
	$100,000-$149,999	1.09	168	0.93	
	$150,000 and over	1.21	58	1.05	
Gender	Male	1.08	383	0.94	NS
	Female	0.96	426	1.03	
	Other	0.54	5	1.46	
Age	20 to 29	0.93	158	0.99	NS
	30 to 39	1.09	307	1.00	
	40 to 49	1.05	183	0.93	
	50 to 59	0.87	125	1.05	
	60 +	1.08	51	1.06	
Children	No children	1.02	437	1.03	NS
	Children present	1.02	266	0.98	
Household size	One person	1.01	125	0.91	NS
	Two + persons	1.02	703	1.01	

Home location

Respondents living in Portland are significantly happier with their commutes than those living outside Portland, as shown in Table 11. This is possibly due to the shorter distances and travel times, as well as greater mode options and residential satisfaction for those living in Portland. Among those living outside of Portland, respondents in cities and towns west of Portland reported the highest CWB while respondents to the east of Portland reported the lowest CWB. The differences in CWB among regions were not statistically significant based on an ANOVA test. Among Portland quadrants, northeast (NE) has the happiest commuters and southeast (SE) has the least happy commuters, but differences between respondents living in different quadrants are not statistically significant.

Table 11 Mean CWB by Home location

Variable	Category	Mean CWB	n	Std. Dev.	Sig.
Home in Portland	Yes	1.12	614	0.97	<.001
	No	0.72	214	1.02	
Suburban Regions	West	0.780	63	0.970	NS
	South	0.763	68	1.009	
	North	0.758	46	1.111	
	East	0.517	37	1.020	
Portland Quadrant	NE	1.22	194	0.89	NS
	SW	1.11	67	0.91	
	N	1.09	122	0.95	
	NW	1.09	41	1.04	
	SE	1.04	190	1.05	

The map in Figure 40 displays CWB for each household location identified in the sample. Green dots represent high CWB and red dots represent low CWB. Using the spatial autocorrelation test (Moran's I) in ArcMap confirms that the spatial distribution of CWB is random.

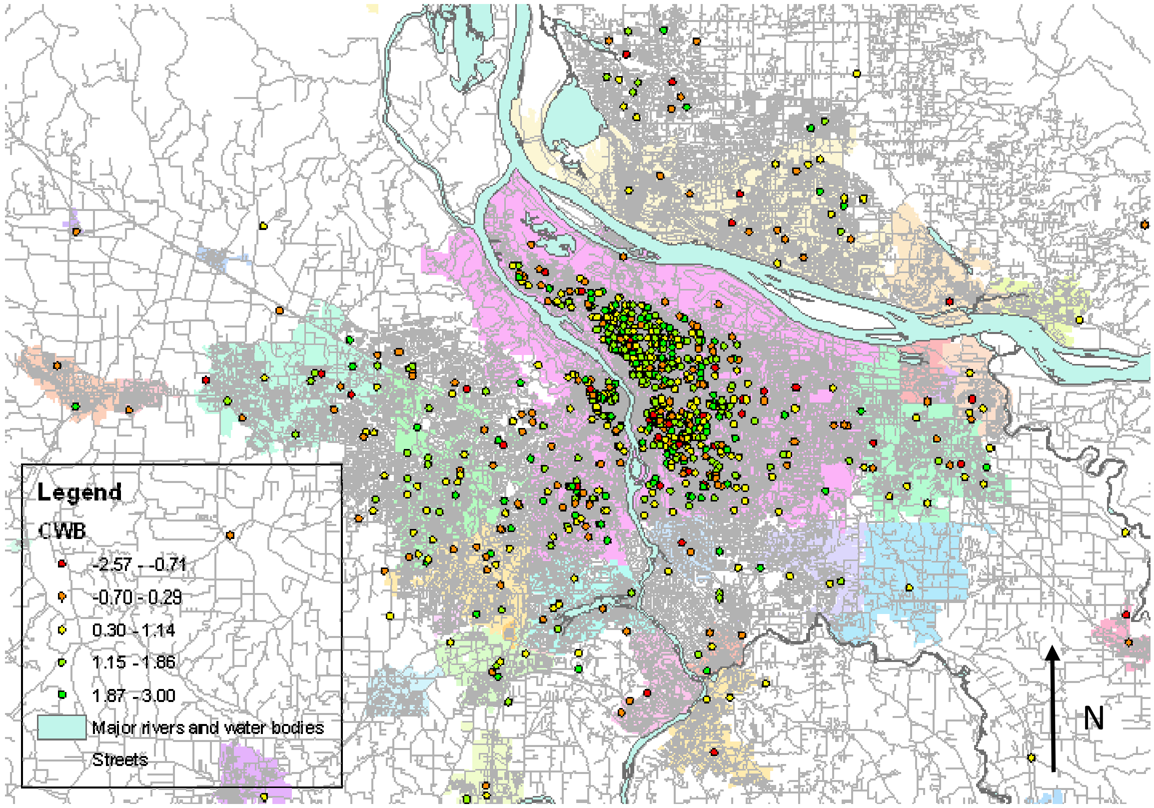


Figure 40 Map of CWB by Household Location

Work Location

Organizations from southeast (SE), southwest (SW), northeast (NE), and northwest (NW) were represented in this study, as these quadrants all have organizations within close proximity to downtown. The majority (64%) was located in southwest, and the fewest were located in SE (3%). Among the Portland quadrants, commuters to SE have the highest CWB (mean=1.37, S.D.=0.79), while commuters to NE have the lowest average CWB (mean=0.81, S.D.=0.81) and commuters to SW and NW have CWB that falls in between, as shown in Figure 42. An ANOVA test shows that CWB between the four quadrants is significantly different ($p < .05$). SE commuters primarily commute by bike (74.1% of respondents compared to 31.5% in the sample overall), which may explain the higher CWB among this relatively small group. SE may also allow commutes that that do not require traveling downtown or paying for metered parking.

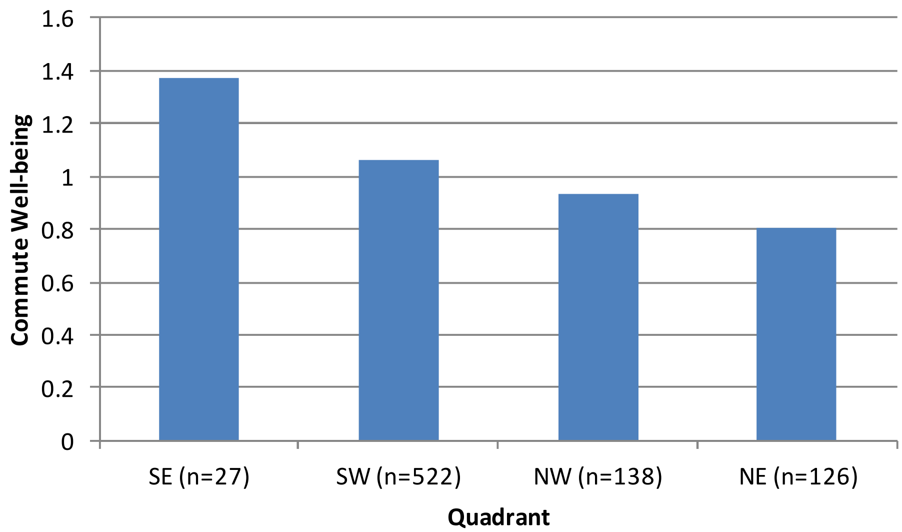


Figure 41 Commute well-being by company quadrant

Looking at differences in CWB among quadrants, by mode, those who biked to work have remarkably similar CWB in each quadrant (means = 1.57-1.60), with the exception of NE, where bike commuters had lower CWB (mean=1.22, n = 13). This result is intuitive because respondents in NE work in the Lloyd District, which is auto-oriented with longer blocks and many wide roads, parking lots, and stoplights. Exposure to these conditions likely detracts from the experience of riding a bike. Figure 43 shows the intersection of NE 9th Avenue and NE Multnomah Street, a typical Lloyd District intersection.

Among car commuters, CWB is highest in SE (mean = 1.10) and lowest in NW (mean = 0.53), with NE and SW falling in between. An ANOVA test shows that the differences are not significantly different. It is possible, however, that car commuters to SE may experience lower congestion and have an easier time finding parking than commuters to other areas. NW, on the other hand, requires driving on congested streets and has lower parking availability, leading to lower CWB.

CWB among transit users is highest in NE (mean = 0.78) and lowest in SE (mean = 0.38), with NW and SW falling in between, but the differences were not significantly different. The Lloyd Center in NE is particularly well-served by transit (with CTRAN, several light rail stops, and bus stops) and this level of service may be reflected in the higher CWB rankings. Relatively few respondents used transit to access a job in SE (n = 3), so little stock should be taken in this result.

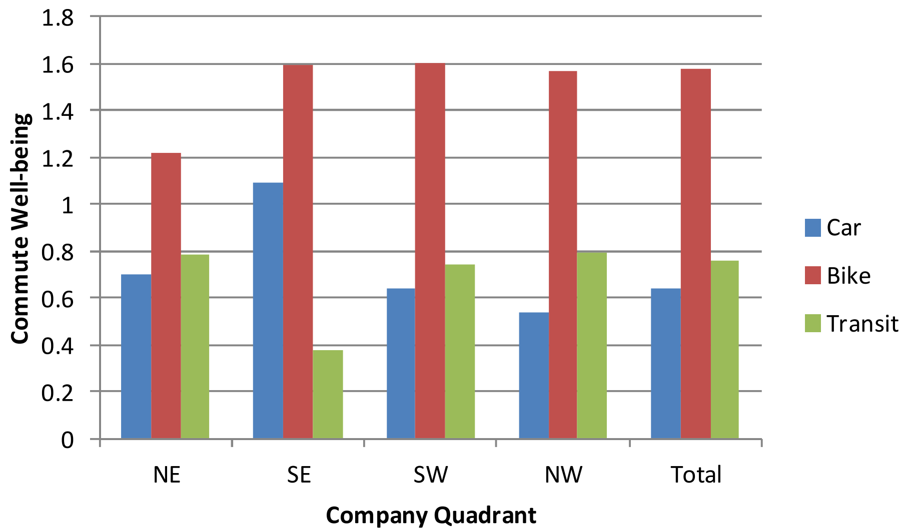


Figure 42 Commute Well-being by Company Quadrant and Mode

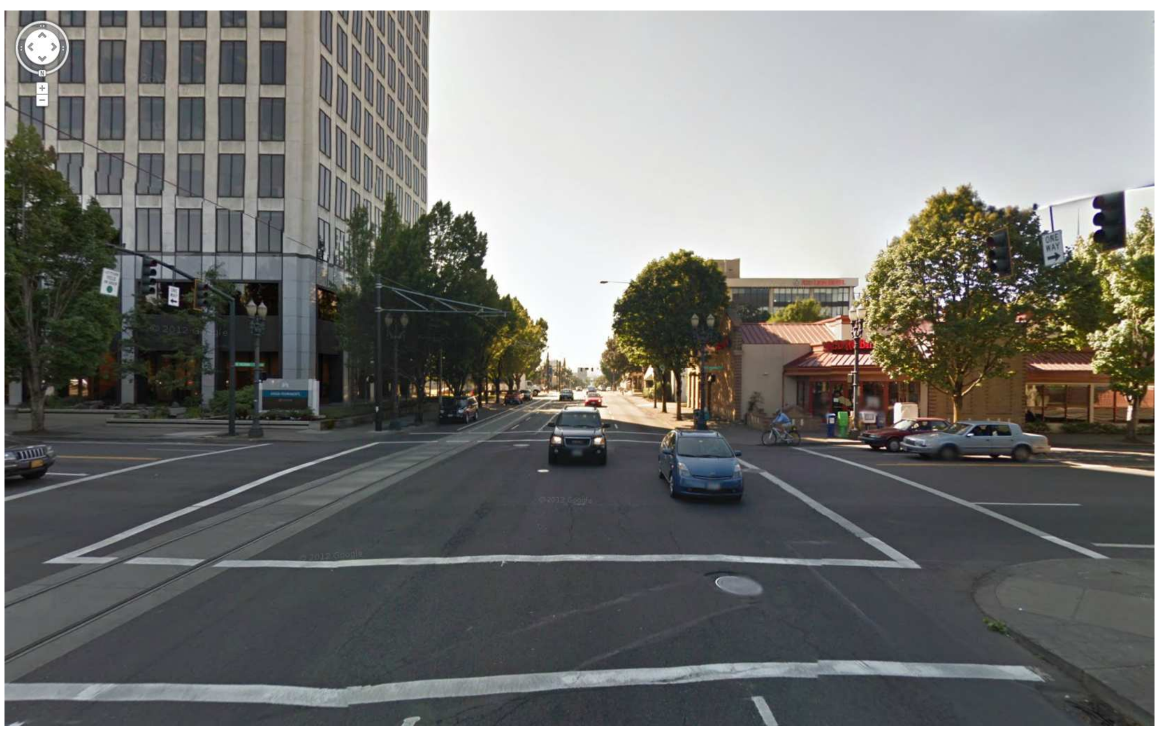


Figure 43 Typical Auto-Oriented Intersection in Lloyd District – NE Grand Ave. and NE Multnomah St. (source: Google Maps)

Liking Modes

In addition to questions about commute well-being, several questions about the degree to which respondents simply "like" driving, taking transit, and biking. The questions did not refer to specific trip purposes such as commuting, but rather all purposes. Results to these questions are summarized in Table 12. Stark differences in preferences by mode emerge.

Comparing "mode allegiance" across modes, virtually all bike commuters (99%) (somewhat or strongly agree that they) like riding a bike, 71% of transit commuters like using transit, and 67% of car commuters like driving. This suggests that while car commuters are least prone to like their commute mode, the majority of all respondents like their chosen commute mode.

Most (94.3%) bike commuters somewhat or strongly agree with the statement "I prefer to bike than drive whenever possible," while a much lower percentage of transit commuters (65%) "prefer to take transit than drive whenever possible." Car commuters disagreed most with these statements; only 24% "prefer to bike rather than drive whenever possible" and 23% "prefer to take transit rather than drive whenever possible."

It is worth noting that about half of transit and car commuters like riding a bike. Indeed, over half of these respondents bike to work at least one day per week even though they used transit or a car for their most recent commute. Relatively fewer bike commuters (46%) and car commuters (29%) like transit. Bike commuters are the least likely to like driving (38%), but over half of transit commuters (51%) like driving.

Taken together, these results suggest that people generally like the mode that they use. This is most clearly evident for bike commuters, which supports the finding of higher commute well-being among bike commuters. Mode users also generally like their mode more than other modes. However, slight caution should be taken with interpreting the results. It may be that some people justify their mode choice when answering these questions.

Table 12 Liking modes by recent commute mode

I…	Bike	Car	TriMet
…like riding a bike.	98.8%	48.5%	51.5%
...prefer to bike rather than drive whenever possible.	94.3%	24.0%	29.1%
…like taking transit.	45.8%	29.4%	70.7%
…prefer to take transit rather than drive whenever possible	54.8%	22.8%	64.5%
…like driving.	37.7%	66.8%	50.8%
…think travel time is generally wasted time.	27.5%	43.0%	31.7%

Attitudes about Commuting and Travel

A number of attitudes about commuting, general travel and mode choice were asked about in this survey. These questions primarily came from previous research by Heinen et al. (2011) and Mokhtarian and Ory (2005).

Agreement with statement “I use my trip to/from work productively” varied by mode, as shown in Figure 44. Car commuters are more likely to disagree with this statement, while bike commuters and transit commuters are more likely to agree that they use their commute trip productively. There is generally strong agreement with the statement "The trip to/from work is a useful transition between home and work," but some differences among modes, as shown in Figure 45. Forty-five percent of bike commuters strongly agree that "the trip to/from work is a useful transition between home and work", compared to 17% of car commuters and 25% of transit commuters. Most respondents disagree with the statement "The only good thing about traveling is arriving at your destination", as shown in Figure 46. Strong disagreement was expressed by more bike commuters (37%) than car and transit commuters (15% for both).

Agreement with the statement "Traveling by car is safer than walking" varies substantially by mode. 72 percent of bike commuters disagree with this statement, compared to 35% of car commuters and 48% of transit commuters, as Figure 47 shows. Similarly, 35% or car commuters agree that traveling by car is safer than walking, compared to 6% of bike commuters and 18% of transit commuters.

In general, these findings show that most people, regardless of commute mode, value the act of traveling in addition to the destination activity. This is consistent with theories of travel liking and a positive value of time spent traveling (Mokhtarian and Solomon, 2001). However, bike commuters agree that their commute is substantially more productive and useful than car commuters do. Transit commuters' agreement on these items falls between those of car and bike commuters.

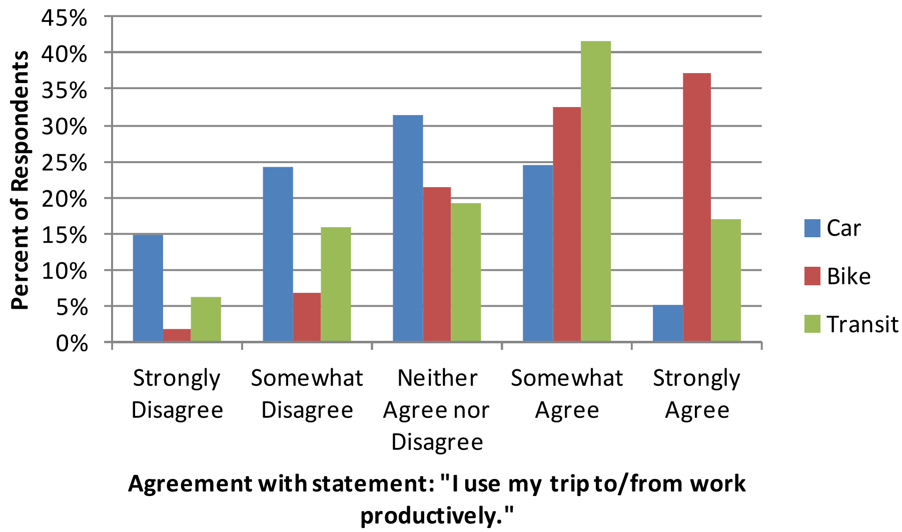


Figure 44 Agreement with statement: "I use my trip to/from work productively" by mode

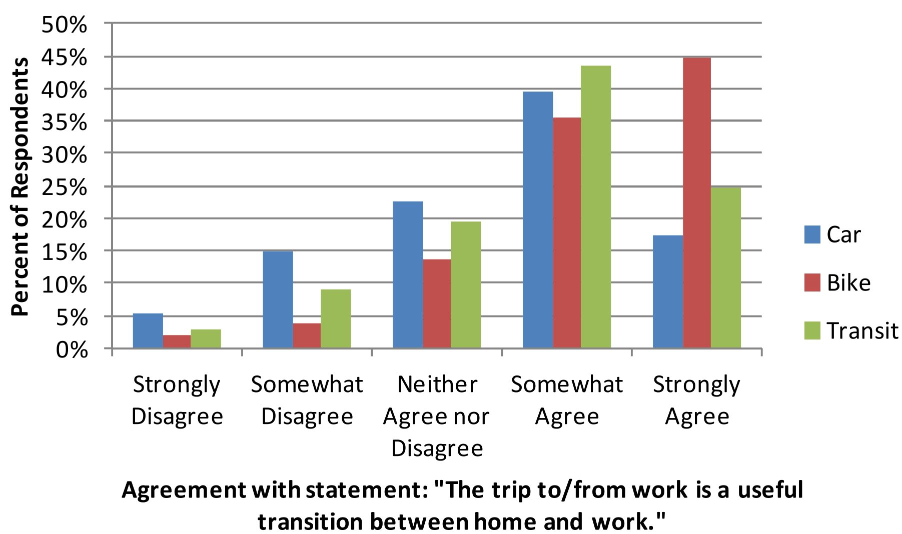


Figure 45 Agreement with statement "The trip to/from work is a useful transition between home and work" by mode

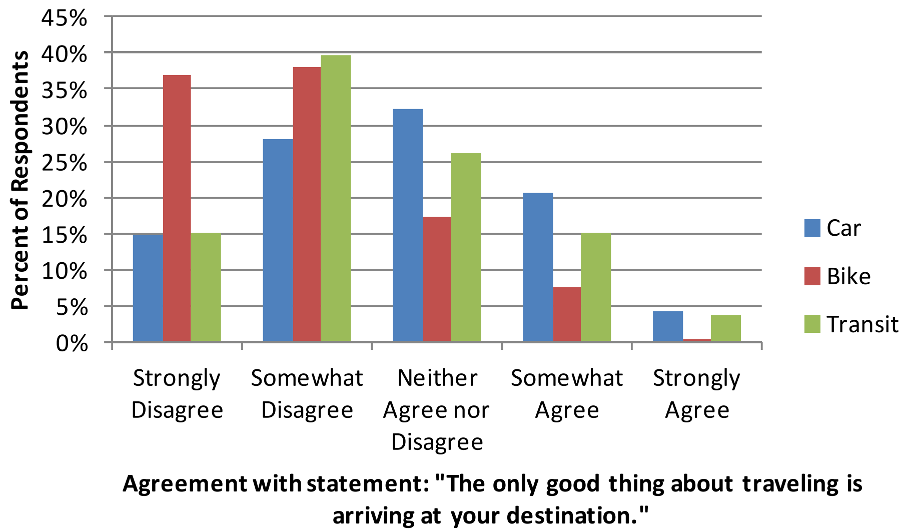


Figure 46 Agreement with statement “The only good thing about traveling is arriving at your destination” by mode

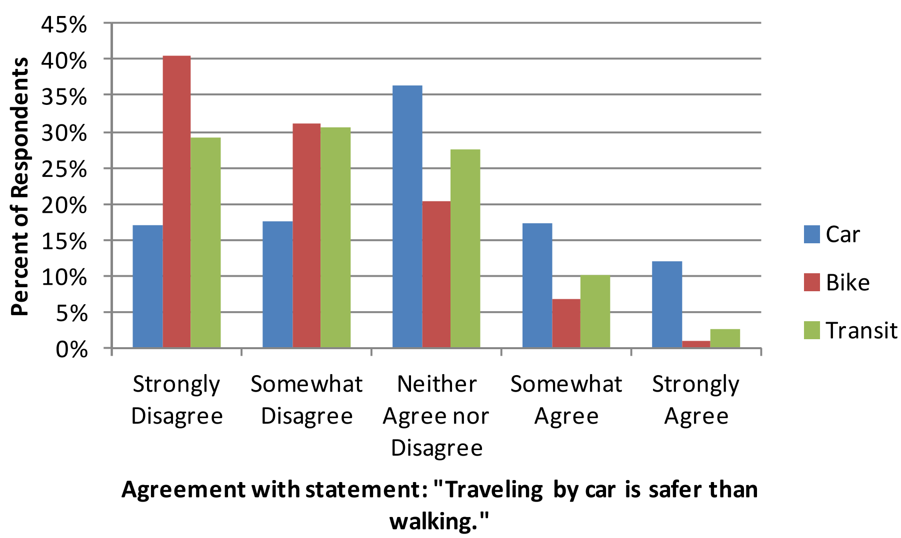


Figure 47 Agreement with statement “Traveling by car is safer than walking” by mode

Multiple Linear Regression on CWB

To test whether the factors described in this chapter have independent effects on commute well-being when controlling for each other, multiple linear regression models were tested. Two multiple linear regression models were tested in which CWB is regressed on the full list of possible explanatory variables, such that:

$$N = \beta + \beta'T + \beta'M + \beta'J + \beta'S + \beta'A + u$$

where

N = CWB;

T = trip attribute variables;

M = mode

J = job and residential satisfaction variables;

S = sociodemographic variables;

A = attitudinal variables

u = regression error term.

All of the independent variables are categorical except the attitudinal variables, which are continuous. The attitudinal variables were also adjusted to control for the distribution of responses for each attitude. This helped show the strength of agreement for each respondent relative to the sample mean. The mean response for each item (for the sample) was calculated and then subtracted from the individual responses for each attitude.

Results of the multiple linear regression analysis are provided for all modes and specific modes in Table 13, respectively. Unstandardized coefficients and their significance are reported. For the most part, only significant variables ($p < .05$) are included in the estimation. However, all mode coefficients are included, even when non-significant, to provide a full explanation of their relative influence on commute well-being.

Two models are presented in Table 13: (1) a nested model, in which car and transit modes are grouped, respectively; and, (2) a full model that includes all modes. An F-test was performed to examine whether the full model provided significantly better fit than the nested model. The F-test (F-value = 2.557, $p = 0.054$) showed that the full model does not provide significantly greater explanatory power. However, the p-value shows that the full model is extremely close to providing significantly greater explanatory power. Therefore, both models are presented.

Table 13 Estimation Results of Multiple Linear Regression Models on Commute Well-Being with All Modes and Condensed Modes

	Nested model - Condensed modes (car excluded)		Full Model - All modes (Drive alone excluded)	
Variable	B	Sig.	B	Sig.
Intercept	.719	.000	.672	.000
Mode				
Carpool			.191	.075
Walk	.401	.014	.454	.006
Bike	.457	.000	.512	.000
Transit	-.066	.428		
MAX			.046	.663
Trimet bus			-.115	.268
CTRAN bus			.223	.237
Trip Attributes				
Travel Time > 40 minutes (car)	-.351	.006	-.373	.003
Congested (Car)	-1.202	.000	-1.187	.000
Congested (Trimet Bus)	-.774	.007	-.684	.020
Crowded Transit	-.616	.000	-.580	.000
To Lloyd Center by Bike	-.365	.095	-.365	.094
Job & Home Satisfaction and Health				
Job - very satisfied	.125	.035	.124	.036
Home - very satisfied	.194	.001	.191	.001
Health - very good	.185	.002	.182	.002
Attitudes				
Transition useful	.150	.000	.154	.000
Use trip productively (Trimet bus + MAX)	.154	.001	.157	.001
Use trip productively (Car)	.123	.007	.122	.007
Only good thing destination (Trimet bus + MAX)	-.104	.011	-.103	.011
Car safer than bike (Bike)	-.095	.054	-.103	.036
Demographics				
Income > $75,000	.149	.009	.138	.015
Observations	762		762	
R^2	0.432		0.438	

Results in both models show that even when trip attributes, mode options, job and home satisfaction, health, demographic, and attitudinal variables are taken into account, both biking and walking to work have positive significant effects ($p < 0.001$ for both variables in the full model) on CWB. All other modes have insignificant coefficients, presumably because other elements in the model, such as crowding, congestion, and travel time explain a substantial portion of the variation in CWB among modes.

Commute time for car commutes (i.e. car commutes at least 40 minutes long) has a significant negative effect on CWB ($p < 0.01$) and its magnitude is moderate. The findings somewhat surprising, as it was expected that longer transit commutes would significantly reduce CWB. Other ways of specifying travel time were examined, but only the forty minute "break point" was found to be significant, and only for car commuters. The findings add some support to findings in other research (e.g. Mokhtarian and Solomon, 2001; Paez and Whalen, 2010) that (1) travel time is not always something to be minimized and (2) people "budget" their travel time and will be satisfied as long as their commutes fall within a certain expected amount of time.

The magnitude of the effect of traveling to work on highly congested streets on CWB is particularly large and highly significant. In other words, encountering heavy traffic on the way to work substantially diminishes CWB. However, this is only the case for car and TriMet bus users; light rail users were not asked about congestion. This finding is in line with previous research (e.g. Anable and Gatersleben, 2005; Novaco and

Gonzales 2009) showing that the delays, reduced predictability, and stress caused by congestion have a negative effect on well-being.

As expected, commuting in crowded public transit vehicles has a highly negative and significant ($p < 0.001$) effect on CWB. While the question was subjective – people's conceptions of crowded transit vehicles may differ – having lots of people on one's bus or light rail vehicle clearly reduces CWB. On crowded transit vehicles, it is more likely that users would have to stand, sit next to someone they would rather not sit next to, or endure some other uncomfortable incident that would reduce one's well-being.

Following the finding of lower CWB among cyclists commuting to northeast Portland relative to other employment areas in the sample, regression results show a marginally significant ($p < 0.1$) negative effect for bike commuters to NE (Lloyd Center) locations. The auto-oriented environment of Lloyd Center and the surrounding area, which is flanked by Interstates 5 and 84, seems to decrease commute well-being for cyclists, even when controlling for other variables. While other variables with marginal significance were left out of the model, this variable was left in the model because its coefficient is intuitive. It shows that location and land-use factors likely play a role in shaping commute well-being.

Job and residential (including home and neighborhood) satisfaction variables both have positive and significant effects on CWB ($p < 0.05$ and $p < 0.01$, respectively), although the effect is larger and more significant for residential satisfaction. The job satisfaction result is in line with previous research (Abou-Zeid and Ben-Akiva, 2011). The results suggest that people who can optimize their residential location choice with respect to their work location express both high home and commute satisfaction. Bivariate correlations confirm significant but low correlations between CWB, income and residential satisfaction (Pearsons's correlation < 0.220; $p < .05$). It is possible that accessibility variables are not significant predictors of CWB because home satisfaction, which was significant, encompasses people's preferences for accessibility to different commute modes, such as a preference for a bike friendly neighborhood.

Having very good health has a positive and significant ($p < 0.005$) effect on CWB. For bike commuters, better health may facilitate greater enjoyment of the trip by allowing faster speeds with less discomfort. Bike commuters with relatively poorer health may have greater discomfort and more frequently be overtaken by other bike commuters, thereby reducing CWB. Greater health may allow car commuters to more effectively cope with the stresses of commuting. Better health may also increase CWB because the sedentary nature of the car allows them be physically active during non-commute activities, such as running during lunchtime or after work. The relationship between CWB and health could also be bi-directional; however the effect of CWB on health was not tested.

For all modes relatively strong agreement with the statement "The trip to/from work is a useful transition between home and work" positively and significantly increases CWB. For TriMet and car users, relatively strong agreement with the statement “I use my trip to/from work productively” increases CWB moderately. Similarly, relatively strong agreement with the statement “The only good thing about traveling is arriving at your destination” decreases CWB among TriMet and light rail users. For bicyclists, greater agreement that “Traveling by car is safer overall than riding a bicycle” decreases CWB slightly. Although the final model specification is quite different, these results support findings in Paez and Whalen that commuters that believe that the trip is a useful transition between home and work (among all modes) and use the trip productively (among car modes) have more positive views of commuting.

Of all the demographic variables examined in this analysis, only income has a significant effect ($p < .05$ in the full model) on CWB. Income could affect CWB through a number of pathways. Higher incomes tend to reflect greater flexibility to optimize other areas of one’s life, which may result in better commute experiences. Income is a large predictor of overall happiness, a correlate of CWB. Income is also associated with having greater mode options, job satisfaction, home satisfaction and health, although these variables are controlled for in the model. That income is the only significant demographic variable is consistent with most but not all studies on commute well-being.

The fit of the model (adjusted $r^2 = 0.438$ in the full model) is high considering the use of a relatively new measure (CWB). However, commute well-being is multifaceted and these results suggest that other factors explain more than one-half of the variation in CWB. Alternative ways of making the factors examined in this analysis operational could also increase the models fit and provide more realistic model coefficients.

Predicted Commute Well-Being

Results from the multiple regression equations allow one to make predictions of commute well-being under various scenarios. Using the intercept value and coefficients from Model II, commute well-being is predicted for 13 scenarios related to mode choice, traffic congestion, travel time and transit crowdedness (see Figure 48). Commute well-being for the "base" mode accounts for the other factors in the model (attitudes, income, job and home satisfaction, etc). For carpool, drive alone, and bus modes, commute well-being is predicted for both "base" commutes and congested commutes. Drive alone commutes that are congested and at least forty minutes long are predicted. Crowded light rail and bus commutes are also predicted.

The model predicts the highest commute well-being for bike commutes (CWB = 1.18) and the lowest commute well-being for drive alone commutes longer than 40 minutes that also include congestion (CWB = -0.89). Predicted commute well-being for persons using the bus, encountering a lot of traffic and having a crowded vehicle (CWB = -0.71) is also especially low. The following comparisons can be made:

- A person that rides the bus and encounters traffic congestion will have seven percent higher CWB than if that person drives alone and encounters traffic.

- A person with a crowded light rail vehicle commute will have ten percent lower CWB than if he/she rides a light rail with no crowdedness.
- A person with an uncongested, uncrowded light rail commute will have three percent higher CWB than if he she had an uncongested, uncrowded bus commute.

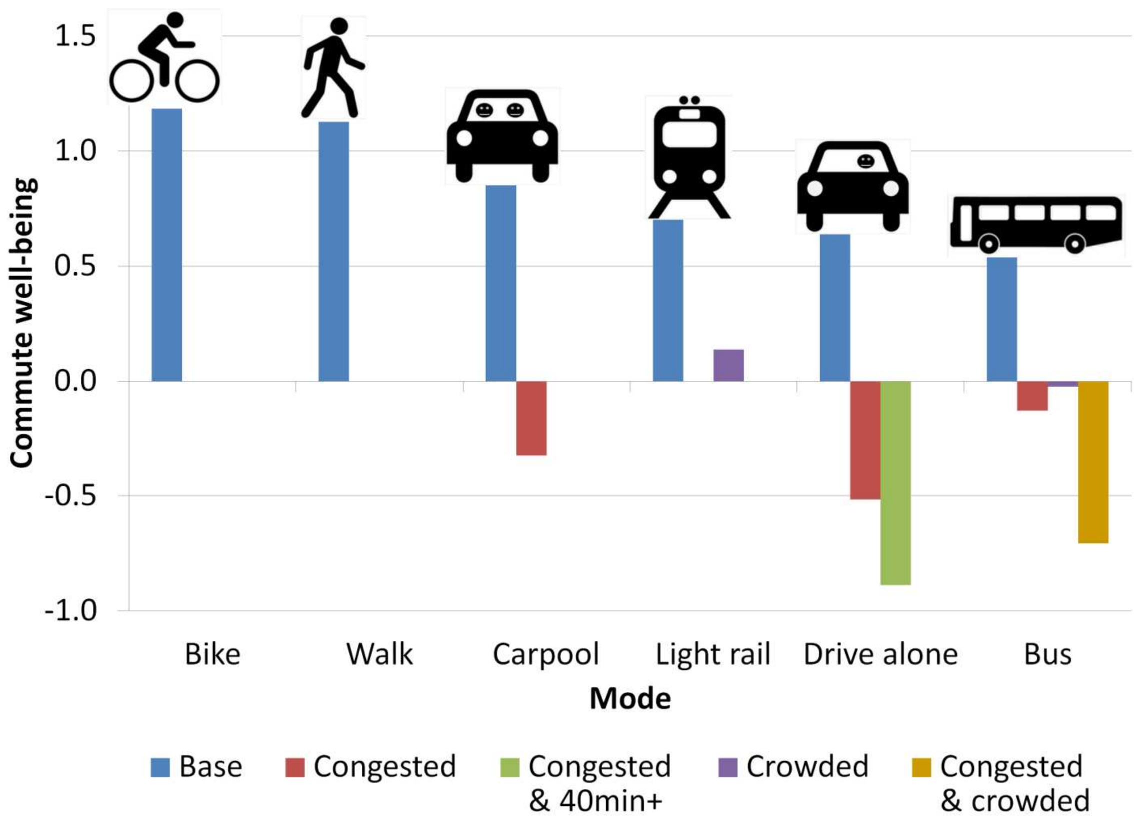


Figure 48 Predicted commute well-being based on OLS regression

An important implication of the predictions is that levels of CWB predicted for different modes with the model are different than the mean CWB for modes shown in

Figure 21. Figure 49 illustrates these comparisons. For example, predicted CWB for bike commutes is 25% lower than the actual mean CWB for bike commuters in the sample. The model predicts that a person driving alone will have 13% higher CWB than the mean CWB for drive alone commuters in the sample. The differences occur because other elements in the model (e.g. travel time, traffic congestion, attitudes, etc.) explain much of the variation in CWB. Also note that even though predicted CWB for base bus commutes is lower than for base car or light rail commutes, the differences are not significant.

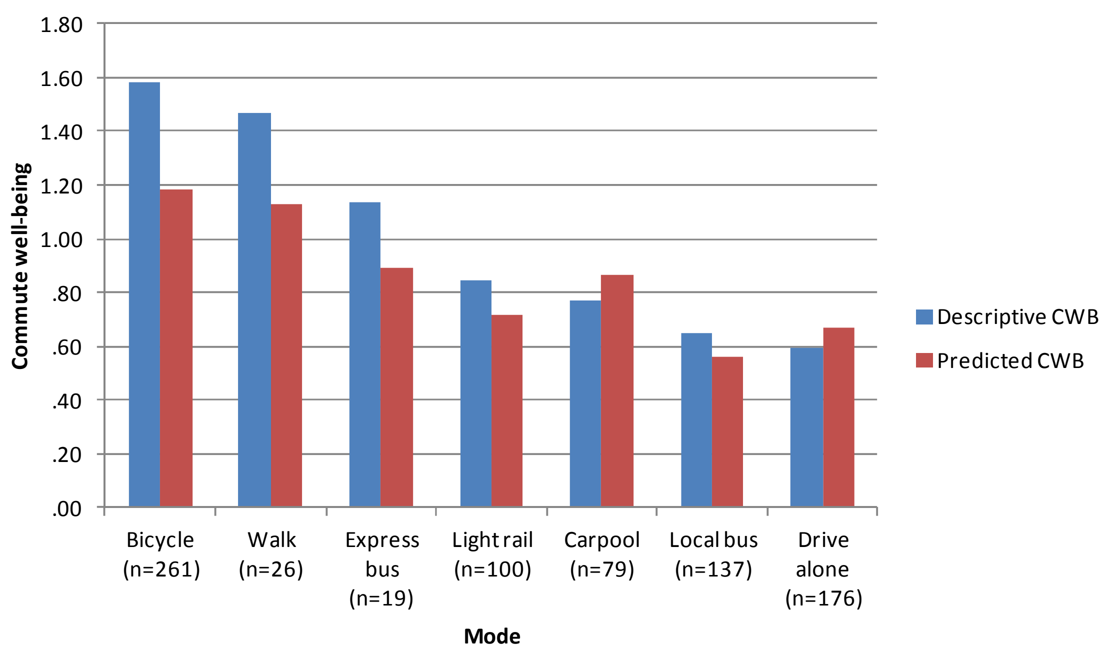


Figure 49 Descriptive CWB Versus Predicted CWB Based on OLS Regression

Variables left out of model

In the process of testing different model specifications, many variables were tested that were theorized to play a role in affecting commute well-being. The following variables were tested but left out of the final models because their coefficients were not significant at the .05 level or better.

- **Distance** (miles of shortest path route between home and work) – It was hypothesized that distance would negatively affect CWB. For all modes, distance has no significant effect on CWB when controlling for other variables.
- **Travel time (for bike and transit)** – Like distance, travel time was assumed to be negatively correlated with CWB, even when controlling for other variables. For bike and transit commutes, travel time had no significant effect on CWB. Unlike car commuters, it appears that bike and transit commuters can cope with commutes of varying duration.
- **Traffic congestion (for bike)** (encountered a lot of congestion) – Traffic congestion for those that bike to work is not a significant predictor of CWB. It is likely that the benefits for bike commuters of being able to pass through congested vehicle traffic balance with the costs of the extra exhaust, noise, and safety concerns. It is also possible that bike commuters answered the survey question as if it were asking about the level of bicycle congestion rather than motor vehicle congestion.

- **Vehicles per household** (also vehicles per adult and vehicles per worker) – Although not a hypothesis, it was theorized that having a vehicle readily available for commuting would increase CWB. However, this was not the case. This variable was interacted with a dummy variable for those that used a car to get to work. Again, results were not significant.
- **Using two modes at least twice per week** – Many respondents commute using different modes on different days. In this way, they may optimize their mode depending on the weather or activities required before or after work, as examples. However, there was no significant effect of using two modes each at least two days per week.
- **Accessibility –** While a bivariate correlation tests shows that a greater number of easy modes is positively associated with CWB, controlling for other variables in the regression model shows having more easy modes does not significantly affect CWB. Home location variables (by Portland quadrant) had no effect on CWB. In addition, proximity to transit stops (for transit commuters) and bike facilities (for bike commuters) both had no effect on CWB. The experiences during time commuting likely play a much greater role in determining CWB than the possibilities for commuting using alternative modes.
- **Bus transfers** – It was suspected that having to make a bus transfer would decrease CWB, but model estimates show that transfers have no significant

effect on CWB. The lack of a significant effect may be partially due to the fact that only 11 percent (n = 15) of bus users in the sample made transfers.

- **Trip chaining** – Respondents were asked whether they made a stop on the way to work. Model testing showed that making (at least one) stop on the way to work has no significant effect on CWB. The type of stops (i.e. dropping off a child at school, getting coffee, etc.) were not obtained in this study but likely play a role in shaping CWB.
- **Gender** (Female) – While gender differences in CWB were not hypothesized, it is somewhat surprising that no significant differences in CWB among genders were found, even when interacting gender with mode choice and travel time.
- **Race** (white) – While whites have significantly higher CWB than non-whites, there is no significant effect of being white when predicting CWB and controlling for other variables in the model.
- **Age** (categories) – No significant differences were found among age categories in the sample, even when interacted with mode. Different ways of specifying the age variable could yield significant results, but theory does not provide any strong hypotheses about how age affects CWB.
- **Education** (four-year college degree) – While four-year college graduates have significantly higher CWB than non four-year college graduates in the sample, there is no significant effect of having a four-year college degree on CWB when accounting for other variables in the model.

Finally, a separate model was tested with SWB (life satisfaction) included as an independent variable. Life satisfaction, along with biking and walking to work and other variables, has a positive effect on commute well-being. In other words, one's overall happiness (and other variables) and active travel have separate influences on commute happiness. SWB was left out of the models above because job satisfaction, home satisfaction, income and health provided better explanatory power and because CWB was theorized to affect SWB rather than SWB affecting CWB.

Summary

A seven-item measure of commute well-being was adapted from Ettema et al. (2010) and showed good reliability overall. Relationships between commute well-being and a long list of variables were tested using t-tests and ANOVA tests, as well as Pearson correlations. Next, these variables were tested empirically using an OLS regression model. Results show that walking and biking to work, high job satisfaction, high home satisfaction, very good health, a household income of at least $75,000, and relatively strong agreement that the commute being a useful transition time or being productive during the commute each had significant positive effects on commute well-being. Encountering traffic congestion (for car and bus commuters), car commutes over 40 minutes, crowded transit vehicles, biking to work in the Lloyd Center, strong agreement that "the only good thing about traveling is arriving at your destination" among TriMet users and "traveling by car is generally safer than traveling by bike" among bike commuters each had negative effects on commute well-being. Several items were dropped from the regression specification for having non-significant coefficients. Contrary to expectations, results indicate that travel time, accessibility, and sociodemographic variables all have limited or no effect on commute well-being.

Chapter 5. Commuting and Overall Well-Being

This chapter has two objectives: (1) Examine variations in overall well-being among categories of commute-related variables and common correlates of SWB; and, (2) Demonstrate whether commute well-being significantly affects overall well-being when controlling for these common correlates. Descriptive results are provided on the measure of SWB, the Satisfaction with Life Scale, and its variations by health, income, household structure, job and home satisfaction variables. A structural equation model is used to test the hypothesized pathway of relationships among these variables and commute well-being.

Distribution of Subjective Well-Being in Sample

Following the construction of Diener et al.'s (1985) Satisfaction with Life Scale (SWLS), responses (from 1-"strongly disagree" to 5-"strongly agree" for each) to the following five items were summed:

1. In most ways my life is close to my ideal;
2. The conditions of my life are excellent;
3. I am satisfied with my life.
4. So far I have gotten the important things I want in life.
5. If I could live my life over, I would change almost nothing.

The resulting scores range from 5 (indicating extreme dissatisfaction with life) to 25 (indicating extreme satisfaction with life). A score of 15 indicates neutral satisfaction with life. Mean life satisfaction for the sample is 18.49 (S.D. = 3.72, n = 827) and the distribution of life satisfaction is slightly skewed to the right (skewness = -0.409), as shown in Figure 50, meaning that the sample expresses moderate satisfaction with life overall. Using the guidelines of West, Finch and Curren (1995), the distribution of life satisfaction does not substantially depart from normality as the Skewness is less than two and Kurtosis (0.152) is less than seven.

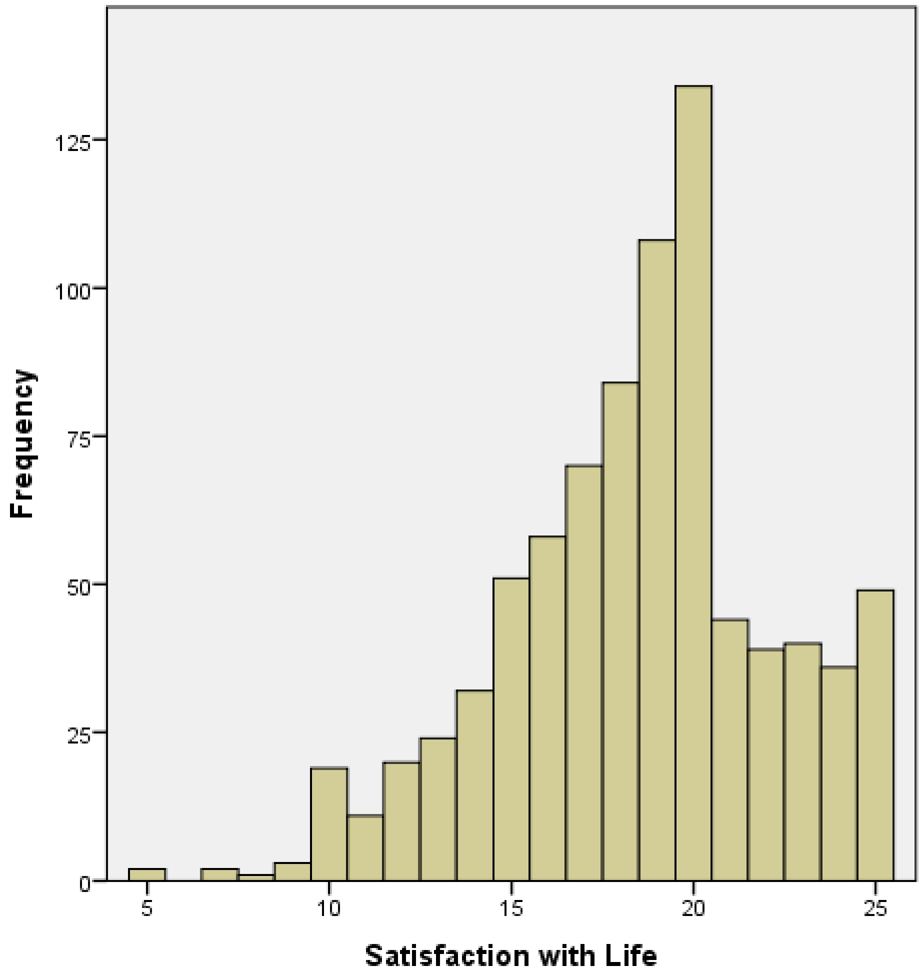


Figure 50 Distribution of Satisfaction with Life (n=827)

The SWLS scale shows very good reliability, with a Cronbach's Alpha of .874 (.881 based on standardized items). A confirmatory factor analysis was performed to examine the fit of the model. Results suggest a good fit ($\chi 2$ (5) = 44.39; CFI = .982; RMSEA = .097) considering the sample size and low degrees of freedom. Factor loadings were determined using the maximum likelihood method and four out of five items have high standardized loadings (greater than .7), indicating strong associations between the indicators and Life Satisfaction. In addition, factor loadings compare favorably with average standardized factor loadings from published SWB studies presented in a meta-analysis by Bontempo and Hofer (2007), as shown in Table 14. One item - “If I could live my life over, I would change almost nothing” had a loading of .64, 14.7% lower than the average standardized loading for this item reported by Bontempo and Hofer (2007). However, many researchers refer to loadings above .6 as “high.” In general, results support the inclusion of all five items to represent subjective well-being for this study.

Table 14. Comparison of Factor Loadings in Meta-Analysis of SWB with This Study

SWB Scale Item	Bontempo & Hofer (2007)	This Study	Percent Difference
In most ways my life is close to my ideal.	0.86	0.84	-2.3%
The conditions of my life are excellent.	0.86	0.81	-2.3%
I am satisfied with my life.	0.86	0.81	-4.7%
So far I have gotten the important things I want in life.	0.80	0.74	-10.0%
If I could live my life over, I would change almost nothing.	0.75	0.71	-14.7%

Correlates of Life Satisfaction

SWB (life satisfaction) varies greatly by mode, as shown in Figure 51. Those that bicycled to work (on their most recent commute) have the highest SWB (mean = 19.0, n = 260, S.D. = 3.5), while those that used light rail have the lowest SWB (mean = 18.9, n = 100, S.D. = 3.7). The differences between group means are not significant, according to an ANOVA test. However, t-tests show that bike commuters are significantly happier than commuters that drive alone ($p < .05$) or commute by light rail ($p < .01$). No other significant differences in SWB were found among modes shown in Figure 51.

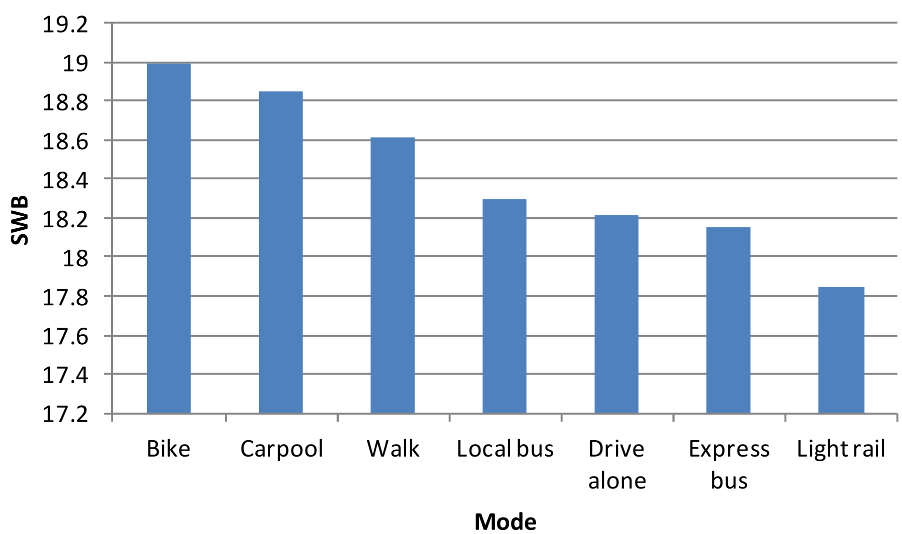


Figure 51 SWB by Commute Mode

When the mode groups are collapsed, as shown in Figure 52, SWB still varies by mode and the differences are significant ($p < 0.05$) based on an ANOVA test. Results show that people that bike for the most recent mode are happiest (mean = 19.0, n = 260, S.D. = 3.5), while transit users are the least happy (mean = 18.0, n = 271, S.D. = 3.9).

It should also be noted that there is a weak but significant positive correlation between frequency of commuting to work by bike and overall SWB (Pearson's Correlation Coefficient = .155, $p < .001$). There are significant weak negative correlations between SWB and bus and light rail (Pearson's Correlation Coefficient = -.088 and -.117, $p < .05$ and .01, respectively). As people use a bike to commute more frequently, happiness increases slightly, on average. As people use the bus or light rail to commute more frequently, happiness decreases slightly, on average. Results in Figure 53 suggest that that those that own a bike and use it to commute at least one day per week have higher life satisfaction than those that do not own a bike. Those with a bike that do not use it to commute (but may use it for recreation) fall in between and the differences between the three groups are significant ($p < .01$). These tests do not control, however, for any other of the myriad factors affecting happiness, such as residential satisfaction.

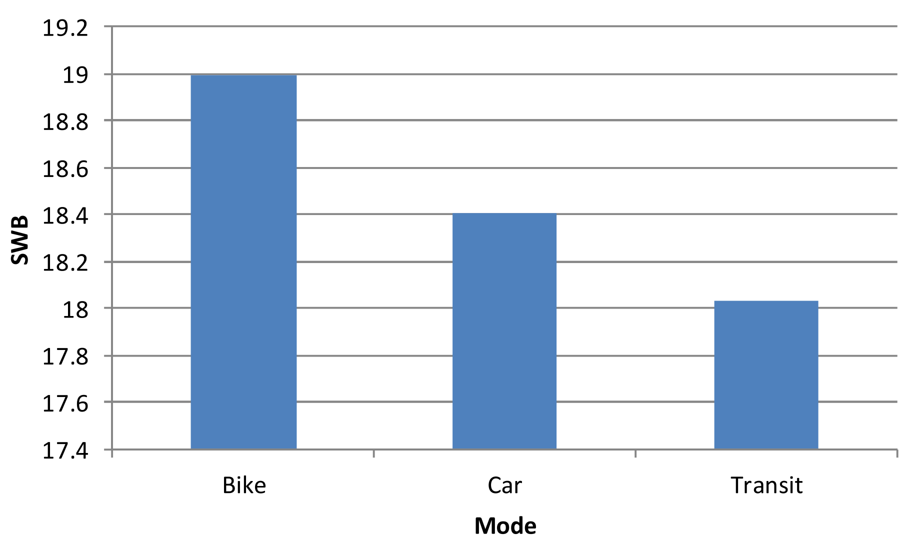


Figure 52 SWB by collapsed commute mode

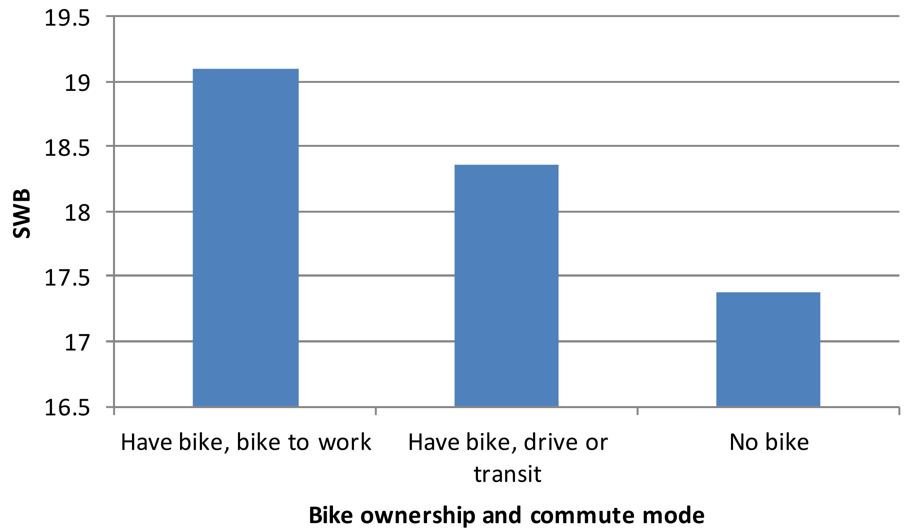


Figure 53 SWB by Bike Ownership and Commute Mode

Residential satisfaction is moderately correlated with SWB (Pearson's Correlation = 0.392, $p < .001$). Mean SWB for different levels of residential satisfaction and between mode groups is shown in Figure 54 and indicates that the differences in SWB are more likely due to residential satisfaction than to mode. Figure 8 from Chapter 3 showed that most respondents (92%) are either somewhat or very satisfied with their living environment. For this group, SWB is almost equal between modes. Satisfaction with one's home and neighborhood may encompass many things (e.g. quality of life at home, neighborhood aesthetics, access to recreation, grocery stores) that overwhelm any possible effect of mode on life satisfaction.

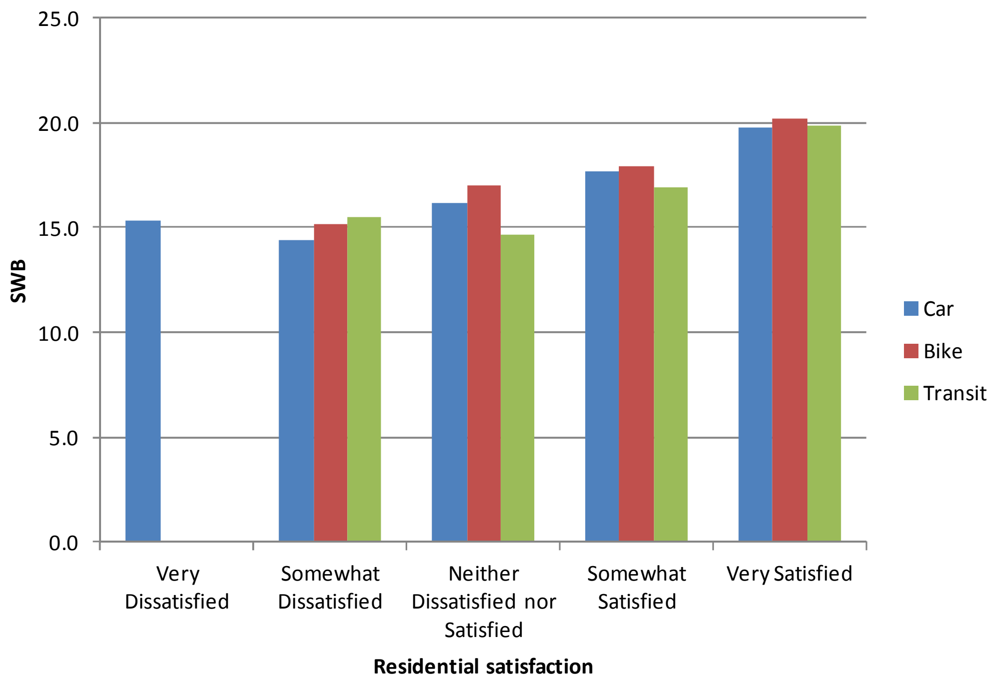


Figure 54 SWB by Residential Satisfaction and Mode

SWB increases as household income increases, as expected, and while the correlation is low, it is highly significant (Pearson's Correlation Coefficient = .220, $p < .001$). Figure 55 shows that the relationship is quite linear as well. On average, those with household incomes of at least $150,000 are happiest (mean = 20.3, n = 58, S.D. = 3.6) while those with household incomes of less than $35,000 are the least happy (mean = 17.0, n = 99, S.D. = 3.8). An ANOVA test confirms that the differences in mean SWB between income categories are significantly different ($p < .001$).

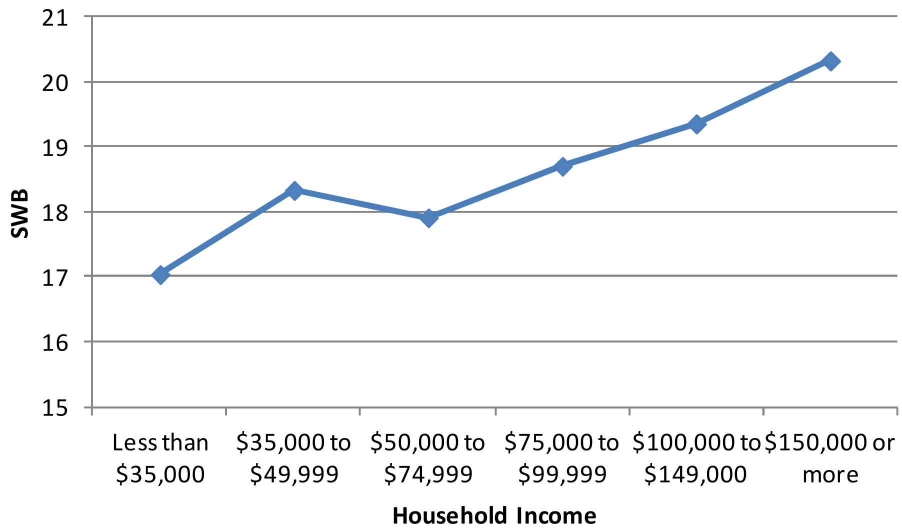


Figure 55 SWB by Household Income

Health is also positively and significantly correlated with SWB (Pearson's Correlation Coefficient = .285, $p < .001$). Mean SWB by self-reported general health category is shown in Figure 56. Those with very good health (mean = 19.5, n = 343, S.D. = 3.5) are significantly ($p < 0.001$) happier than those with very or somewhat bad health (mean = 15.5, n = 40, S.D. = 4.3), based on a t-test. An ANOVA test confirms significant differences ($p < 0.001$) in SWB between respondents based on general health.

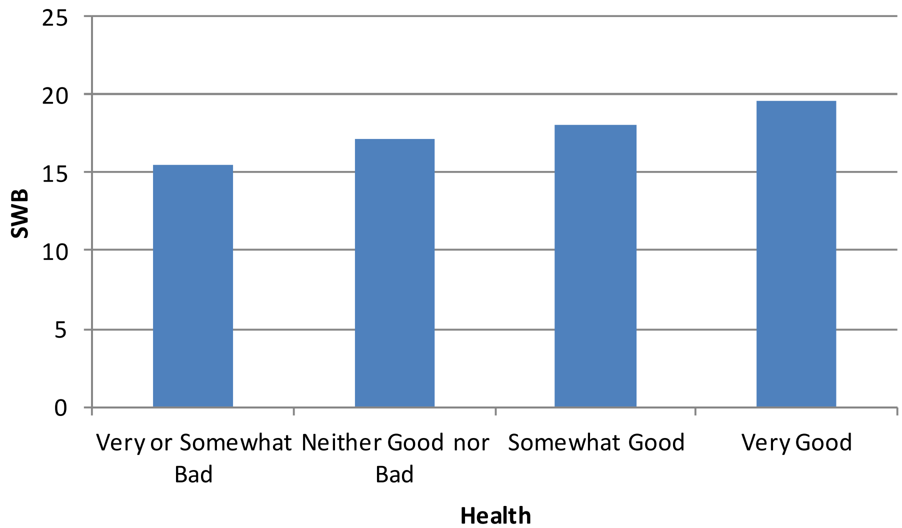


Figure 56 SWB by Self-Reported General Health

Job satisfaction is positively and significantly correlated with SWB (Pearson's Correlation Coefficient = 0.358; $p < 0.001$). The results were expected. The correlation is somewhat higher than the bivariate correlations between income, health and SWB. Figure 57 shows SWB by job satisfaction categories. ANOVA tests confirm significant differences in SWB between these job satisfaction categories.

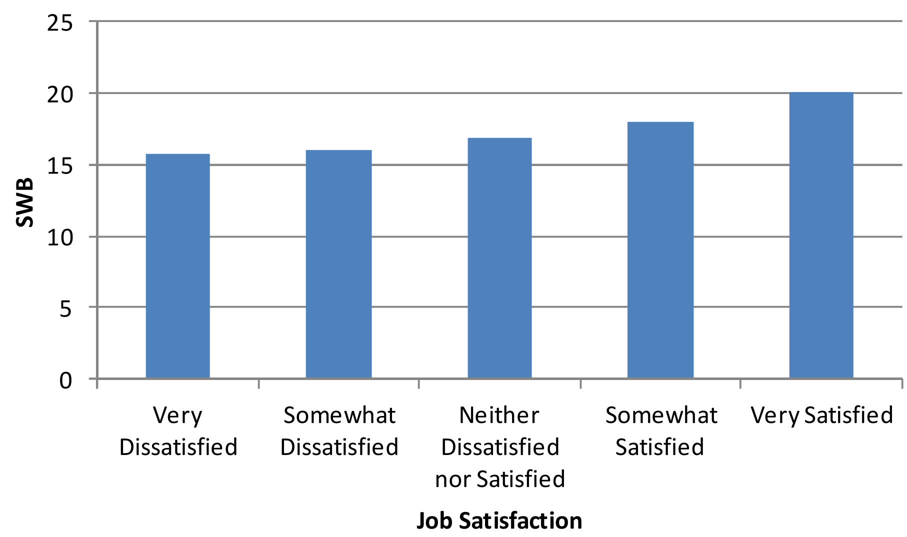


Figure 57 SWB by Job Satisfaction

Household size is also associated with SWB, a finding that is in line with previous research. There is a weak, but positive and significant correlation (Pearson's Correlation = 0.111; $p < .01$) between the number of household members and SWB. Figure 58 shows that the jump in SWB from one to two household members is much larger than the subsequent increases in SWB as household size increases beyond two members. Respondents in households with at least two persons (mean = 18.7, n = 702, S.D. = 3.7) are significantly happier, on average, ($p<.01$) than respondents living alone (mean = 17.2, n = 125, S.D. = 3.7).

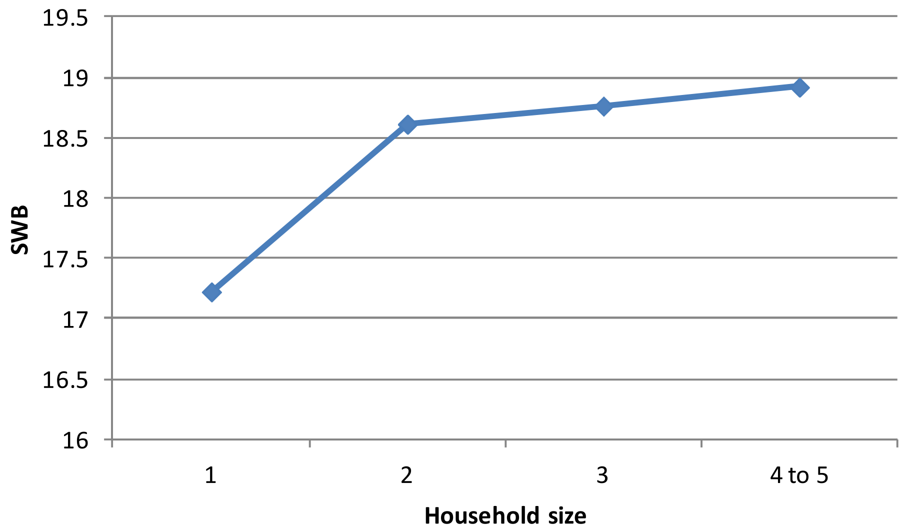


Figure 58 SWB by Household Size

Because structural equation models assume normally distributed variables (and produce biased results when this assumption is violated), descriptive information was obtained about the skew and kurtosis of the five variables: income, general health, job satisfaction, home satisfaction, and household size. Based on West, Finch, and Curran's (1996) recommendations on skew and kurtosis, there should be no concern about the skewness or kurtosis of the variables as they are far below the thresholds for concern.

Structural Equation Model

A structural equation model is used to test the pathway of relationships among commute well-being, overall well-being, health, income, job and home satisfaction. The model shows reasonable fit (χ^2 = 601.4; df = 117; Comparative Fit Index = 0.92; RMSEA = .07) and intuitive parameter estimates.

To improve model fit, certain error terms were correlated as suggested by modification indices. Error terms are correlated among three pairs of items: (1) “arrival time confidence” and “stress”; (2) “boredom/enthusiasm” and “excitement,” and; (3) “very satisfied with job” and “very satisfied with home.” The model presented in Figure 59 shows excellent fit (χ^2 = 176.9; df = 113; Comparative Fit Index = 0.95; RMSEA = .05).

Model fit remains stable even when using testing the model with data from subgroups based on most recent commute modes, as shown in Table 15.

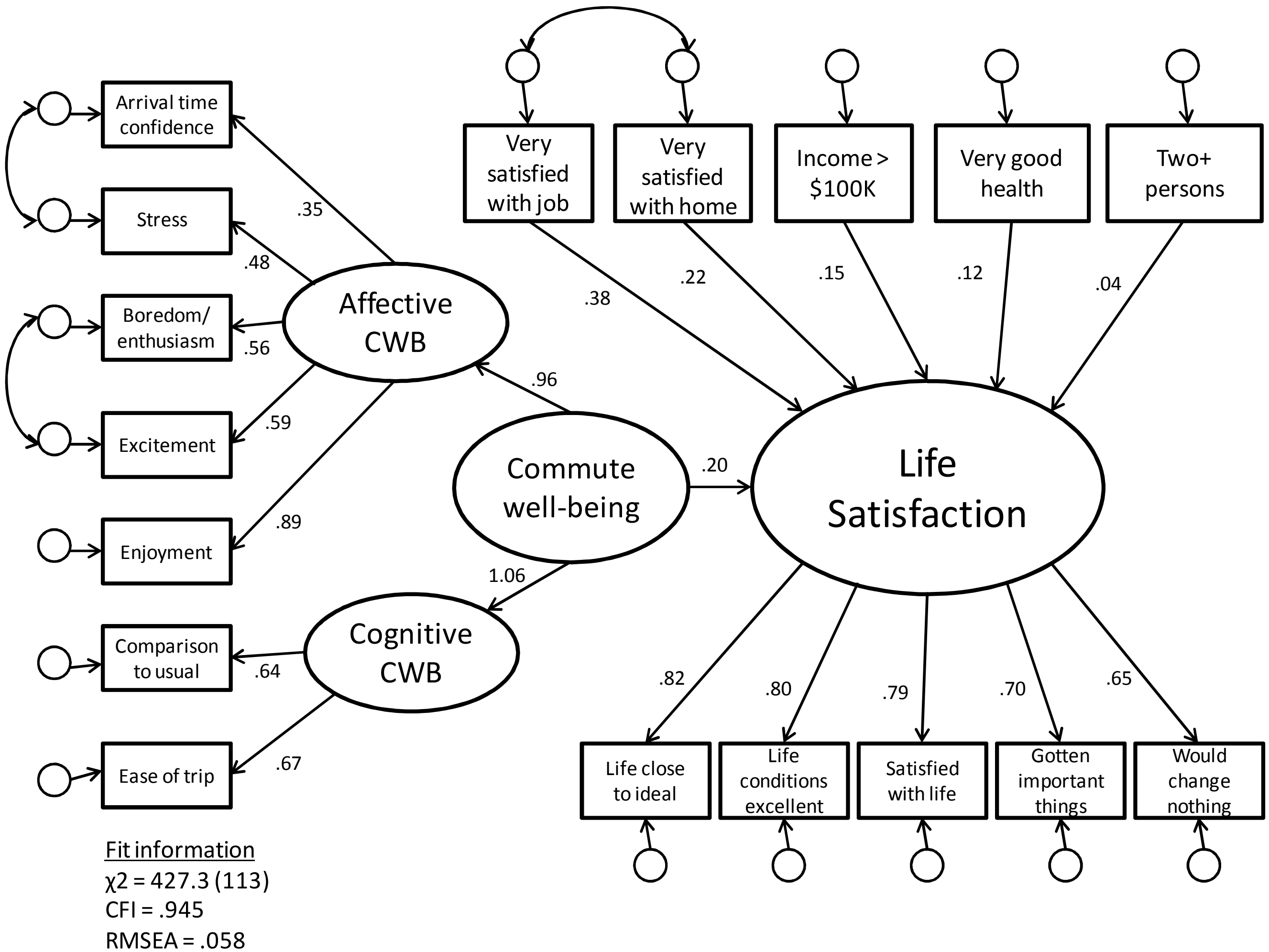


Figure 59 Structural Equation Model of Well-Being Influences, Including Commuting

Indicators of commute well-being and overall subjective well-being (satisfaction with life) were described in the previous sections "The Commute Well-being Measure and Its Reliability" and "Distribution of Subjective Well-Being in Sample." The "Arrival time confidence" item is the only indicator with a particularly low loading ($\lambda = .35$) on Affective CWB but was retained in this analysis because of its theoretical importance, its use in similar studies, and the excellent fit of the overall model. Aside from commute well-being (a continuous variable), predictors of SWB are dummy variables.

Path estimates are intuitive. Having an income of at least $100K ($\beta = .150$, $p < .01$), very good health ($\beta = .267$, $p < .001$), at least two people in the household ($\beta = .251$, $p < .001$), and high satisfaction with one's job ($\beta = .415$, $p < .001$) and home ($\beta = .410$, $p < .001$) have individual positive effects on overall well-being. These findings are in line with previous research on correlates of SWB. Based on the magnitudes of the standardized coefficients, having a household income of at least $100K has the least direct effect on SWB while being very satisfied with one's home and neighborhood environment has the greatest direct effect on SWB.

More importantly for this analysis, the model indicates a significant direct effect of commute well-being on overall subjective well-being. The standardized path coefficient (.20) indicates that the effect of commute well-being on life satisfaction is slightly larger than the effect of having an income of at least $100K (standardized path coefficient = .15).

Construct equivalence of the model between mode groups was also tested. Results (in Table 15) show that the model fits well for each mode group. Furthermore, the factor structure is similar for each mode group, as shown in Table 16. While the parameter estimates were positive across all modes, some direct effects were not significant for all modes, as shown in Table 16. The effect of CWB on SWB was positive and significant for the bike ($p < .01$) and overall models ($p < .001$) and not significant for the car and transit models. On the one hand, this suggests that for car and transit commuters, commute well-being has no effect on overall life satisfaction. It could be that for people that bike to work, the commute experience plays a greater role in shaping identity, lifestyle and overall well-being than for people that commute by car and transit. Income also is a significant predictor of SWB in the bike and overall models, but not significant in the car or transit models. Having two or more persons in the household is a positive and significant predictor of SWB for all the mode groups except transit commuters.

Table 15 SEM Model Fit by Model

	$\chi2$	Df	p	CFI	RMSEA
Car	611.9	339	0.000	0.944	0.032
Transit	218.1	113	0.000	0.941	0.059
Bike	395.1	226	0.000	0.946	0.038
All	427.3	113	0.000	0.945	0.058

Table 16 Parameter estimates for SEM model by mode

			Car	Bike	Transit	All
SWB	<---	Very satisfied with home	0.24***	0.21***	0.35***	0.28***
SWB	<---	Income > $100K	0.06	0.14*	0.09	0.09**
SWB	<---	Very satisfied with job	0.29***	0.37***	0.18**	0.27***
SWB	<---	Very good health	0.16**	0.12*	0.17**	0.18***
SWB	<---	Two+ persons	0.19***	0.04	0.12*	0.12***
Affective	<---	CWB	0.94***	1.05***	1.19***	1.01***
Cognitive	<---	CWB	0.95***	0.96***	0.75***	0.88***
SWB	<---	CWB	0.07	0.19**	0.08	0.12**
Stress	<---	Affective	0.60***	0.48***	0.67***	0.60***
Boredom/ enthusiasm	<---	Affective	0.58***	0.56***	0.63***	0.68***
Excitement	<---	Affective	0.68***	0.58***	0.61***	0.70***
Enjoyable	<---	Affective	0.98***	0.89***	0.97***	0.99***
Arrival time confidence	<---	Affective	0.52***	0.34***	0.38***	0.41***
Ease of trip	<---	Cognitive	0.77***	0.64***	0.76***	0.77***
Comparison to usual	<---	Cognitive	0.79***	0.68***	0.81***	0.78***
Life close to ideal	<---	SWB	0.88***	0.83***	0.84***	0.85***
Life conditions excellent	<---	SWB	0.89***	0.83***	0.82***	0.85***
Satisfied with life	<---	SWB	0.76***	0.79***	0.85***	0.80***
Gotten important things	<---	SWB	0.64***	0.67***	0.71***	0.66***
Would change nothing	<---	SWB	0.63***	0.64***	0.56***	0.62***

*** p < .001; ** p < .01, * p < .05

That commute well-being is a significant predictor of overall well-being for bike commuters is a unique finding compared to previous studies on commute well-being. In this study, job satisfaction “spills over” into the commute happiness as well as overall happiness. This is consistent with the theoretical framework set out in Ettema et al. (2010). However, in a structural equation model of commute satisfaction, work well-being, and overall well-being, Abou-Zeid found that commute satisfaction was a significant predictor of work well-being and that overall well-being had a positive, but non-significant effect on commute satisfaction. In other words, these two pathways were the reverse of pathways specified in this study. This alternative model was tested but yielded a poor fit, suggesting that commute well-being has a greater effect on life satisfaction than life satisfaction has on commute well-being.

Several other models were tested during the model specification process. A model was tested that included most recent commute modes, but had poor fit. Mode choice appears to be reflected in CWB rather than having a direct influence on SWB. Models were tested using ordinal variables (for income, health, household size, job and home satisfaction) and these models produced similar estimates to the final model but had a poorer overall fit. Moreover, using dummy variables allowed easier interpretation of results. The model presented in Figure 59 represents the relationships hypothesized in this research. Alternate specifications, however, should be tested in future research. The relationships between commute well-being, overall well-being, income, and home and work satisfaction are complex and testing alternative hypotheses about the pathways of influences could yield different results and conclusions.

Summary

In line with previous research, associations between subjective well-being (measured with the Satisfaction with Life Scale) and health, income, job satisfaction and home satisfaction were found. Associations between commute mode choice and well-being were also found, although mode choice variables were not significant (and therefore left out) in the final structural equation model. Most notably, this analysis finds that commute well-being is a positive and significant predictor of overall well-being, controlling for other key variables that influence well-being. The effect may not hold for all mode groups, however; commute well-being's effect on life satisfaction is not significant for car and transit commuters.

Chapter 6. Conclusions and Future Research

Findings in this study have implications for future research on travel and well-being and this chapter describes these implications. It examines whether the study's findings support or reject the hypotheses set out in Chapter 1. It also discusses how the findings could influence policymaking efforts. Limitations of the study's findings are summarized and possible avenues for expanding this study are offered to address these limitations.

Research implications

Unlike most previous studies on commute well-being, findings in this research come from a relatively large U.S. (Portland)-based sample using commuters from a non-university setting. It therefore offers evidence from a population that is more representative of U.S. commuters than previous studies. Original findings from this study follow.

First, the commute well-being measure used in this study supports the reliability of the basic structure of the Satisfaction with Travel (STS) scale developed by Ettema et al. (2010) and supported by Friman et al. (2013). This study improves upon the measure by adding an indicator of enjoyment, which better captures feelings of pleasure, escape, and thrill that would not fall clearly into previous iterations of this scale. It also adapts the scale by reducing the number of measured items from nine to seven and the number of latent items related to affective aspects of commute well-being from two to one. While further refinements could enhance this scale, expanded use of the commute well-being scale in future research (in other cities, population groups) could greatly improve our understanding of satisfaction and well-being related to commuting and other travel.

Second, commute well-being has many influences, ranging from trip attributes, to land-use, to attitudes. Multiple regression analysis shows that walking and biking have a significant positive effect on commute well-being, while other modes have no significant effect when controlling for other key variables. This finding confirms findings in previous research by Abou-Zeid and Ben-Akiva (2011), Friman et al. (2013), and Páez and Whalen (2010), among others. Bicycling to work appears to benefit mental as well as physical health. Travel time is not a significant predictor of commute well-being for transit and bike commuters, supporting existing theories on a positive value of travel among some populations (Mokhtarian and Solomon, 2001). Attitudes about the usefulness of time spent commuting also influence the commute experience as other research (e.g. Páez and Whalen, 2010) has found. Many of these variables have been found in mode choice studies. It appears that similar factors affect both the mode choice decision and the ultimate experience following this decision.

Third, commute well-being positively and significantly affects overall life satisfaction, even when controlling for other key predictors of life satisfaction. Previously, few associations between commuting and overall well-being have been empirically studied; the correlation found in this study represents an important building block for future research in this domain. Since commuting is a routine activity, positive experiences could regularly spill over into the workplace and the home, similar to how commute stress spills over into other life domains (Novaco and Gonzales 2009). Testing the model among specific mode groups, however, shows that the relationship between commute well-being and life satisfaction is strong for people that bike to work, but is not significant for transit and car commuters. This could be because the benefits of biking to work extend beyond the commute, helping to cultivate people's identities in a more significant way than for driving or transit commutes.

Hypotheses set forth in Chapter 1 were mostly, but not entirely, confirmed in this study, as follows.

- *Hypothesis*: Commute well-being varies widely among the population.
    - Confirmed. There is a fairly normal distribution of commute well-being across the sample population. On average, commute experiences are slightly positive.
- *Hypothesis:* Active travelers (walk and bike commuters) have higher commute well-being than bus, rail or car commuters, controlling for other variables (i.e. age, income, gender, education, vehicle availability, job satisfaction, residential location satisfaction, and accessibility).
    - Mostly confirmed. Bike and walk commuters have the highest (and second highest, respectively) commute well-being of any mode group. Results suggest that commuters using active modes are significantly

happier with their commutes than transit and car commuters. When other variables (demographic, vehicle availability, job and home satisfaction, and attitudes about travel) are accounted for in a regression model, bicycling and walking to work still have a positive effect on commute well-being. However, commuting by car or does not have a significant effect on commute well-being when these other variables are accounted for.

- *Hypothesis:* For motorized modes, long distances, motor vehicle congestion, and commuting during peak-hours are each associated with lower commute well-being, while short and medium distances, a lack of congestion, and off-peak travel times are associated with greater commute well-being.
    - Mostly confirmed. Travel time is weakly negatively correlated with commute well-being. Car commutes greater than 40 minutes long have a significant negative effect on commute well-being even when controlling for other variables in a regression, but long transit commutes do not have this same effect. Congestion has a significant negative effect for both car and transit commutes.
- *Hypothesis:* For active modes, commute well-being will vary by distance, motor vehicle congestion, peak-hour travel and other contextual trip factors.

- Rejected. For bike commutes, distance and travel time are not correlated with commute well-being. Congestion also has no significant effect on commute well-being for people that bike. The number of walk commutes in the sample is too low to examine the effects of these variables.

- *Hypothesis:* People have different values and preferences regarding commuting.
  - Confirmed. There is substantial variation in people's attitudes about commuting with respect to its value as a transition time between home and work, a time to be productive, and the safety of individual modes.

- *Hypothesis:* Travelers who commute using modes that align with their values and preferences have higher commute well-being. Travelers with values that are not in line with the modes they use have low commute well-being. For example, those who value sustainability, but require a car to meet their commute needs, will have lower CWB. Similarly, those who value car travel but do not have access to a car will have low CWB.
  - Partially confirmed. Strong agreement that traveling by car is safer than riding a bicycle has a negative effect on commute well-being for those that bike. Valuing using a commute trip productively has a positive effect on commute well-being for car and transit commuters. However, variables related to environmental conscientiousness have no significant interaction effects with mode in a regression on commute well-being. For

most people, having a strong environmental ethic is relatively inconsequential in determining the commute experience; it neither makes a car commute worse or a bike commute better.

- *Hypothesis:* Some features associated with greater commute well-being will differ depending on mode. For walking and bicycling, stress reduction, excitement, and pleasure will be common. For bus and rail, listening to music, reading, and working will be common. For driving, excitement, control, and status will be common.
    - Partially confirmed. Bike and walk commuters tend to feel more relaxed during their commutes, while car commuters tend to feel more stress. Bike and walk commuters feel significantly more excited and enthusiastic during their commutes compared to car and transit commuters. Bike and walk commuters also express significantly higher enjoyment during their commutes. In terms of control, no single mode expresses significantly higher confidence about arriving at work on time. Those that read during transit commutes have significantly higher CWB than those that do not read however there is no significant effect from reading, listing to music, working or using one’s phone on CWB for transit users when considering other relevant variables.

- *Hypothesis:* There is a positive association between commute well-being and overall well-being, controlling for some key correlates of subjective well-being.
    - Mostly confirmed. Commute well-being has a significant positive effect on overall life satisfaction, even when controlling for job satisfaction, home satisfaction, income, household structure, and health in a structural equation model. When testing the model groups by mode, however, the significance of the relationship between commute well-being and life satisfaction only holds for bike commuters and not car or transit commuters.

Policy Implications

With limited research connecting travel and well-being, policymakers have little guidance on how to increase well-being using transportation policies. This research offers some evidence that could, if supported by other research, inform policymakers on how to increase well-being.

More than any other individual factor in this study, traffic congestion affects commute well-being for car and transit users. This result confirms previous research on psychological costs of congestion showing that traffic congestion elicits feelings of loss of control and raises stress levels, which have negative physiological consequences (Novaco and Gonzales, 2009). Combating congestion in cities, however, is difficult to accomplish, costly, and often conflicts with sustainable transportation goals. There may be policy options for reducing congestion for buses, such as establishing dedicated rights of way that could increase the commute well-being of bus users. More frequent service could possibly reduce congestion (and crowded transit vehicles). Reducing congestion for the population of car commuters is even more challenging. Organizations could allow more flexible work schedules so commuters could avoid commuting during heavily congested times of the day. It should be noted that car users that endure very congested streets may have lower commute well-being but also gain something that increases their well-being that is not accounted for in this study. The lack of a significant decrease in commute well-being for cyclists that encounter congestion could, if supported by other research, offer policymakers new ways of promoting cycling to work that emphasize the ease of commuting by bike amongst congested streets.

Policies often focus on increasing the mobility of the workforce. This research confirms other research that suggests that policymakers should consider possible reductions in commute well-being when looking at such efforts (Hansson et al., 2011). For example, policies that increased the percentage of car commutes longer than 40 minutes would decrease CWB, all other factors being equal. Strategies that help move people closer to their workplaces or help move workplaces closer to their employees could be more effective from well-being standpoint.

More generally, this study contributes to transportation psychology research that could help policymakers make transportation more sustainable. Policymakers in Portland and many other large cities aim to shift travel modes to away from single-occupancy car use. For such shifts to be successful, people should be reasonably happy with their (non-car) modes. Results in this study suggest that people who bike and walk to work are happier with their commutes and more satisfied with life and therefore policy efforts to promote these modes should continue. This will complement other transportation-related goals of reducing air pollution, congestion, oil consumption, and greenhouse gases. Policies that shift single-occupancy car commuters to public transit or carpooling may address these other goals but may not significantly increase commute well-being, based on the findings in this study.

Steg (2005) stresses that policies to reduce driving must better recognize motivations to drive. To date, the mixed results of travel demand management policies have shown that it is difficult to change mode choices (Meyer, 1999; Steg 2005). Focusing on the environmental or exercise benefits of commuting by bike, for example, may be misguided. This study found that those elements were not related to commute well-being for any mode group. Appealing to affective feelings of joy, excitement, or relaxation may be more effective ways to market bicycling. Evidence shows that people make decisions about their travel mode based on their satisfaction with it (Abou Zeid, 2011). Further research is needed to identify types of policies that more directly connect with the values held by different travel segments, and encourage sustainable travel behavior.

Limitations and Future Research

This study has several limitations stemming from its convenience-based sample, its focus on Portland, and the lack of route choice information. In addition, the commute well-being composite measure could be biased towards non-motorized modes and the use of subjective data may affect the findings in the study and their generalizability. Future research can address these many of these limits and expand on this study's findings.

The findings may not be generalizable to other cities due to the study's focus on commuters to downtown Portland. Portland's climate, culture, and transportation infrastructure are different compared to most other cities in the U.S. and abroad. For example, there is likely less social stigma around riding a bike in Portland than in other cities. The sample was also convenience-based, largely based on organizations and individuals that were willing to participate in the study. Some of the participating organizations likely offer commute benefit programs for commuters that bike, walk or use transit. For these reasons, findings on the influences of commute well-being and its relationship to life satisfaction should be studied in other metropolitan settings.

Commute routes are estimates rather than actual routes and therefore preclude the inclusion of route-level attributes, such as the quality of bicycle infrastructure and actual congestion. Route-level attributes affect people's route choice decisions and likely also affect their commute well-being. Future studies would ideally obtain greater detail on route choices through survey questions or GPS. Similarly, using objective measures of commute options would help enhance the results from this research. Objective measures of commute mode options could provide a more accurate understanding of how such options affect people's commute well-being, even if the options are not used.

The composite commute well-being measure could possibly be biased to favor non-motorized modes due to the inclusion of items related to excitement and enthusiasm that may not directly apply to car and transit commute travel. While the commute well-being measure appears to be reliable and confirms findings in other peer-reviewed research (e.g. Friman et al., 2013), the equal weighting of items in the composite variable may not accurately represent actual commute well-being. Future research should test other modifications to the measure, such as using alternative questions or assigning weights to the items.

Future research should also employ different measures of commute well-being and data collection techniques and compare the findings to those in this study. The experience sampling method is one promising technique in which commuters could be asked about how they feel during the commute using text messages or other methods. This technique has been used in the past (and is summarized in Kahneman and Krueger, 2006) but has not, to the author's knowledge, focused on differences between mode users. Adapting other validated measures to focus on commuting is another potential technique to measure commute well-being. For example, Diener's Satisfaction with Life scale could be adapted by changing the word “life” with “commute” (i.e. “In most ways my commute is close to my ideal”…).

Commute well-being and its influences are modeled using multiple regression analysis in this study but a structural equation model should be tested in future research. It would be useful to specify a model of both the factors influencing mode choices and the influence of mode and other variables on commute well-being. It could provide a more realistic representation of the relationships among these variables and avoid the possible bias of the composite CWB measure.

Other trip purposes should also be examined. This study looks at one particular trip – the most recent commute from home to work. It does not closely examine the commute from work to home, commute trips in general, other trip purposes, or tours (i.e. trips with several stops along the way). Previous research shows that people feel better during the evening commute than during the morning commute (Kahneman and Krueger, 2006). Happiness with other trips is likely influenced by a variety of factors that are different than those affecting the commute from home to work (Anable and Gatersleben, 2005). Future research should test a similar measurement and modeling structure to the one used here to focus on particular trip purposes at different times of the day.

While findings in this study indicate that mode choices affect commute well-being, mode choices may mask other household location-based factors that affect well-being. For example, results suggest that residential satisfaction is a more important predictor of life satisfaction than mode. Including additional data about home satisfaction and neighborhood attributes in future studies may also improve our understanding of their relationship to commuting and well-being.

Other potential influences on commute well-being should be tested. For example, comparisons with previous commutes and peer's commutes have been shown to influence commute well-being (Abou-Zeid and Ben-Akiva, 2011). Weather conditions during commutes may also influence commute well-being but are not examined in this study. Expanding the survey with alternative questions, using a stated preference format, and bringing in other data (e.g. weather conditions for specific commutes) would increase our understanding of other influences on commute well-being. Stated preference surveys using videos could allow respondents to evaluate "virtual commutes" with different attributes, providing the researcher with greater control over the variables of interest. In addition, specifying some variables in alternative models could better represent their influence and improve model fit. For example, attitudes and preferences regarding modes may play a greater role in commute well-being than are represented in this study if they were tested in a structural equation model.

Finally, this study is cross-sectional and as a result, precludes making causal inferences from the results. Not only could confounding variables be present, but changes in the population of commuters, the transportation network, and vehicle technology will result in different future commuting experiences than those measured in this study. Similarly, commute satisfaction may impact future mode choices; however, examining this relationship is beyond the scope of this project. Future studies would ideally sample commuters longitudinally. Those that make changes in their commute mode would provide better information about the effect of mode on commute well-being.

Bibliography

Abou-Zeid, M. and Ben-Akiva, M., 2011. The effect of social comparisons on commute well-being. Transportation Research Part A: Policy and Practice, Vol. 45, Iss. 4, May 2011, pp. 345–361.

Anable, J. and Gatersleben, B., 2005. All work and no play? The positive utility of travel for work compared to leisure journeys. Transportation Research Part A, Vol. 39, pp. 163-181.

Bennett, D., 2009. Perfectly Happy. Boston Globe. March 10, 2009. http://www.boston.com/bostonglobe/ideas/articles/2009/05/10/perfectly_happy/?page=1.

Broach, J., et al., 2012. Where do cyclists ride? A route choice model developed with revealed preference GPS data. Transportation Research Part A, Vol. 46, Iss. 10, December 2012, pp. 1730–1740.

Cook, C. et al., 2000. A Meta-Analysis of Response Rates in Web- or Internet-Based Surveys. Educational and Psychological Measurement. December. Vol. 60, No. 6, pp. 821-836.

Diana, M. and Mokhtarian, P.L., 2009. Desire to change one's multimodality and its relationship to the use of different transport means, Transportation Research Part F: Traffic Psychology and Behaviour, Vol. 12, Iss. 2, March 2009, pp. 107-119.

Diener, E., 2006. Understanding Scores on the Satisfaction with Life Scale. Accessed May 5, 2011 from http://internal.psychology.illinois.edu/~ediener/Documents/Understanding%20SWLS%20Scores.pdf.

Diener, E. et al., 2009. Well-being for Public Policy. Oxford University Press.

Diener, E., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. Journal of Personality Assessment. 49, pp. 71-75.

Dora, C. & Phillips, M. 2000. *Transport, Environment and Health, Vol. 1.* WHO Regional Office Europe.

Ettema, D. et al., 2010a. Out of home activities, daily travel, and subjective well-being. Transportation Research Part A, Vol. 44, pp. 723-732.

Ettema, D., et al, 2011. Satisfaction with travel and subjective well-being: Development and test of a measurement tool. Transportation Research Part F, Vol. 14, Iss. 3, pp. 167-175.

Friman, M. et al., 2001. Frequency of negative critical incidents and satisfaction with public transport services. Journal of Retailing and Consumer Services, Vol. 8, pp. 95-104.

Friman, M. et al., 2013. Psychometric analysis of the satisfaction with travel scale. Transportation Research Part A, Vol. 48, pp. 132-145.

Gatersleben, B. and Uzzell, D., 2007. Affective Appraisals of the Daily Commute: Comparing Perceptions of Drivers, Cyclists, Walkers, and Users of Public Transport. Environment and Behavior, Vol. 39, No. 3, May 2007, pp. 416-431.

Hansson, E., et al., 2011. Relationship between commuting and health outcomes in a cross-sectional population survey in southern Sweden. BMC Public Health. 11:834.

Hayes, Bob, 2008. Measuring customer satisfaction and loyalty: survey design, use, and statistical analysis methods. American Society for Quality, Quality Press, Milwaukie, WI.

Heinen, E. et al. 2011. The role of attitudes towards characteristics of bicycle commuting on the choice to cycle to work over various distances. Transportation Research Part D, Vol. 16, pp. 102-109.

Hicks, N. and P. Streeten (1979). Indicators of development: The search for a basic needs yardstick. World Development, Vol.7, Iss. 6, June 1979, pp. 567-580.

Hoehner, C. et al., 2012. Commuting Distance, Cardiorespiratory Fitness, and Metabolic Risk, American Journal of Preventive Medicine, Vol. 42, Iss. 6, June 2012, pp. 571-578.

Jakobsson Bergstad, C. et al., 2011. Subjective well-being related to satisfaction with daily travel. Transportation, Vol. 38. No. 1, pp. 1-15.

Kahneman, D. and Thaler, R., 2006. Anomalies – Utility Maximization and Experienced Utility. Journal of Economic Perspectives. Vol. 20, No. 1, Winter 2006, pp. 221-234.

Kahneman, D., 1999. Objective happiness. In Kahneman, E. Diener & N. Schwarz (Eds.), *Well-being: The foundations of hedonic psychology.*

Kahneman, D., 2000. Experienced Utility and Objective Happiness: A Moment-Based Approach, Chapter 37, pp. 673-692, in: D. Kahneman and A. Tversky (Eds.), 2000.

Choices, Values and Frames. New York: Cambridge University Press and the Russell Sage Foundation.

Mokhtarian, P. & Solomon, I., 2001. How derived is the demand for travel? Some conceptual and measurement considerations. Transportation Research Part A, Vol. 35 Iss. 8, pp. 695–719.

Mokhtarian, P. & Chen, C., 2004. TTB or not TTB, that is the question: a review and analysis of the empirical literature on travel time (and money) budgets, Transportation Research Part A, Vol. 38, Iss. 9–10, November–December 2004, pp. 643-675.

Novaco, R. & Gonzales, O. 2009. Commuting and Well-being. In Yair Amichai-Hamburger (Ed.) *Technology and Psychological Well-Being.* Cambridge University Press.

Oshagbemi, T., 1999. Overall job satisfaction: how good are single versus multiple-item measures? Journal of Managerial Psychology, Vol. 14 No. 5, pp. 388-403.

Ory, D. & Mokhtarian, P., 2005. "When is Getting there Half the Fun? Modeling the Liking for Travel," Transportation Research Part A, Vol. 39, Iss. 2&3, 2005, pp. 97-124.

Ory, D. & Mokhtarian, P., 2009. Modeling the structural relationships among short-distance travel amounts, perceptions, affections, and desires. Transportation Research Part A, Vol. 43, Iss. 1, 2009, pp. 26-43.

Páez A, Whalen K (2010) Enjoyment of commute: A comparison of different modes, Transportation Research A, Vol. 44, Iss. 7, pp. 537-549.

Pedersen, T., Kristensson, P., and Friman, M., 2011. Effects of critical incidents on car users' predicted satisfaction with public transport, Transportation Research Part F: Traffic Psychology and Behaviour, Vol. 14, Iss. 2, March 2011, pp. 138-146.

Portland Bureau of Transportation, 2011. Portland Bicycle Count Report 2010.

Larsen, R. and Eid, M., 2008. Ch. 1. Ed Diener and the Science of Subjective Well-Being. In *The Science of Subjective Well-Being.* Eds. Eid, M. and Larsen, R. New York: The Guilford Press.

Meyer, Michael, D., 1999. "Demand management as an element of transportation policy: using carrots and sticks to influence travel behavior," Transportation Research Part A, Vol. 33, pp. 575-599.

Schneider, Robert J., 2011. Understanding Sustainable Transportation Choices: Shifting Routine Automobile Travel to Walking and Bicycling. Dissertation, U.C. Berkeley, Spring 2011.

Sener et al., 2009. An analysis of bicycle route choice preferences in Texas, US. Transportation, Vol. 36, Iss. 5, pp. 511-539.

Spinney, J. et al. (2009) Transport mobility benefits and quality of lift: A time-use perspective of elderly Canadians. Transport Policy, 16, pp. 1-11.

Stratton, A., 2010. David Cameron aims to make happiness the new GDP. The Guardian. November 14, 2010. Available online: http://www.guardian.co.uk/politics/2010/nov/14/david-cameron-wellbeing-inquiry

Tavakol, M. and Dennick, R., 2011. Making sense of Cronbach's alpha. International Journal of Medical Education. 2011; 2:53-55.

U.S. Census, 2010. 2009. S0801. Commuting Characteristics by Sex. 2009 American Community Survey 1-Year Estimates for Portland city, OR; Portland-Vancouver-Beaverton, OR-WA Metro Area. http://factfinder.census.gov/ .

U.S. Census, 2012. DP03: 2007-2011 American Community Survey 5-Year Estimates .

Wagner, A. et al., 2001.Leisure-time physical activity and regular walking or cycling to work are associated with adiposity and 5y weight gain in middle-aged men: The PRIME Study. International Journal of Obesity and Related Metabolic Disorders, 25 (2001), pp. 940–948.

Zeid, Maya Abou, 2009. Measuring and Modeling Activity and Travel Well-Being. Dissertation. Massachusetts Institute of Technology. September 2009.

Appendix A. Survey Instrument

You are invited to participate in a research study led by Oliver Smith, a doctoral student from Portland State University in the Nohad A. Toulan School of Urban Studies and Planning, who wants to learn more about how your commute to work makes you feel - and why. You were selected as a possible participant in this study because you work for an organization located in or around downtown Portland that agreed to cooperate with this research study.   If you decide to participate, you will be asked to fill out the following survey. It should take about 15 minutes to complete and include questions about: Feelings you experience during your commute   Your commute route (distance, traffic congestion, safety from crime, etc.)   Your general preferences about travel   Where you live and work   As an incentive, you may enter into a random drawing for a new Apple iPad 2 if you complete the survey. If you agree to participate, please select “Next.”

- Next
- Decline to take survey

You may not receive any direct benefit from taking part in this study, but the study will help to increase knowledge which may help others in the future.   Any information that is obtained in connection with this study and that can be linked to you or identify you will be kept confidential. No one from your workplace will have access to the data. Access to data will be limited to the researcher and will be kept on a secure, password-protected server at Portland State University. Federal regulations require keeping all data and records on file for at least three years after completion of this research.   Your participation is voluntary. You do not have to take part in this study, and your decision of whether or not to participate will not affect your relationship with Portland State University. You may end the survey at any time without penalty. If you have concerns or problems about your participation in this study or your rights as a research subject, please contact the Human Subjects Research Review Committee, Market Center Building, 6th floor, 1600 SW 4th Ave., Portland, OR 97207, (503) 725-4288 / 1-877-480-4400. If you have questions about the study itself, contact Oliver Smith (a) by mail at P.O. Box 751-USP, Portland, OR 97207-0751; (b) by phone at 503-201-3294; or, (c) by email at osmit@pdx.edu. Please print a copy of this consent form if you wish.   If you agree to participate and are at least 18 years of age, please select “Next.”

- Next
- Decline to take survey

What is your current employment status?

- Not Employed or Work exclusively from home
- Employed outside the home, Full-time
- Employed outside the home, Part-time

Thank you for your interest. However, only people that are employed and travel to work outside the home are eligible to take the survey.

On average, how many days per week do you work outside the home?

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7

Thank you for your interest. However, only people that are travel to work outside the home at least 2 days per week are eligible to take the survey.

Questions about your commute to work in general

At this time of year, how often do you use each of the following as your primary mode of transportation to work? By "primary" I mean the mode you use for the longest duration of your trip. Please fill in each row.

	4-5 days/week	2-3 days/week	1 day/week	1-3 days/month	Less than once a month	Never
Drive alone						
Carpool						
MAX						
TriMet bus						
Streetcar						
Bicycle						
Walk						
Other (specify)						

What type of car do you usually commute in?
(Make; Model; Year)

If you do drive or if you were to drive to work, would you have to pay to park?

- Yes
- No

How often do you make a stop (e.g. at a coffee shop, school, supermarket, gym) on your way to work?

- Rarely or never
- Sometimes
- Most days or always

How important is it to you to arrive at work on time?

- Not at all Important
- Somewhat Unimportant
- Neither Important nor Unimportant
- Somewhat Important
- Very Important

Please rank how easy it is for you to commute to work by the following modes:

	Very Difficult	Somewhat Difficult	Somewhat Easy	Very Easy	Don't Know
Drive alone					
Carpool					
Public transit (TriMet bus, MAX, or streetcar)					
Bicycle					
Walking					

To what extent are the following important to you when choosing your travel mode? For each, indicate the degree of importance.

	Very unimportant	Somewhat unimportant	Neither unimportant nor important	Somewhat important	Very important
Is cheap					
Is comfortable					
Saves time					
Is flexible					
Is mentally relaxing					

Is physically relaxing					
Is enjoyable					
Impresses people					
Offers privacy					
Benefits my health					
Reduces environmental impact					
Provides safety from traffic					
Provides safety from crime					
Suits my lifestyle					

Think about your commutes with the mode (car, bike, MAX, bus, walk) you choose most often. How frequently does your commute to work make you feel:

	Never	Very Infrequently	Somewhat Infrequently	Somewhat Frequently	Very Frequently
Stressed out?					
Relaxed?					
Anxious?					
Tired / drowsy?					
Awake?					
Happy?					
Angry / frustrated?					
Impatient / intolerant?					

With the mode you choose most often, how satisfied would you say you are with your regular commute from home to work?

- Very Dissatisfied
- Somewhat Dissatisfied
- Nether Satisfied nor Dissatisfied
- Somewhat Satisfied
- Very Satisfied

Questions about your most recent commute to work

For your most recent commute to work, please select how you traveled:

- Drove alone
- Carpooled with another person (could be a family member)
- Walked
- Rode a bicycle
- Rode MAX
- Rode a TriMet bus
- Rode streetcar
- Other (please specify) ____________________

How did you get from home to the MAX stop?

- Walked
- Rode a bicycle
- Rode a bus
- Carpooled
- Drove alone
- Other ____________________

How crowded was the MAX?

- Not at all crowded
- Somewhat crowded
- Very crowded

How did you get from the MAX stop to work?

- Walked
- Rode a bicycle
- Streetcar
- Carpooled
- Drove alone
- Other ____________________

How did you get from home to the streetcar?

- Walked
- Rode a bicycle
- Rode a bus
- Rode the MAX
- Other ____________________

How crowded was the streetcar?

- Not at all crowded
- Somewhat crowded
- Very crowded

How did you get from the streetcar to work?

- Walked

- Rode a bicycle
- Rode a bus
- Rode the MAX
- Other ____________________

How did you get from home to the bus stop?

- Walked
- Rode a bicycle
- Carpooled
- Drove alone
- Other (please specify) ____________________

How crowded was the bus?

- Not at all crowded
- Somewhat crowded
- Very crowded

Did you have to make any bus transfers?

- Yes
- No

How did you get from the bus stop to work?

- Walked
- Rode a bicycle
- Carpooled
- Drove alone
- Other (please specify) ____________________

How congested were the streets?

- Not at all congested
- Somewhat congested
- Very congested

Please select the box that best corresponds to your experience during the trip. For example, if you were very tense, select the box for -3. If you were neither tense nor relaxed, select the box for 0.

	-3	-2	-1	0	1	2	3
Tense (-3) to Relaxed (3)							
Worried that you would arrive on time (-3) to Confident that you would arrive on time(3)							
Bored (-3) to Enthusiastic (3)							
My trip was the worst I can imagine (-3) to My trip was the best I can imagine (3)							
Tired (-3) to Excited (3)							
Not enjoyable (-3) to Enjoyable (3)							
My trip went poorly (-3) to My trip went smoothly (3)							

How long did the total trip take, from the time you left home to the time you arrived at work (in minutes)?

Minutes

Which of the following things did you do during the commute? Pick as many as apply.

- Working/studying
- Reading for leisure

- Listening to music/radio
- Used Internet for leisure
- Sleeping/resting
- Email/Text messaging/Phone
- Gaming
- Talking to other travelers
- Windowgazing/people watching
- Other ____________________
- None of the above

How satisfied were you with your commute from home to work on this particular day?

- Very Dissatisfied
- Somewhat Dissatisfied
- Neither satisfied nor dissatisfied
- Somewhat Satisfied
- Very Satisfied

According to your responses above, you also drive alone to work at least two days per week. The following questions refer to the most recent commute from home to work that you made while driving alone.

[Repeated questions from above for all modes]

Your preferences with respect to daily travel (i.e. errands, shopping, and commuting) are important to know. For each, please tell me the degree to which you disagree or agree.

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
I would like to own at least one more car					

Travel time is generally wasted time					
I prefer to take transit rather than drive whenever possible					
I like riding a bike					
I use my trip to/from work productively					
I like taking transit					
Traveling by car is safer overall than walking					
Air quality is a major problem in this region					
I need a car to do many of the things I like to do					
I prefer to walk rather than drive whenever possible					
I like driving					
I prefer to bike rather than drive whenever possible					
Traveling by car is safer overall than riding a bicycle					
I try to limit my driving to help improve air quality					
Traveling by car is safer overall than taking transit					
I like walking					

The only good thing about traveling is arriving at your destination					
I prefer to organize my errands so that I make as few trips as possible					
The prices of gasoline affects the choices I make about my daily travel					
The trip to/from work is a useful transition between home and work					
Fuel efficiency is an important factor for me in choosing a vehicle					
I often use the telephone or the Internet to avoid having to travel somewhere					
My household could manage pretty well with one fewer car than I/we have (or with no car)					
Vehicles should be taxed on the basis of the amount of pollution they produce					
When I need to buy something, I usually prefer to get it at the closest store possible					

The region needs to build more highways to reduce traffic congestion					
My household spends too much money on owning and driving our cars					
I have a lot of free time.					

The following questions ask about your satisfaction with your job, home, and life in general.

All things considered, how satisfied are you with your job?

- Very Dissatisfied
- Somewhat Dissatisfied
- Neither Dissatisfied nor Satisfied
- Somewhat Satisfied
- Very Satisfied

How satisfied are you with your living environment (including your home and neighborhood)?

- Very Dissatisfied
- Somewhat Dissatisfied
- Neither Dissatisfied nor Satisfied
- Somewhat Satisfied
- Very Satisfied

Please indicate your agreement with each item by selecting one of the options.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
In most ways my life is close to my ideal.					
The conditions of my life are excellent.					
I am satisfied with my life.					
So far I have gotten the important things I want in life.					
If I could live my life over, I would change almost nothing.					

The following four questions ask about your health.

During the last 7 days, on how many days did you do at least 20 minutes of vigorous exercise? This could include your walking or biking to work or other destinations.

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7

Does your job require regular physical exertion such as lifting heavy boxes or standing for long periods of time?

- Yes

- No

Please rate your general health.

- Very Bad
- Somewhat Bad
- Neither Good nor Bad
- Somewhat Good
- Very Good

Do you have any physical condition that seriously limits or prevents you from...

	Yes	No
Driving a vehicle?		
Riding a bicycle?		
Using public tranportation?		
Walking?		

Almost there! There are just a few more questions.

Including yourself, how many people live in your household?

- 1
- 2
- 3
- 4
- 5
- 6 or more

Of these, how many are 16 years or younger?

- 0
- 1
- 2
- 3
- 4 or more

Including yourself, how many household members work full-time?

- 0
- 1
- 2
- 3
- 4
- 5 or more

Do you have a valid driver's license?

- Yes
- No

How many vehicles are available to you at your home? (do not include Zipcar)

- 0
- 1
- 2
- 3
- 4
- 5 or more

Are you a Zipcar member?

- Yes
- No

How many working bicycles do you (not other household members) own?

- 0
- 1
- 2
- 3
- 4
- 5 or more

Are you:

- Single, never been married
- Married
- Living with partner
- Separated or divorced
- Widowed

Are you of Hispanic, Latino or Spanish origin?

- Yes
- No
- Decline to respond

Which of the following best describes your race? You may choose multiple options.

- White
- Black or African American
- American Indian or Alaska Native
- Asian
- Other (Specify) ______________________
- Decline to respond

What is your age (in years)?

- 18
- 19
- …
- 75+

Which gender do you most identify with?

- Male
- Female
- Other ____________________
- Decline to respond

How many years of school have you completed? (please select one)

- Some high school or less
- High school or GED
- Some college
- Trade/vocational school
- Associate degree
- Bachelor's degree
- Master's degree
- Doctoral or professional degree
- Decline to answer

What is your approximate household income before taxes?

- Less than $15,000
- $15,000-$24,999
- $25,000-$34,999
- $35,000-$49,999
- $50,000-$74,999
- $75,000-$99,999

- $100,000-$149,999
- $150,000 and over
- Decline to answer

Knowing where you live is essential for understanding your commute. Please provide your place of residence. Remember, all data from this survey will be kept confidential and available only to the researcher.

- Address or closest intersection
- City
- State
- Zip

How long have you lived in your current home?

(Years; Months)

Please provide the name and location of your workplace.

Workplace name

Address or closest intersection

City

How long have you worked in your current workplace?

(Years; Months)

Please select the industry you work in.

- Agriculture, forestry, fishing and hunting, and mining
- Construction

- Manufacturing
- Wholesale trade
- Retail trade
- Transportation and warehousing, and utilities
- Information
- Finance and insurance, and real estate and rental and leasing
- Professional, scientific, and management, and administrative and waste management services
- Educational services, and health care and social assistance
- Arts, entertainment, and recreation, and accommodation and food services
- Other services, except public administration
- Public administration
- Other (please specify) ____________________

Is there anything else you would like to add or explain?

Thank you for taking this survey! Your responses are appreciated. If you would like to be entered into a raffle for an Apple iPad 2, please provide your name and email address. Remember that this information will be kept confidential, only available to the researcher, and will be separated from your survey responses.

Name

Email address

Appendix B. Email from Scott Cohen to Organizations

From: Cohen, Scott

Sent: Thursday, December 15, 2011 1:15 PM

To: Cohen, Scott; Hoyt-McBeth, Steve

Subject: Commuting and health - new study in Portland

Hello Sustainability Coordinators -

Oliver Smith, a Ph.D candidate in Portland State University's school of urban studies, is focusing his doctoral dissertation on commute behavior and health. As part of his study, he is conducting a survey of central city employees. Oliver asked me to help him gain more data points. Oliver's research could help bolster the work we do and provide peer-reviewed research that demonstrates the impact of commute choices on individual health.

Oliver is asking that you send an email to employees at your organization asking them to take the survey. The text of the email is included below. Note that everyone who takes the survey is eligible to win an iPad2! A pretty nice incentive for about 10-15 minutes of time.

Here is more detailed information on Oliver's study and the text of the email Oliver is asking that you send. Please don't hesitate to contact me directly if you have questions or Oliver, who's contact information is below.

Thanks for your time!

Scott Cohen

SmartTrips Business Coordinator

City of Portland Bureau of Transportation

scott.cohen@portlandoregon.gov

(503) 823-5345

http://portlandonline.com/smarttrips

Appendix C. Email from Oliver Smith to organizations and contacts

Dear __________,

Below is the information about the survey and some text to use when sending it out.

I really appreciate your help getting this to ____ staff! Please let me know how many people you send it to.

Sincerely,

Oliver

Please Help Me with a Study about Your Commute

I am a Ph.D. student in Urban Studies at Portland State University and need your help distributing a survey for my doctoral dissertation. Please read the details below and, if you have questions, contact me at ______(503)201-3294___ or osmit@pdx.edu. Thank you for your participation! – Oliver Smith

Study Description

Commuting to work has been shown to affect people's moods, emotions, job satisfaction and performance, and possibly overall happiness. This study examines how specific commuting characteristics impact people's sense of well-being. Results could enhance tools for analyzing transportation investments. This study will also contribute to emerging research on happiness and travel.

I will use an online survey to collect data from commuters in Portland. Surveys will take about 15 minutes and include questions about:

- Satisfaction with commuting
- Commute environment (distance, traffic congestion, travel mode)
- Work schedule (hours, days, flexibility)
- Attitudes and preferences about travel

Results of the study will be available to employers. As a way to say thank you and increase survey participation, I will offer respondents entry to a raffle for an **Apple iPad 2.**

What is Needed

To get the survey out, I am hoping you will agree to send the survey invitation to your fellow employees by Tuesday, January 31. The invitation text and link are copied below - just cut the section below, paste it into a new email, and send it on. I would appreciate it if you would BCC me on the email or let me know how many people you sent it to. Note that survey responses and emails will be kept confidential. **Please call or email me** at ______(503) 201-3294___ **or** osmit@pdx.edu to ask any questions about participating.

Email to Send to Employees

Subject: "A study about your commute"

"You are invited to participate in a research study led by Oliver Smith, a Ph.D. student from Portland State University in the Nohad A. Toulan School of Urban Studies and Planning, who wants to learn more about **how your commute to work makes you feel** - and why. You were selected as a possible participant in this study because you work for an organization located in Portland that agreed to cooperate with this research study.

If you decide to participate, you will be asked to fill out the following survey. It should take about **15 minutes** to complete and include questions about:

* Feelings you experience during your commute
* Your commute route (distance, traffic congestion, travel mode, etc.)
* Your general preferences about travel
* Where you live and work

As an incentive, you may enter into a random drawing for a new **Apple iPad 2** if you complete the survey. For more information and to enter the survey, click here https://portlandstate.qualtrics.com//SE/?SID=SV_6xmKv9t62EM1tkwor here: http://goo.gl/HMI3c Please complete this survey by Monday, February 6, 2012."

Appendix D. Correlation Matrix for Independent Variables in Regression on CWB

	Car	Transit	Walk	Bike	Trip time >40min (Car)	Congested (car)	Congested (Trimet bus)	Crowded Transit	To Lloyd Center (Bike)	Job - very satisfied	Home - very satisfied	Health - very good	Transition useful	Use trip productively (Trimet	Use trip productively (Car)	Only good thing destinati	Car safer than bike (Bike)	Income > $75,000
Car	1	-.473**	-.125**	-.470**	.379**	.298**	-.072*	-.193**	-.087*	0.001	-0.001	-.139**	-.220**	-0.021	-.408**	-0.043	.152**	.087*
Transit	-.473**	1	-.127**	-.481**	-.183**	-.144**	.150**	.400**	-.089*	0.022	-0.052	-.119**	-0.03	0.043	.197**	.088*	.155**	-0.027
Walk	-.125**	-.127**	1	-.124**	-0.047	-0.037	-0.019	-0.051	-0.023	-0.002	0.024	0.045	0.05	-0.005	0.051	-0.011	0.04	-0.054
Bike	-.470**	-.481**	-.124**	1	-.178**	-.140**	-.072*	-.192**	.186**	-0.021	0.04	.237**	.230**	-0.021	.192**	-0.042	-.323**	-0.036
Trip time >40min (Car)	.379**	-.183**	-0.047	-.178**	1	.303**	-0.027	-.073*	-0.033	0.028	0.024	-.108**	-.085*	-0.008	-.145**	-0.016	0.057	0.069
Congested (car)	.298**	-.144**	-0.037	-.140**	.303**	1	-0.022	-0.058	-0.026	-0.05	-0.032	-0.059	-.231**	-0.006	-.212**	-0.013	0.045	0.043
Congested (Trimet bus)	-.072*	.150**	-0.019	-.072*	-0.027	-0.022	1	.240**	-0.013	0.012	0.064	-0.018	-0.038	-.153**	0.03	.167**	0.023	-0.024
Crowded Transit	-.193**	.400**	-0.051	-.192**	-.073*	-0.058	.240**	1	-0.036	-0.004	-0.041	-0.056	-0.033	-0.02	.079*	.115**	0.062	-.073*
To Lloyd Center (Bike)	-.087*	-.089*	-0.023	.186**	-0.033	-0.026	-0.013	-0.036	1	-0.022	0.017	.111**	0.031	-0.004	0.036	-0.008	0.003	-0.028
Job - very satisfied	0.001	0.022	-0.002	-0.021	0.028	-0.05	0.012	-0.004	-0.022	1	.300**	.072*	.144**	0.061	-0.001	-0.055	0.018	0.003
Home - very satisfied	-0.001	-0.052	0.024	0.04	0.024	-0.032	0.064	-0.041	0.017	.300**	1	.151**	.168**	0.038	0.049	-0.027	-0.056	.152**
Health - very good	-.139**	-.119**	0.045	.237**	-.108**	-0.059	-0.018	-0.056	.111**	.072*	.151**	1	.182**	.109**	0.038	-0.056	-.109**	0.051
Transition useful	-.220**	-0.03	0.05	.230**	-.085*	-.231**	-0.038	-0.033	0.031	.144**	.168**	.182**	1	.218**	.230**	-.142**	-.099**	0.038
Use trip productively (Trimet	-0.021	0.043	-0.005	-0.021	-0.008	-0.006	-.153**	-0.02	-0.004	0.061	0.038	.109**	.218**	1	0.008	-.156**	0.007	0.049
Use trip productively (Car)	-.408**	.197**	0.051	.192**	-.145**	-.212**	0.03	.079*	0.036	-0.001	0.049	0.038	.230**	0.008	1	0.017	-0.062	-0.067
Only good thing destination	-0.043	.088*	-0.011	-0.042	-0.016	-0.013	.167**	.115**	-0.008	-0.055	-0.027	-0.056	-.142**	-.156**	0.017	1	0.014	-0.014
Car safer than bike (Bike)	.152**	.155**	0.04	-.323**	0.057	0.045	0.023	0.062	0.003	0.018	-0.056	-.109**	-.099**	0.007	-0.062	0.014	1	0.053
Income > $75,000	.087*	-0.027	-0.054	-0.036	0.069	0.043	-0.024	-.073*	-0.028	0.003	.152**	0.051	0.038	0.049	-0.067	-0.014	0.053	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).