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The green dividend of urban biking? Evidence of improved community and sustainable development

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As the cost of car ownership has skyrocketed, urban biking has experienced the largest share increase of any transportation mode, rising by 40% between the years 2000 and 2014. Growing attention is being paid to the potential local economic development impacts of urban neighbourhoods becoming more bike-friendly. It is now a green economic development strategy in cities as diverse as Chicago, New York City, Portland, and San Francisco to increase bicycling as a transportation mode. This paper reports the results of a survey of 2032 responses from faculty, staff, and students of a car-dependent, downtown university. We use a mixed methods approach, including data from the American Community Survey, to support our arguments and to inform potential savings and economic benefit calculations that can be achieved from bicycle infrastructure investments and anticipated redistributed spending patterns. We argue that urban biking results in a green dividend that promotes local community development and more importantly results in zero carbon emissions.

Keywords: neighbourhood renewal; sustainable development; biking; green; community development; transportation

Introduction

In the late 1800s and early 1900s, the bicycle was one of the most popular forms of transportation in the USA and its historical and sociological importance has been noted by the likes of Annie Londonderry, Albert Einstein, and Friedrich Nietzsche. In 1896, for example, feminist icon Susan B. Anthony noted that bicycles were one of the most important tools for the liberation of women; giving women a "feeling of freedom and self-reliance".

With the mass production of the automobile in the early twentieth century, however, the convenience of private cars was made affordable to the working class, and the preference of the bike as a mode of transportation steadily declined. Bikes along with light rail and pedestrians were pushed off the roadways in favour of cars. Urban development patterns changed to meet the needs of ubiquitous car use, resulting in central business districts full of parking lots and extensive highway systems contributing to suburban sprawl. Fast

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forward to today, and we find the cost of car ownership and operation has skyrocketed, and biking has experienced the largest mode share increase of any kind of transportation mode from 2000 to 2010, rising by 40%, with the lowest socio-economic groups reporting the largest bicycle use growth rates (McKenzie 2014).

Less attention has been paid to the potential local economic benefits to cities and urban neighbourhoods from their becoming more bike-friendly. Increasing bicycling as transportation – or at least the infrastructure that allows for increased bicycle transportation – is now a green economic development strategy in cities as diverse as Chicago, New York City, Portland, and San Francisco. Growing demand for bike-friendly urban biking has its roots in responding to young people who want to live car free near downtown, reduce carbon footprint, improve the safety and quality of downtown neighbourhoods, and improve personal health and finances. This paper seeks to answer the question: What kind of green economic return might a community expect to see by getting car-dependent commuters to a large urban university to alter their commuting behaviour and increase bike commuting?

Literature review

Operating, owning, and accommodating vehicles is expensive, representing a significant portion of household income. Much has been written about these costs and the health and environmental benefits derived from reducing car-dependency (Pucher and Buehler 2012). Less, however, has been published in the scholarly literature on the potential local economic benefit that might be generated from the cost savings that result from altered individual commuting behaviours.

Some articles discussing the economic returns that come from encouraging biking through the provision of bike infrastructure note that the number of cyclists in the USA is too small to have any significant or measurable impact (Gilderbloom 2008, Pucher *et al.* 2011). Others argue that the recent surge in biking is too recent and therefore is a phenomenon that has yet to be studied by scholars, thus limiting the availability of peer-reviewed literature on the topic (Weigand 2008). Weigand's (2008) review of studies of the economic impact of the bicycling industry argues that many of the published studies must be utilised with caution (see Colorado Department of Transportation 2000, Maine Department of Transportation 2001, Governor's Bicycle Coordinating Council 2006). Weigand (2008) explains that much of the published work was conducted by cities and states with existing and robust bicycling-related activities and industries, rather than new pro-biking initiatives. The studies reviewed by Weigand (2008) do not discuss an individual's motivation for using the bicycle as a mode of transportation, nor do they report on the economic benefits specifically witnessed by urban neighbourhoods.

Since 2008 more research into various aspects of increasing non-motorised transportation on University campuses has been conducted. This research has concluded that transportation demand management programmes can both reduce the costs of increased parking capacity and increase the use of non-motorised and non-auto-based transportation (Riggs 2014, Tudela-Rivadeneyra *et al.* 2015), and that systematic documentation and benchmarking of commuter behaviour should be conducted (Riggs 2014). Scholars know less, however, about the economic impacts of increasing alternative transportation options. Pucher and Buehler's (2012) City Cycling, one of the best original scholarly readers on the topic, has 15 chapters by leading experts, but none of them is dedicated to the impact of bike riding on consumer spending. Nor is there an entry in the index concerning community development or the green economic benefits of bicycling. Similar omissions on the economic impact of urban biking can be found in other scholarly works (Wray 2008, Mapes 2009, Heying 2010) and applied planning publications (Birk 2010, Byrne 2010). While the literature does provide estimations of the savings generated from substituting bicycles for automobile transportation, it does not address the potential economic benefits of cost savings on urban neighbourhoods. This paper aims to fill this gap in the knowledge by using survey results and calculated estimates to demonstrate the potential local "green dividend" that can result from increased urban biking.

The costs of car dependence

The Bureau of Labor Statistics (BLS 2009) estimates the average cost of owning and operating a car has risen in cities to $8689. According to the Automobile Association of America (AAA) (2013), excluding loan payments, Americans driving a medium-sized sedan 15,000 miles per year can expect to spend $9151 per year, or approximately $0.61 per mile driven. Americans driving large sedans can expect to spend about $0.75 per mile, or a total of $11,248 per year (AAA 2013). These figures include average expenses on fuel, routine vehicle maintenance, including tyres, insurance coverage, licence and registration fees, loan finance charges, and vehicle depreciation costs. Total car ownership and operation costs for both medium and large sedans are detailed in Table 1 (AAA 2013).

The AAA (2013) also reports that these costs are expected to rise, as they did from 2009 to 2010, when the cost of driving increased by nearly 3.5% (about $290) despite a national average decrease in maintenance and insurance rates. Biking and walking, meanwhile, are considered the least expensive modes of transportation. Biking is only a fraction of the cost, with one estimate putting the cost at just $120 per year (Portland Plan Partners 2012, p. 125).

Spending on highway construction and expansion that raises peak-period speeds discourages use of transportation alternatives, including public transit, alternate routes, and off-peak travel times (Downs 1962). Downs (1962) explains that this is a result of induced demand. Such commuting behaviour results in maximising road capacity during peak travel times, which ultimately leads to congestion (Downs 1962, Schrank *et al.* 2011). Schrank *et al.* (2011) estimate that urban road congestion cost Americans $101 billion in 2010 and required drivers to purchase 1.9 billion gallons of extra fuel. Encouraging investments that would, instead, reduce congestion in the urban areas with the greatest travel delays could lower the costs of congestion by 20%, or $7.2 billion per year (Schrank *et al.* 2011). Other costs associated with congestion that could be lowered with changes in commuting travel mode are motorists' opportunity costs and the increased operating costs of trucking and shipping companies (Local Government Commission's Center for Livable Communities 2000, Schrank *et al.* 2011).[1]

Table 1. Total costs (per year and per mile) of car ownership and operation for medium and large Sedans (AAA 2013).

Total cost per mile (15,000 miles/year)	Medium Sedan	Large Sedan
Cost per mile × 15,000 miles	$3164	$3522
Cost per day × 365 days	$5987	$7726
Total cost per year	$9151	$11,248
Total cost per mile	$0.61	$0.75

Source: AAA (2013).

Increased interest in cycling and financial benefits of decreasing car dependence

In the literature, the recent upsurge in bicycling and its associated benefits are addressed at two levels: the household level and the community level. Changing commuter behaviour and housing choice and the value derived from altering that behaviour are discussed, but how households and communities would invest the cost savings and value derived from those choices is not addressed. Mapes (2009) attributes the recent increase in bike ridership to a renewed interest in urban neighbourhoods and walkable cities. The age groups most likely to commute by bike are 16–24-year-olds (1% commute by bike) and 25–34-year-olds (0.8% commute by bike). No other age group has a bike commute rate of higher than 0.7%. It is this demographic (16–34-year-olds), more than any other, which is moving into city neighbourhoods.

The 2007–2008 increases in gas prices and the housing market collapse are also accelerating the growth in bicycle ridership (Mapes 2009). When deciding where to live, individuals in the USA will often accept a longer commute in exchange for more affordable housing (Sermons and Seredich 2001, Lovins and Cohen 2011).[2] An economic trade-off between home location and commuting time, however, may be substituted for a trade-off between transportation modes (Boarnet and Sarmiento 1998, Duany *et al*. 2001). McAnn (2000) estimates that in substituting a bike, walking, or public transit travel for a car, commuters could save enough money to locate closer to the central city. McAnn (2000) reports that households in car-dependent communities spend on average $1200 to $6000 per year more on surface transportation than households in walkable areas with access to transit.[3]

Geller (2013) calculated costs for Multnomah County (where Portland is located) and found each dollar-year increase in gasoline (one dollar increase in cost sustained over the course of a year) results in $240 million not spent on other goods and services, many of which would eliminate the environmental detriment created by car commutes in Multnomah County (Geller 2013). Those dollars spent on commuting result in fewer new local jobs and no wage increases. Nationally, according to the Texas Transportation Institute, a 30% increase in non-motorised travel in the USA would reap estimated monthly savings of $168.3 billion, or roughly $2 trillion per year (Schrank *et al*. 2011).

Kenworthy and Laube (1999) and Hartgen and Fields (2009) report that cities that are the most dependent on the automobile are less wealthy and less economically competitive than cities oriented to a greater diversity of transportation modes. Douma and Cleveland (2008), Rietveld and Daniel (2004), and Topp (2008) argue that cities can reduce their car dependency by increasing access to or improving the condition of existing bicycle facilities.

The largest socio-economic group most likely to commute via bike is that making $0–$24,999 (up to 1.5% commute by bike) (McKenzie 2014). It is this same socio-economic group that tends to commute by bike and live in the central city. As an aside, car ownership and operation is, in fact, a regressive tax on lower-income groups, as the proportion of household income spent on cars is higher for the poor than for upper-middle- and high-income households. Table 2 below shows the bike commuting rates for 2008–2012 by Census Bureau household income group United States Census Bureau 2008, 2010.

Why more people do not bike

Despite the potential savings and the increased costs associated with driving, the number of Americans owning and operating automobiles continues to grow (Federal Highway Administration and the United States Department of Transportation 2003, Federal Highway

Table 2. Bike commuting by household income group (2008–2012, ACS).

Household income	% of workers	Margin of error
$0–$9999	1.5	0.1
$10,000–$14,999	1.1	0.1
$15,000–$24,999	1.0	Z
$25,000–$34,999	0.7	Z
$35,000–$49,999	0.6	Z
$50,000–$74,999	0.5	Z
$75,000–$99,999	0.4	Z
$100,000–$149,999	0.4	Z
$150,000–$199,999	0.5	Z
$200,000+	0.5	Z

Source: McKenzie (2014).
Note: Z = rounds to 0.

Administration 2005, United States Bureau of Transportation 2009, Schrank *et al*. 2011).[4] So, why is it that less than 1% of the overall US population uses a bike as its primary mode of transportation? Pucher and Dijkstra (2003) cite that the greatest deterrents to cycling are (1) the lack of appropriate facilities for cycling and walking and (2) the real or perceived danger of cycling and walking in American cities. The world's best cycling cities use both carrots and sticks to encourage increased bicycle use. Carrots represent such amenities as better bike facilities and infrastructure; sticks represent such tactics as higher gas prices, adjusting congestion "fees", and tolls. In the USA, we focus too much on carrots and not enough on sticks.

Safety concerns also have a detrimental impact on biking. The provision of appropriate and adequate bike facilities can do much to eliminate the dangers associated with cycling (Burden 2001). Pucher and Buehler (2007, 2008) argue that providing separate cycling facilities on high-traffic roads at intersections, along with implementing traffic-calming measures in residential areas, is the key to achieving high levels of cycling. Pucher and Buehler (2007, 2008) also note that providing adequate bike parking, integrating the cycling facility network with the public transportation network, and conducting comprehensive traffic education and training for cyclists and motorists have increased cycling in European cities. The USA, Pucher and Buehler (2008) suggest, could adopt similar strategies to increase ridership. While Goetzke and Rave (2010) argue that the addition of bike lanes in German cities did not increase the number of individuals biking, they found that social networking does increase the number of people cycling; people are more likely to bike when they see or hear about others biking. Contrary to Goetzke and Rave's findings in German cities, Dill and Carr (2003) find that for American cities with populations greater than 250,000, the addition of one mile of bike lanes per square mile in the city results in approximately a 1% increase in the number of trips made by bikes.

Case study: economic benefits of increased bicycle usage in a midsized city

Our study examines the potential economic benefits of increased bicycle usage by auto-commuters to The University of Louisville. We believe that increased bicycle usage can be attributed to several factors, such as shorter distances between work and home within the city, the increasing cost of automobile transportation, increases in housing prices, and the presence of bike-friendly infrastructure. We implemented a survey tool to better understand these benefits, which has also been done in other studies of alternative transportation choices (Goetzke and Rave 2010, Clifton *et al.* 2012c, Pucher and Buehler 2012). Currently, Louisville ranks especially low for cities in which citizens choose bicycling, walking, and other non-automotive travel. Louisville ranks 153rd of 384 metropolitan areas in individuals who typically bike to work, 182nd in individuals who walk to work, and 188th in the percentage of individuals who do not use an automobile to commute (i.e., public transportation, bike, foot, ferry, work from home). Moreover, the League of American Cyclists recently ranked the Commonwealth of Kentucky (where Louisville is the largest city) as next to last in being bike-friendly (Broken Sidewalk 2015).

One of the largest employers in the downtown area is The University of Louisville. Our study found that, within the university community, the proportion of the survey population using alternative means of transportation to get to the campus is quite low compared to other university populations. This is demonstrated by the high percentages of university students and employees in "college towns" that walk and/or bike to work, and the higher rates of walking and/or biking by the best educated (Shoup 2005, Riggs 2013, McKenzie 2014). For example, Ithaca, NY, has a walk commuting ratio of 42.4% of workers, and San Luis Obispo, CA, has a biking commuting ratio of 6.6% of workers. Davis, CA, has a biking commuting ratio of 18.6% of workers. Isla Vista a student community next to the University of California at Santa Barbara has the highest known bike ratio of 32.7 for any community.

Universities such as the University of California campuses of Santa Barbara and Davis, University of Colorado (Boulder), Indiana University and Portland State University have been proactive in creating campuses that are conduits of alternative transportation modes to help lower the cost of education and to help increase retention rates (Pucher and Buehler 2012). Our study concentrated on exogenous and endogenous factors that affect transportation mode selection in the hopes of identifying barriers that could be overcome through investments and incentive programmes.

Methods

In the spring of 2010, the University's Sustainability Council requested that a comprehensive transportation survey be conducted of the university community as a part of the greenhouse gas emissions reporting required through the American College & University Presidents' Climate Commitment. A professor of Urban and Public Affairs collaborated with the assistant to the Provost for sustainability initiatives (both of whom are co-authors of this paper) to administer the survey. The lead author of this paper, with permission from the Provost, used the survey development and administration process as a teaching tool for a graduate-level seminar course at the university. The university granted the professor and the students a small sum of money to cover the costs of survey administration.

The purpose of the survey was to better understand the commuting behaviours of the university community and its willingness to consider transportation alternatives. The survey included questions about how survey recipients commute to and from campus, their willingness to pay more for parking permits and gasoline, their views on bicycling as a means of transportation, and their opinions on cycling and transportation safety. The questions were composed with student, faculty, staff, community, and Sustainability Council input, and benchmarked against previous surveys cited by national bicycling organisations. The survey was reviewed and approved with several small changes in the survey wording by the Institutional Review Board (IRB). Controls for the survey included:

housing location, gender, race, or ethnicity, occupation at the university, and educational attainment.

The survey was distributed via email to a random sample of 9653 students, faculty, and staff at the university. Of those surveyed, 2032 responded. Just more than one of every five persons in the random sample responded to the survey, with faculty and staff responding at a rate of 31% (± 1% margin of error) and a student response rate of 11% (± 5% margin of error). The higher rate of response from faculty and staff is interesting, suggesting that they may be more responsive to requests from the provost. In an age where the validity of survey results are called into question because random dialling surveys do not include cell phone numbers, having the weight of the provost's request for participation helped deliver a strong response. The response rate does raise the question of potential bias in respondents and it is possible that only those interested in transportation issues responded to the survey request. However, for a survey response, this is a large sample, which provides greater representation and precision in terms of the estimates. The questionnaire was constructed following the design guidelines of the University of Chicago National Opinion Research Center and follows conventional social science guidelines for survey instruments (Babbie 1990, 2013, Engel and Schutt 2012).

Finally, this study was conducted in a University environment, and thus may not be directly applicable to the larger urban environment. Furthermore, Louisville and the Old Louisville neighbourhood containing The University of Louisville may be unique. This limitation suggests further research in this area is warranted.

Addressing limitations of survey research

This study is largely dependent upon cross-sectional survey data for an understanding of the degree to which investments in bicycle infrastructure might impact behaviour and economic activities. The task of understanding the economic impacts of reducing automobile usage is quite daunting and currently the only reliable method is surveying (Cortright 2009). Academics have frequently used surveys to measure attitudes towards biking and consumer spending by government and non-profit groups in bike-friendly cities like Portland, Davis, Minneapolis, Berkeley, and Amsterdam (Portland Plan Partners 2012). Surveys are one of the chief tools for measuring all types of behaviours from sex to voting to buying habits (Babbie 1990, 2013, Engel and Schutt 2012). It is also used in research that has a focus on bicycling (Bartholomew and Ewing 2011, Clifton *et al*. 2012a, 2012b, Pucher and Buehler 2012).

Additionally, there are limitations associated with asking individuals how their behaviour might change when presented with hypothetical situations (Akar *et al*. 2011, 2012). This is a perennial survey problem, specifically, in efforts to predict the response to transportation investments and in planning policies more generally. Survey responses about abortion, war, or health have been shown to vary by multiple percentage points due to variations in question phrasing, and this is also possible with transportation surveys. Researchers have developed an approach to address these limitations, known as stated preference surveys (Adamowicz *et al*. 1994, DiMaggio and Louch 1998, Hanley *et al*. 1998). Such surveys systematically test the response to situational changes while accounting for the important trade-offs involved. Stated preference surveys are not without limitations, and people will not always behave in real-world situations as they claim in surveys, but they are one tool to gauge likely behavioural responses. Several key questions in our survey used the stated preference style. Beyond the physical environment, we also explore the social environment of biking as a reason for people to ride a bike. Of particular note are the questions asking whether bike usage would increase if the respondent had someone to ride with. Goetzke and Rave's (2010) survey asks whether social networks play a role in getting on a bike but surveys by Clifton *et al*. (2012a, 2012c) and Change and Chang (2005) do not explore this social dimension.

While recognising the limitations of surveys, we disagree with those who believe that only studies of actual behaviour provide useful information. Social science surveys have been used since the 1850s with the founding of sociology, and have since been adopted by researchers in political science, history, and economics (Appelbaum 1978, Goetzke and Rave 2010, Schutt 2010, Babbie 2013). We have found that surveys of consumer spending by bicyclists and drivers can illuminate how household money is spent (Akar *et al*. 2011, 2012, Clifton *et al.* 2012a, 2012b, 2012c).

To further test the reliability and validity of our results, we also added two additional measures for this study: First, the wording of the questions used probed consumer spending desires in unique and original ways by asking qualitative questions developed in our initial interviews. Second, our study used the American Community Survey to give a portrait of national biking trends to further inform our research findings. We think these additional approaches help reinforce the findings of the survey research.

Data analysis

The University of Louisville is a highly car-dependent campus community. Nearly four out of five university employee respondents and nearly two-thirds of student respondents report that they typically drive to campus alone. When accounting for carpooling, we found that nearly 9 in 10 employees are dependent upon automobiles for their regular commute. Only 4% of students and 2% of employees reported that they bike to campus on a regular basis. Students are more likely to walk to campus, though only one out of five do so regularly. This includes the roughly one-quarter of the student body which lives in university-affiliated housing on or near campus. More than half of students, faculty, and staff commute more than 30 minutes to campus. This high level of car dependence is fairly typical of US cities, as explained in the literature review (Pucher *et al*. 2011).

Our survey results suggest that a large number of the car-dependent faculty, staff, and students would be more willing to consider commuting by bike if additional bike infrastructure were provided. This number varies according to estimated cost of gas, nearness to the University, and type of bike infrastructure in question. In general, however, 16% of students and faculty responded approvingly to the question "If a dedicated bike lane was provided from my neighborhood to campus, I would be more likely to bike to campus." We also asked respondents whether they were more likely to bike if they could ride with another person and found that 9% of the students and 7% of the employees indicated they would do so. Our findings show that both the physical infrastructure and social factors are keys to obtaining an increase in urban biking.

Consumer preference surveys can also be tested by the reality of where existing bike infrastructure has been installed. The 2010–2011 Campus Travel Survey for the University of California Davis found that 47% of undergraduate students and 55% of graduate students commute to class by bike, while 46% of faculty and 40% of staff commute to the campus by bike (Handy 2011). Furthermore, the University of California Santa Barbara reports that 57% of undergraduate students, 35% of graduate students, 22% of faculty, and 7% of staff members use bikes to commute to campus. For UC Santa Barbara these numbers have grown significantly over the past 40 years. In 1970, 38% of the student population commuted to campus by bike, now 52% choose bikes. Additionally, UC Santa Barbara finds that for every three students bicycling, there is approximately one walking to campus.

When asked what would most encourage people in the University of Louisville community to bike, the top answer given by respondents was: the installation of bike lanes, bike routes, and signage to make the commute safer. Figure 1 shows the results obtained on this question. A sizable percentage of respondents said that they would be more willing to bike to campus if secure, out-of-the-elements bike parking, maps, and information about safe bike routes to campus, and more bike racks were provided. Specifically, respondents want more, separate/protected bike lanes (facilities and safety), maps and way-finding signs (facilities and safety), and secure places to store bikes (facilities). It should be noted that a less popular response was "training in safe and confident cycling in traffic" – suggesting that bikers recognise the dangers of riding on roads that have traffic, fast multi-lane one-way streets, or in unprotected or non-segregated bike lanes. Bikers prefer to ride on streets that are calm and slow even without a bike lane. Louisville's most dangerous biking area is considered a multi-lane one-way street that has an unprotected bike lane (Riggs and Gilderbloom 2015)

Another potential impetus for altering commuting habits is an increase in the price of gas. Our survey revealed that as the price of gas per gallon increases, more people would consider moving closer to campus (thus making bike commuting more likely). If the price were to exceed $5 per gallon, more than one-third of the survey respondents said they would consider such a move. The response trend lines for this question seem to suggest that the price of a gallon of gas may enter into transportation mode decision-making up to a price level that seems "possible" – but less so for per gallon prices above a level that may seem "improbable" or "impossible". Also of note are the end points of the response trend lines. Many respondents already live near campus, and many will live wherever they want regardless of the price of gasoline; the latter suggesting that neighbourhood qualities outside the cost of transportation are most important in their place of residence decision-making. In other words, this suggests that qualities such as neighbourhood vibrancy, safety, walkability, and density and transportation mode diversity,

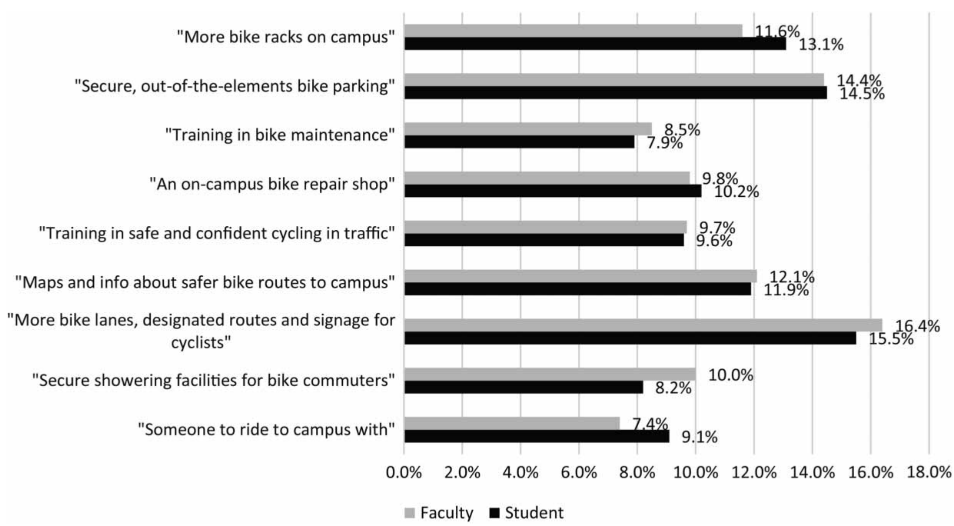

Figure 1. Survey question: what would incentivise you to bike to campus more often?

as found by Deakin *et al.* (2004) and Gilderbloom *et al.* (2014), drive choice of residence location just as the cost of driving does. Figure 2 shows the results obtained on this question.

Our survey also asked how people would spend the \$3000–\$8000 savings generated from reducing or discontinuing automobile use for commuting to the campus of The University of Louisville. Respondents were allowed to pick multiple options, and one in three said they would use the savings to improve their housing. Roughly, one in four would buy better quality groceries and one in five would buy clothes and accessories. One-tenth of the respondents noted that they would plant a garden, while another one-tenth said they would join a fitness club. One-twelfth of the population said they would splurge by eating out more often. Figure 3 shows these survey results. The impact of this re-distributed spending could be significant for the local economy, especially considering that 10 of the 14 answer choices occur at the local level and would be more likely satisfied by local sources.

How does this compare to "average" American spending habits? A 2009 study by the BLS estimated that the average American household spends 21 cents of every dollar on shelter.[5] Transportation is the second largest spending category, roughly 16 cents of every dollar spent. Food accounts for 13 cents, insurance and pension (excluding home insurance) amounts to 7 cents, equal to the 7 cents spent on utilities. Other household needs account for another 7 cents, healthcare is roughly 7 cents, and entertainment adds up to 6 cents. Apparel, services, and cash contributions each account for 4 cents, while education and reading consumes just 2 cents out of every dollar spent.

In our analysis, we calculated a conservative cost-saving projection based upon the number of individuals who indicated that they would ride a bicycle to campus based upon changes in bike infrastructure and services provided by the university. This calculation is straightforwardly done by multiplying the number of potential cyclists by the amount of money saved by an individual by not owning a car. If roughly 10% of the campus community, or 3041 individuals, would give up their cars and bike to the university,

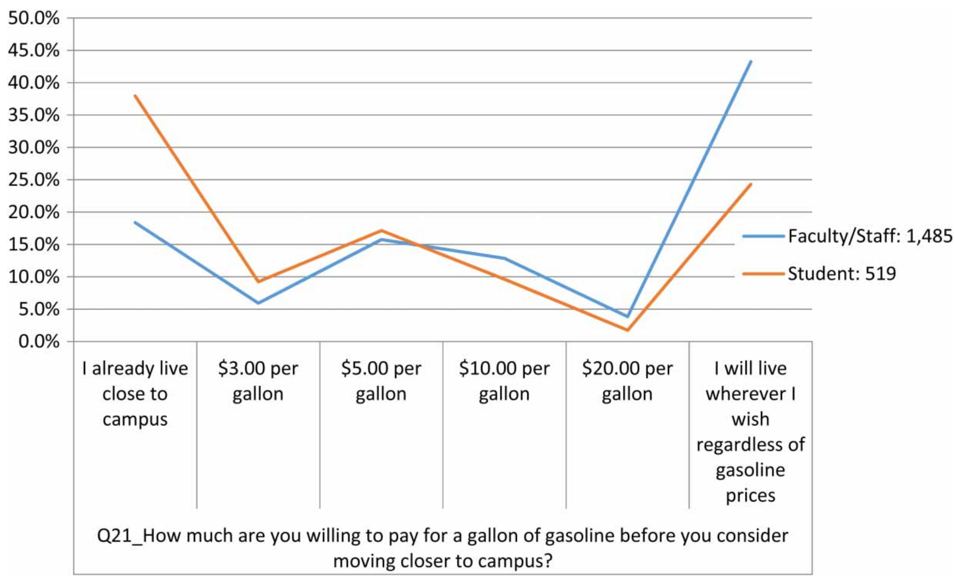

Figure 2. Results of survey question on residential choice based on gas prices.

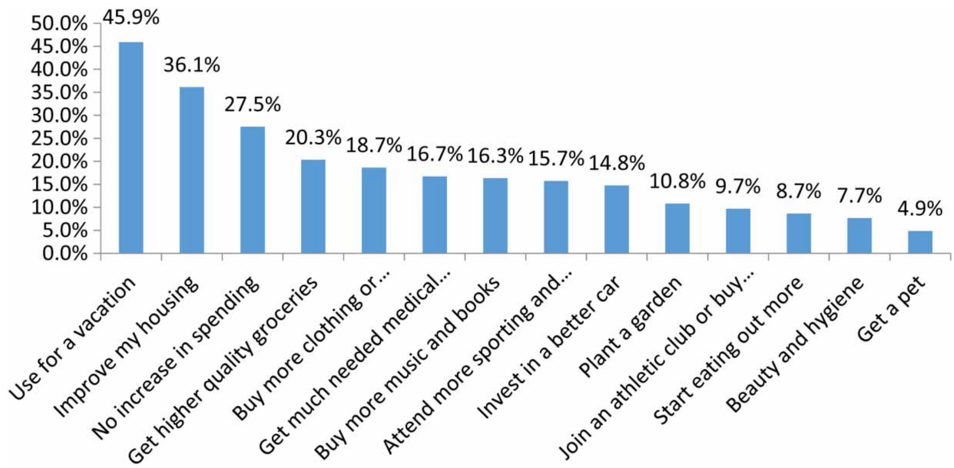

Figure 3. Results of the survey question on how respondents would spend savings from reduced or discontinued auto-based commuting. "Economists have estimated that non-car commuters from home to campus can save thousands of dollars a year –roughly $3000–$8000 a year. If such savings were to be realized, what would you do with this savings?"

these individuals would realise an estimated annual savings of $24 million (approximately $8000 each per year). If that percentage increased to 30%, or 7603 individuals, the savings would be close to $61 million. If bike lanes were installed within a 10-minute bike commute of the campus to neighbourhoods, the savings within that commute radius would amount to $26 million. According to respondents, a significant portion of savings would be spent in the community; thus, monies previously sent to outside the metro area of Louisville, to such industries as national finance, car manufacturing, and oil companies, none of which are located in most cities, would instead be available to support local economies. If bike lanes were extended out from the University to within an 11–20-minute commute radius, the savings would increase to $55 million dollars. Altogether, if bike lanes were installed throughout Louisville, the economic return for just faculty, staff, and students who would chose a bike as a primary mode of transportation would be around $78 million – Table 3 provides details of these calculations. This does not include others outside of the university community who would also use bike lanes for commuting. Consumer preference surveys cannot accurately predict an exact amount of savings and reinvestment, but provide us with an approximate measure.

Table 3. Saving estimates given variation in the number of people and amount of reduction in driving.

Commute time	Would bike	Would not bike	Individual savings	Cumulative total savings
Within 10 minutes	3226	2483	$25,804,680	$25,804,680
11–20 minutes	3670	5505	$29,360,000	$55,164,680
21–30 minutes	1906	6347	$15,251,544	$70,416,224
31–40 minutes	581	2918	$4,645,344	$75,061,568
41–60 minutes	318	1400	$2,541,160	$77,602,728
Over 1 hour	95	223	$763,200	$78,365,928

Note: Cost calculation formula: would bike (*n*) × $8000.

Another more nuanced way of calculating the potential economic impact of bicycling is to create alternative scenarios based on variable estimates of the annual costs of owning and operating a car. The conventional AAA estimate of the annual cost of operating a car is now approximately $8000. One might ask how much could be saved if someone would not completely give up their car, but instead just limited the number of trips by car. Figure 4 takes this scenario into consideration and estimates the total potential savings ($2000, $4000, $6000, and $8000) based upon variations in the amount individuals reduce driving and the percentage of employees and students of the University of Louisville that bike. We estimate that even if individuals reduced rather than eliminated car dependency, and saved $2000–$4000 a year, the potential overall impact on the local economy due to monies remaining in the community instead of flowing out to national and international companies would be more significant than many other municipal projects, private developments, and tax cuts that tend to grab headlines.

Not surprisingly, our survey also suggests that people who live close to work or school are more willing to consider bicycling as a practical means of transportation. Considering that Louisville is a monocentric city (Gilderbloom and Appelbaum 1988) where the highest concentration of jobs and educational institutions are still in the central business district (Gilderbloom and Appelbaum 1988), those who live close to downtown are more likely to choose or demand alternative modes of transportation if a proper infrastructure exists. Therefore, to maximise bicycle usage, the most logical first step is to build infrastructure in the central business district and then extend out to nearby neighbourhoods.

Discussion and policy implications

There is a powerful green dividend to urban biking – economy, environment, and ecology

This paper finds support for the argument that increased bike commuting is dependent on social and infrastructure factors. We found no support for Goetzke and Rave's (2010)

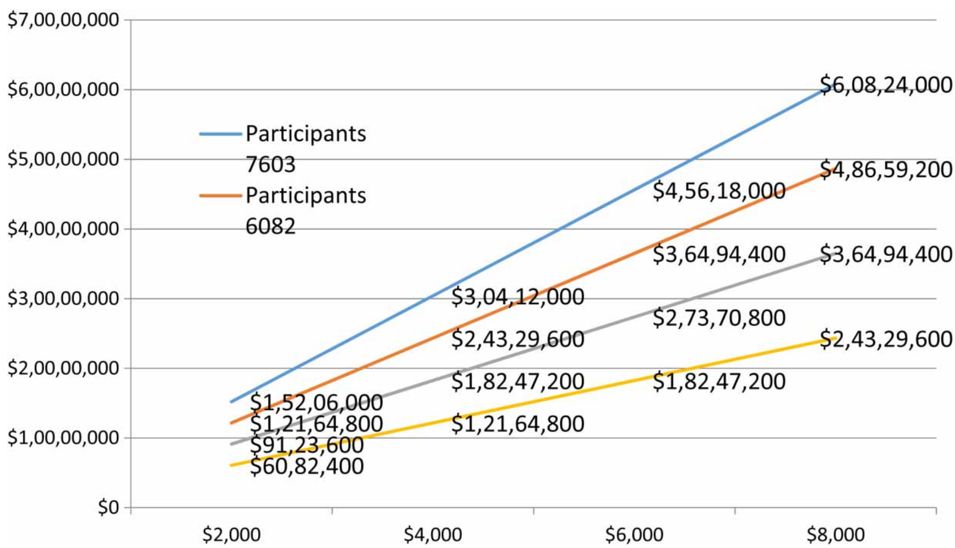

Figure 4. Projected/estimated savings based on varying levels of savings resulting from reduced or discontinued auto-commuting.

assertion that bike infrastructure is not correlated with an increase in biking. We also test claims by bike advocacy groups that an increase in urban biking results in greater neighbourhood consumer spending on a variety of essential and non-essential consumer products. BLS (2009) data on consumer spending help bolster our findings that savings from urban biking will result in greater local spending through reallocation of monies not spent supporting car-based transportation. Our research suggests that increased urban biking means our neighbourhoods will become more prosperous and sustainable. More scholarly research is needed to further explore how urban biking creates and expands neighbourhood sustainability.

Achieving a "green dividend from urban biking" relies upon greater investment in bike infrastructure. According to McMahon (2012), the cost of adding bike lanes is minimal compared to building freeways. For the $50 million spent on building just one mile of a four-lane freeway, 150 miles of on-road bike facilities could be constructed (McMahon 2012). Mapes (2009, p. 143) estimates that the building of an extensive 250 miles of bike lanes between 1993 and 2008 would cost $100 million compared to $143 million to rebuild just one of the city's freeway interchanges. It is estimated that bike lane construction costs even less for urban streets. According to Walkinginfo.org (2011), lane striping or the addition of signage for a bicycle lane on a roadway costs approximately $5000–$50,000 per mile. The cost range accounts for the variation in pavement conditions, as well as the need for removal and repainting of lines, and adjustment of existing signage. Walkinginfo.org (2011) explains that it is "most cost efficient to create bicycle lanes during street reconstruction, street resurfacing, or at the time of original construction". Traffic lanes can also be narrowed to accommodate the addition of bicycle lanes, at costs ranging from $1000 to $100,000 per mile (Walkinginfo.org 2011). This cost range represents the difference of adding striping to a shoulder on the low end to constructing a raised median or widening an existing sidewalk on the high end (Walkinginfo.org 2011). The larger point is that a one million dollar investment in bike facilities would bring back a return of 25 to 100 times that in community spending.

The university community's car dependence not only imposes direct costs on the students and employees. The indirect and externalised costs should not be ignored. The (Partnership for a Green City 2009) estimates that every day local residents drive 24 million miles in the county where Louisville and the University of Louisville are located. DeCorla-Souza and Jensen-Fisher (1997) calculate a cost of $0.20 to $1.00 per additional peak-period automobile trip on urban highways. Reducing the number of car commuters saves taxpayers money and preserves land that would otherwise be used to construct and maintain parking garages and surface parking lots. The cost incurred by The University of Louisville to construct a parking space is estimated to be $20,000 in a covered garage and $2000 in a surface lot. In comparison, the installation of bike racks costs less than $250 per bike – and multiple bikes can be stored in the space required for one car. Even ignoring the considerable on-going costs of maintaining, lighting, cleaning, and enforcing regulations for parking areas, the university stands to save a considerable amount of money from deferring the need to construct additional parking structures and lots as would be needed to meet expected future demand. If roughly 10% of the campus community were to start commuting by bicycle instead of by car, the university could save an estimated $59 million by deferring the construction of 3000 additional parking garage spaces planned to meet projected university needs, as stated in the latest revision of the campus master plan (University Planning, Design & Construction 2009).

A few related points are worth making before closing. First, it appears the potential positive economic impact of providing more bike infrastructure could be quite large. As it stands now, the average nationwide rate of bike commuting is roughly 1% of the population, or 3,000,000 people. If another 1% could be added to that total, and each saved just $2000 per year from doing so, it could divert as much as $6,000,000,000 from going to just a few national industries, and instead flow to business with more beneficial impact on local economies.[6]

Finally, our estimates of savings do not reflect savings and other benefits obtained through improved air quality, reduced health care costs, added employment, and pollution control costs (i.e. higher prices for gasoline), among others. More research focused on determining comprehensive cost savings and quality of life benefits that may result from bike infrastructure investments should be conducted.

Conclusion

The local economic benefits are significant in shifting car-centred transportation towards a more bike-friendly culture in urban neighbourhoods. Fewer cars and more bikes and bike-oriented infrastructure could translate into higher property values, more jobs, decreased traffic congestion, and ultimately more money in the consumer's pocket. To determine the potential size of these impacts, we conducted a study of an urban university community. Our survey, with over 2000 respondents who either work at or attend the University of Louisville, revealed some surprising results. Approximately one-fourth of those sampled reported they would start biking to campus if more bike infrastructure – bike lanes, signage, and secure parking facilities – were provided. Survey respondents also noted that they would be more likely to bike to campus if bike safety courses, bike shop vouchers, secure bike parking, and bike repair shops were also made available.

Another one-fourth of the respondents said that they would switch their transportation mode of choice from a car to a bike, and another one-fourth of the respondents said that they would move closer to the university if the cost of gas were to exceed $5 per gallon. Consequently, we estimate that the Old Louisville neighbourhood could see an infusion of up to $26 million in new community spending simply through a reduction in car dependency. This spending – on housing repairs, on the installation of community gardens, and in locally operated grocery stores and restaurants – an expected result of the cost savings created by the reduction or discontinuance of car-based commuting, represents the potential green dividend of investments in urban bicycling.

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Notes

1. Arnott and Small (1994) estimate that for the 39 metropolitan areas in the U.S. having a population over one million, nearly 33 percent of all auto travel is in congested conditions, during which the average speed is one-half of its free-flow value. Arnott and Small (1994) also report that about half of the congested driving takes place on expressways, causing delays of six-tenths of a minute per kilometre. The congestion on arterials causes about 1.2 minutes per kilometre in delays (Arnott and Small 1994).
2. For the typical American household, transportation expenses are second only to housing expenses, but in some cases transportation expenses can be higher than housing expenses. In a study of 28 metropolitan areas, it was reported that residents pay one percent more in transportation expenses than they do in housing expenses (Bernstein *et al*. 2005). According to a study completed by the Surface Transportation Policy Project (Bernstein and Mooney Bullock 2000), a nationwide coalition for safer communities and smarter transportation choices, the average American household devotes 18 cents of every dollar earned to transportation. Furthermore, the report finds that 98 percent of that spending is designated for the purchase, operation, and maintenance of automobiles.
3. Lovins and Cohen (2011) claim that if a family relocates from a suburban neighbourhood that requires them to maintain only one vehicle while having access to other transportation alternatives, the family's annual housing costs could increase by $5000. The family's transportation costs, however, will be cut by an estimated $12,000 per year (Lovins and Cohen 2011). These redistributions of expenses represent a net decrease in the cost of living by 18.3 percent (Lovins and Cohen 2011). Should a family requiring two cars and 25,000 miles driven per vehicle of annual travel reduce to one car, that family could reduce living costs by 9.4 percent (Lovins and Cohen 2011). These figures shed light on the potential cost savings of reducing motor vehicle travel and dependence, but do not accurately reflect the cost savings of substituting automobile travel for bike travel alone, as the calculations include allowances for heavy public transit use.
4. According to a study by the United States Department of Energy (2010), from 1969 to 2009, the USA experienced a 16 percent decrease in the number of persons per household and a 66 percent increase in the number of vehicles per household. According to the 2001 National Household Travel Survey conducted by the U.S. Department of Transportation Bureau of Statistics (2003), 71 percent of all Americans commute more than six miles to work one way each day, with 33 percent of Americans commuting more than 15 miles to work one way each day. Pucher and Dijkstra (2003) cite that 49 percent of all trips made by Americans in metropolitan areas are shorter than three miles, 40 percent are shorter than two miles, and 28 percent are shorter than one mile. More than 14 percent of commuters travel each day from the suburbs to the city (U.S. Department of Transportation 2003).
5. BLS notes that shelter includes mortgages, taxes, insurance, rent, and maintenance.
6. Another indication of the positive community economic development impact of biking is to count the number of businesses added when a "friendly bike infrastructure" of bike lanes, signage, education, bike parking, and conversion of fast multi-lane one-way streets to calmer two-way streets occur in a neighbourhood. This was done in the Old Louisville neighbourhood, which is adjacent to the University of Louisville. First, we found that a local "green developer" responded by building a 255-unit mixed-use development of new and renovated housing adjacent to the university community. This development houses 13 businesses, 10 of which are locally owned. Additionally, several blocks away on a recently converted two-way street with a well-designed bike lane, several other businesses (including a coffee house, 24-hour diner, and a grocery store) were added or expanded. All this new business equates to 150 jobs created by the existence and operation of the 34,650 square feet of commercial space in the new mixed-use development and 27 jobs in the nearby businesses (Gilderbloom, 2008; see also Clinch 2011).

References

Adamowicz, W., Louviere, J., and Williams, M., 1994. Combining revealed and stated preference methods for valuing environmental amenities. *Journal of Environmental Economics and Management*, 26 (3), 271–292.

Akar, G., Clifton, K.J., and Doberty, S.T., 2011. Discretionary activity location choice: in-home or out-of-home? *Transportation*, 38 (1), 101–122.
Akar, G., Clifton, K.J., and Doberty, S.T., 2012. Redefining activity types: who participates in which leisure activity? *Transportation Research Part A*, 46 (8), 1194–1204.
American Automobile Association (AAA), 2013. *2013 your driving costs* [online]. Available from: http://www.aaaexchange.com/main/Default.asp?CategoryID=16&SubCategoryID=76&ContentID=353 [Accessed 10 January 2014].
Applebaum, R., 1978. *Size, growth and US cities*. New York: Preager Press.
Arnott, R. and Small, K., 1994. The economics of traffic congestion. *American Scientist*, 82, 445–455.
Babbie, E., 1990. *Survey research methods*. Belmont, CA: Wadsworth.
Babbie, E., 2013. *The basics of social research*. Belmont, CA: Wadsworth.
Bartholomew, J. and Ewing, R., 2011. Hedonic price effects of pedestrian and transit-oriented development. *Journal of Planning Literature*, 26 (1), 18–34.
Bernstein, S. and Mooney Bullock, R., 2000. *Driven to debt*. Washington, DC: The Surface Transportation Policy Partnership.
Bernstein, S., Makarewicz, C., and McCarty, K., 2005, June. *Driven to spend: pumping dollars out of our households and communities* [online]. Washington, DC: The Surface Transportation Policy Partnership. Available from: http://www.transact.org/library/reports_pdfs/driven_to_spend/Driven_to_Spend_Report.pdf.
Birk, M., 2010. *Joyride: pedaling toward a healthier planet*. Portland, OR: Cadence Press.
Boarnet, M. and Sarmiento, S., 1998, June. Can land use policy really affect travel behavior? A study of the link between non-work travel and land use characteristics. *Urban Studies*, 35, 1155–1169.
Broken Sidewalk, 2015. *League of American cyclists ranks Kentucky 49th in new bike-friendly state rankings* [online]. Available from: http://www.borkensidewalk.com [Accessed 12 May 2015].
Burden, D., 2001, January. *Building communities with transportation* [online]. Washington, DC: The Transportation Research Board. Available from: http://www.walkable.org/assets/downloads/trbpaper.pdf.
Bureau of Labor Statistics (BLS), (2009). *Consumer expenditure survey expenditure tables* [online]. Available from: http://www.bls.gov/cex/csxstnd.htm [Accessed 10 January 2014].
Byrne, D., 2010. *Bicycle diaries*. New York: Penguin.
Change, H.L. and Chang, H.W., 2005. Comparison between the differences of recreational cyclists in national scenic bikeway and local bike lane. *Journal of the Eastern Asia Society of Transportation Studies*, 6, 2178–2193.
Clifton, K.J., Morrissey, S., and Ritter, C., 2012a, May–June. Business cycles: catering to the bicycling market. *TR (Transportation Research) News*, (280), 26–32.
Clifton, K.J., Morrissey, S., and Ritter, C., 2012b. Mode choice and consumer spending: an examination of grocery store trips. Presented at *91st Annual meeting of the Transportation Research Board*, Washington, DC.
Clifton, K.J., *et al.*, 2012c. *Consumer behavior and travel mode choices*. Portland: Oregon Transportation Research and Education Consortium.
Clinch, R., 2011. *The economic and workforce development impacts of the Cardinal Towne Project*. Prepared for 3rd Street Development, LLC.
Colorado Department of Transportation, 2000. *The economic impact of bicycling in Colorado*. Denver: The Colorado Department of Transportation.
Cortright, J., 2009. *Walking the talk: how walkability raises homes values in U.S. cities*. Washington, DC: CEO's for Cities.
Deakin, E., *et al.*, 2004. Parking management and downtown land development in Berkeley, California. *Transportation Research Record: Journal of the Transportation Research Board*, 1898 (1), 124–129.
DeCorla-Souza, P. and Jensen-Fisher, R., 1997. Comparing multimodal alternatives in major travel corridors. Transportation Research Record (No. 1429), 15–23.
Dill, J. and Carr, T., 2003. Bicycle and pedestrian level-of-service performance measures and standards for congestion management systems. *Transportation Research Record (TRB)* [online] (1538), 1–19. Available from: www.trb.org.
DiMaggio, P. and Louch, H., 1998. Socially embedded consumer transactions: for what kinds of purchases do people most often use networks? *American Sociological Review*, 63 (5), 619–637.

Douma, F. and Cleveland, F., 2008. *The impact of bicycling facilities on commute mode share* [online]. Minneapolis, MN: The Hubert H. Humphrey Institute of Public Affairs at the University of Minnesota. Available from: www.hhh.umn.edu/center/slp/pdf/bicycling_facilities.pdf.

Downs, A., 1962, July. The law of peak-hour expressway congestion. *Traffic Quarterly*, 16, 393–409.

Duany, A., Plater-Zyberk, E., and Speck, J., 2001. *Suburban nation: the rise of sprawl and the decline of the American dream*. New York: North Point Press.

Engel, R.J. and Schutt, R.K., 2012. *The practice of research in social work*. London: Sage.

Federal Highway Administration, 2005. *Crash cost estimates by maximum police-reported injury severity within selected crash geometries* [online]. Available from: http://www.fhwa.dot.gov/publications/research/safety/05051/.

Federal Highway Administration and the United States Department of Transportation, 2003. *Licensed drivers and vehicle registrations* [online]. Available from: http://www.fhwa.dot.gov/.

Geller, R., 2013. *What does the Oregon household activity survey tell us about the path ahead for active transportation in the city of Portland?* Salem, OR: Department of Transportation, white paper.

Gilderbloom, J.I., 2008. *Invisible city: poverty, housing, and new urbanism*. Austin: University of Texas Press.

Gilderbloom, J.I. and Appelbaum, R.P., 1988. *Rethinking rental housing*. Philadelphia: Temple University Press.

Gilderbloom, J. I., Meares, W. L., and Riggs, W., (2014). How brownfield sites kill places and people: an examination of neighborhood housing values, foreclosures, and lifespan. *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*. doi:10.1080/17549175.2014.905488

Goetzke, F. and Rave, T., 2010, June. Bicycle use in Germany: explaining differences between municipalities with social network effects. *Urban Studies* [online]. Available from: http://usj.sagepub.com/content/early2010/06/03/0042098009360681.

Governor's Bicycle Coordinating Council, 2006. *The economic of bicycling in Wisconsin*. Madison, WI: Governor's Bicycle Coordinating Council.

Handy, S., 2011. The Davis Bicycle Studies: Why do I bicycle but my neighbor doesn t? *Access*, 39 (Fall), 16–21.

Hanley, N., Wright, R.E., and Adamowicz, V., 1998. Using choice experiments to value the environment. *Environmental and Resource Economics*, 11 (3–4), 413–428.

Hartgen, D. and Fields, G., 2009. *Gridlock and growth: the effect of traffic congestion on regional economic performance*. Reason Foundation Study No. 371 Summary. Available from: www.reason.org.

Heying, C.H., 2010. *Brew to Bikes: Portland's Artisan Economy*. Portland: Ooligan Press.

Kenworthy, J. and Laube, F., 1999, September–November. Patterns of automobile dependence in cities: an international overview of key physical and economic dimensions with some implications for urban policy. *Transportation Research Part A: Policy and Practice*, 33 (7–8), 691–723.

Local Government Commission's Center for Livable Communities, 2000. *The economic benefits of walkable communities* [online]. Available from: http://www.lgc.org/freepub/docs/community_design/focus/walk_to_money.pdf.

Lovins, H.L. and Cohen, B., 2011. *Climate capitalism: capitalism in the age of climate change*. New York: Hill and Wang.

Maine Department of Transportation, 2001. *Bicycle tourism in Maine: economic impacts and marketing recommendations*. Augusta: Maine Department of Transportation.

Mapes, J., 2009. *Pedaling revolution: how cyclists are changing American cities*. Corvallis: Oregon State University Press.

McAnn, B., 2000, March 19. *Driven to spend: the impact of sprawl on household transportation expenses* [online]. Washington, DC: The Surface Transportation Policy Partnership. Available from: http://www.transact.org/progress/jan01/driven.asp.

McKenzie, B., 2014, May. *Modes less traveled: bicycling and walking to work in the United States 2008–2012* [online]. American Community Survey Reports. Washington, DC: U.S. Census Bureau. Available from: http://www.census.gov/prod/2014pubs/acs-25.pdf.

McMahon, E.T., 2012. *Bicycles belong: a growing American way* [online]. Available from: http://citiwire.net/columns/bicycles-belong-a-growing-american-way/.

Partnership for a Green City, 2009. *Climate action report* [online]. Available from: http://www.jefferson.k12.ky.us/Departments/EnvironmentalEd/GreenCity/ClimateActionRpt.pdf.

Portland Plan Partners, 2012. *The Portland plan: prosperous, educated, health and equitable*. Portland, OR: City of Portland.
Pucher, J. and Buehler, R., 2007. Cycling for everyone: lessons from Europe. *Transport Research Record* (2074), 58–65.
Pucher, J. and Buehler, R., 2008, July. Making cycling irresistible: lessons from the Netherlands, Denmark and Germany. *Transport Reviews* [online], 28 (4), 495–528. Available from: http://www.vtpi.org/irresistible.pdf.
Pucher, J. and Buehler, R., 2012. *City cycling*. Cambridge: MIT Press.
Pucher, J. and Dijkstra, L., 2003. Promoting safe walking and cycling to improve public health: lessons from the Netherlands and Germany. *American Journal of Public Health*, 93, 1509–1516.
Pucher, J., Buehler, R., and Seinen, M., 2011. Bicycling renaissance in North America? An update and re-appraisal of cycling trends and policies. *Transportation Research A*, 45 (6), 451–475.
Rietveld, P. and Daniel, V., 2004. Determinants of bicycle use: do municipal policies matter? *Transportation Research A*, 38 (7), 531–550.
Riggs, W., 2013. Reflections on campus planning: lessons for professional practice. *Focus: Journal of the City and Regional Planning Department*, 10 (1), 136–140.
Riggs, W., 2014. Dealing with parking issues on an urban campus: the case of UC Berkeley. *Case Studies on Transport Policy*, 2 (3), 168–176.
Riggs, W. and Gilderbloom, J., 2015. Two-way street conversion: evidence of increased livability in Louisville. *Journal of Education Planning and Research*, 1–14. doi:10.1177/0739456X15593147.
Schrank, D., Lomax, T., and Eisele, B., 2011. *Texas Transportation Institute's 2011 urban mobility report* [online]. The Texas Transportation Institute, the Texas A&M University System. Available from: http://mobility.tamu.edu/ums/report/.
Schutt, R., 2010. *Investigating the social world*. 6th ed. Thousand Oaks, CA: Pine Forge Press.
Sermons, M. and Seredich, N., 2001, November. Assessing traveler responsiveness to land and location based accessibility and mobility solutions. *Transportation Research Part D: Transport and Environment*, 6 (6), 417–428.
Shoup, D.C., 2005. *Parking on a smart campus: lessons for universities and cities*. University of California Transportation Center, UC Berkeley.
Topp, H., 2008. Can meetbike replace the car? *World Transportation Policy & Practice* [online], 14 (3), 24–31. Available from: www.eco-logica.co.uk.pdf/wtpp14.3.pdf.
Tudela-Rivadeneyra, A., *et al*., 2015. The cost versus price for parking spaces at major employment centers: findings from UC Berkeley. In *Transportation Research Board 94th annual meeting* (No. 15–3640), Washington, DC.
United States Census Bureau, 2008. American community survey [online]. Available from: American Community Survey online: http://www.census.gov/acs/www/.
United States Census Bureau, 2010. *American community survey* [online]. Available from: American Community Survey Online: http://www.census.gov/acs/www/.
United States Department of Energy, 2010. *Vehicle technologies program, fact #618* [online]. Available from: http://www1.eere.energy.gov/vehiclesandfuels/facts/2010_fotw618.html.
United States Department of Transportation, 2003. *Highlights of the 2001 National Household Travel Survey*. Bureau of Travel Statistics [online]. Available from: http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/highlights_of_the_2001_national_household_travel_survey/pdf/entire.pdf [Accessed 10 January 2014].
United States Department of Transportation, 2009. *Table 1–11: number of U.S. aircraft, vehicles, vessels, and other conveyances* [online]. Available from: http://www.bts.gov/publications/national_transportation_statistics/html/table_01_11.html.
University Planning, Design & Construction, 2009. *Campus master plan* [online]. University of Louisville. Available from: https://louisville.edu/updc/masterplan.
Walkinginfo.org, 2011. *Bicycle lanes* [online]. Available from: http://www.walkinginfo.org/engineering/roadway-bicycle.cfm.
Weigand, L., 2008, June. *A review of literature: the economic benefits of bicycling*. Portland, OR: Center for Transportation Studies, Portland State University, Publication No. CUS-CTS-08–03.
Wray, J.H., 2008. *Pedal power: the quiet rise of the bicycle in American public life*. Boulder, CO: Paradigm.