Business and Bikeshare User Perceptions of the Economic Benefits of Capital Bikeshare

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ABSTRACT

This study investigates potential economic benefits of bikesharing in commercial areas immediately adjacent to bikeshare docking stations. Using a sample of five Capital Bikeshare (CaBi) stations in Washington, DC, we conducted an intercept survey of 333 bikeshare users at five CaBi stations at commercial activity centers and a door-to-door survey of 140 local businesses within 0.1 miles of those five CaBi stations.

We found that many CaBi riders are motivated to use the system due to travel time (73% of users) and cost (25% of users) savings. In addition, 16% of riders report making new/induced trips because of Capital Bikeshare. Meanwhile, 23% of users reported spending more money because they used bikeshare. Income level was positively associated with new trips, spending levels, and spending during new trips. Joining CaBi to save money had a significant positive association with new trips.

The business survey showed that 20% of the businesses in our sample report a positive impact of bikesharing on sales, and 70% identify a positive impact on the area. In addition, 61% would have either a positive or neutral reaction to replacing car parking in front of their business with a bikeshare station. Businesses that perceive a positive impact on sales from the bikeshare system are more likely to support the expansion of the system and the replacement of car parking with bikeshare stations. Overall, our findings from five CaBi stations in commercial business areas suggest bikesharing may generate benefits among both users and businesses.

INTRODUCTION

Bikesharing, a rapidly growing and flexible form of transportation, offers a wide range of benefits. These include reduced pollution and congestion, increased physical activity and access to transit, and improved transportation system efficiency and neighborhood accessibility [1-4]. However, the repurposing of limited public space for bikeshare docking stations has been met with some resistance, and concerns have been raised regarding the impact of bikeshare systems on local businesses [5, 6]. While supporters contend that bikesharing attracts new customers, opponents argue that the systems actually deter customers and are a waste of valuable public space [7].

The purpose of this study is to investigate the economic benefits of bikesharing, with a particular focus on commercial areas adjacent to bikeshare docking stations. First, we present an overview of research on the economic effects of cycling. Then we describe our empirical method for studying the economic effects surrounding five Capital Bikeshare ("CaBi") stations in Washington, DC, which entailed both a user intercept survey and a door-to-door survey of local businesses. Finally, we present our empirical analysis and results, and conclude with a discussion of our findings.

LITERATURE REVIEW

Interest in the economic effects of cycling is growing. A number of recent studies have investigated: 1) the relationship between mode choice and spending patterns; 2) the relationship between cycling infrastructure and spending; 3) whether bikesharing generates new travel and spending; and 4) business perceptions regarding bikesharing systems and cycling in general. This is an emerging area of research with only a few peer-reviewed publications. Table 1 presents an overview of both domestic and international sources and includes two peer-reviewed articles, four peer-reviewed conference papers, three reports for municipalities and one for a national government transportation agency, seven graduate student research papers, twelve reports for interest groups, two reports for CaBi, and a grant application. The studies originate from geographic areas with a range of cycling levels, including relatively high and relatively low cycling mode share. This may affect the transferability of any given study's findings. Nevertheless, across diverse geographic areas, a number of consistent key findings emerge from the literature.

First, a number of studies suggest cyclists spend less per trip than drivers, but shop more frequently, and therefore spend at levels comparable to or higher than customers arriving by car [7-20]. For example, Clifton et al [12] analyzed consumer spending and mode choice using intercept surveys at local businesses in the Portland, Oregon region. Overall, they found that non-driving customers spent amounts similar to or greater than customers arriving by automobile. Moreover, non-driving customers tended to visit spending locations more frequently. Stzabinski [18] and Forkes & Smith Lea [20] found similar results for sections of Toronto's Bloor Street. Using surveys of businesses and pedestrians, they found that non-drivers were likely to spend more per month than drivers.

Second, a number of recent studies suggest that cycling infrastructure, traffic calming, and investments in walking environments are effective at attracting customers [7, 18-26]. For example, CaBi collected information through surveys of its members [22, 23] on the relationship between the bikeshare system and patronage of local businesses and found that roughly 85% of users reported being "somewhat" or "much more" likely to patronize a business accessible by bikeshare. In addition, a study for the City of Austin, TX, estimated that the Downtown Bicycle Boulevard was likely to have a "very positive" impact on retail sales [21].

Third, there is evidence that bikesharing may generate new travel and spending [22, 23, 27]. For example, Schoner et al [27] analyzed the economic activity associated with bikeshare stations in the Twin Cities's, MN, Nice Ride system using trip data, a survey of local businesses, and a survey of system subscribers. They observed that bikeshare users often travel to spending destinations and estimated that up to about 13% of trips would not have occurred without the bikesharing system. In addition, Capital Bikeshare found that 9%-25% of users made induced (new) shopping trips over the course of a month in the Washington, DC region [22, 23].

Fourth, the literature suggests that businesses tend to have positive perceptions of bikesharing systems and cycling in general, mixed perceptions regarding direct impacts on sales, mixed levels of support for reallocating space to bikesharing or other cycling facilities, and a tendency to overestimate the share of customers arriving by car vs. other modes [11, 15, 16, 18, 19, 27-35]. For example, LoSapio [30] conducted an analysis of the impact of Capital Bikeshare in the Dupont Circle neighborhood of Washington, DC, and found that 11% of businesses observed an increase in daily traffic and 13% perceived a positive impact on sales due to CaBi. In contrast, a study for the City of Vancouver indicated that some businesses attributed losses in sales and profits to newly installed bicycle lanes; nevertheless, review of a sample of sales data suggested losses were not as high as reported by businesses during the initial survey [33]. Schoner et al [27] found that 17% of businesses would support replacing car parking with bikeshare stations and 8% would support using sidewalk space for bikeshare stations. Despite their general support for the Nice Ride program, the majority of businesses surveyed were not supportive of reallocating space in favor of bikeshare. This may relate to the tendency to overestimate the share of customers arriving by car observed in a number of locations [16, 34, 35].

Together, these studies suggest that cycling and bikesharing are associated with consumer spending and some induced travel. In addition, the literature suggests that cycling facilities can attract customers to nearby businesses. Further, businesses are generally supportive of bikeshare systems but have mixed perceptions about direct sales impacts and mixed degrees of support for the reallocation of space for cycling infrastructure. Building on this growing body of research, this present study makes a unique contribution by surveying bikeshare users at stations as well as businesses located adjacent to the same stations. To date, none of the existing literature has analyzed the impacts of a bikeshare system from both the user and business perspective.

156 **TABLE 1 Overview of Literature on Economics and Cycling**

Author(s)	Year	Title	Publication Type	Methods, Data Source, Location	Key Findings
Alliance for Biking & Walking [8]	2014	*Bicycling and Walking in the United States: 2014 Benchmarking Report*	Report for the Alliance for Biking and Walking	Review of local sources, reports, and peer-reviewed articles	Summarizes findings of increased spending relating to cyclists and pedestrians in New York, NY, Fort Worth, TX, Twin Cities, MN, Portland, OR, San Francisco, CA, and Austin, TX
Angelou Economics [21]	2010	*Literature Review and Impact of the Bicycle Boulevard*	Report for the City of Austin, TX	Economic impact analysis of bicycle lanes and boulevards in Austin, TX using IMPLAN modeling, and data from the Texas Comptroller's Office and City of Austin	Austin Downtown Bicycle Boulevard estimated to have a 'very positive' impact on property values, retail sales, and quality of life ($96,000-$274,000 additional annual sales revenue due to bicycle traffic by 2020)
Bent, E. and K. Singa [9]	2009	*Modal Choices and Spending Patterns of Travelers to Downtown San Francisco, California: Impacts of Congestion Pricing on Retail Trade*	Peer-Reviewed Article (Transportation Research Record)	Intercept surveys of a random sample of travelers over 16 years of age in San Francisco, CA on weekday afternoons & evenings in downtown retail areas (1,390 responses in downtown sample)	Transit riders, pedestrians, and cyclists spent less per trip than drivers, but visited downtown stores more frequently; Pedestrians spent the most per month of any modal group
Bernier-Heroux, L. and J. Ryan [10]	2012	*East Village Shoppers Study: A Snapshot of Travel and Spending Patterns of Residents and Visitors in the East Village*	Report for Transportation Alternatives	Intercept surveys of a random sample of pedestrians on First and Second Avenues in East Village neighborhood of New York, NY (420 responses)	Pedestrians and cyclists visit the neighborhood more often than drivers and transit riders, and spend more on a weekly basis; Drivers account for less than 4% of retail spending in the neighborhood
Buis, J. and R. Wittink [11]	2000	*The Economic Significance of Cycling: A Study to Illustrate the Costs and Benefits of Cycling Policy*	Report for Vereniging van Nederlandse Gemeenten (Association of Dutch Municipalities)	Review of local sources, reports, and peer-reviewed articles	Cyclists shop more frequently than drivers, and spend amounts comparable to motorists (over time)

Author(s)	Year	Title	Publication Type	Methods, Data Source, Location	Key Findings
Capital Bikeshare [22]	2011	*2011 Capital Bikeshare Member Survey Report*	Report for Capital Bikeshare	Online survey of Capital Bikeshare members in the Washington DC region (3,731 responses from sample of 11,100 members representing half the total approximately 22,200 members, for a response rate of 34%)	83% of users reported being "somewhat" or "much more" likely to patronize a business if it were accessible by bikeshare; 44% of users made induced trips in prior month, including 25% who made induced shopping trips
Capital Bikeshare [23]	2013	*2013 Capital Bikeshare Member Survey Report*	Report for Capital Bikeshare	Online survey of Capital Bikeshare members in the Washington DC region (5,464 responses out of approximately 18,000 members for a response rate of 31%)	85% of users reported being "somewhat" or "much more" likely to patronize a business if it were accessible by bikeshare; 40% of users made induced trips in prior month, including 9% who made induced shopping trips
Clifton, K., K. Currans, C. Muhs, C. Ritter, S. Morrissey, and C. Roughton [12]	2012	*Consumer Behavior and Travel Choices: A Focus on Cyclists and Pedestrians*	Conference Paper (Transportation Research Board 92nd Annual Meeting)	Intercept surveys in Portland, OR at 78 businesses (restaurants, convenience stores, and drinking establishments) on weekday evenings (1,884 total responses, 52% combined response rate for 'short' and 'long' surveys)	Pedestrians, cyclists, and transit riders visit spending locations more frequently, and spent amounts similar to or greater than drivers
Clifton, K., S. Morrissey, and C. Ritter [36]	2012	*Business Cycles: Catering to the Bicycling Market*	Peer-Reviewed Article (TR News 280)	Review of local sources, reports, and peer-reviewed articles	Summarizes findings of lower or equal spending per trip but higher trip frequency of cyclists in Portland, OR, San Luis Obispo, CA, as well as Muenster in Germany and Utrecht and Amsterdam in The Netherlands

Author(s)	Year	Title	Publication Type	Methods, Data Source, Location	Key Findings
Drennen, E. [28]	2003	*Economic Effects of Traffic Calming on Urban Small Businesses*	Graduate Student Report (San Francisco State University)	Interviews in San Francisco, CA with merchants in the service, food, and retail sectors via a modified random sampling about the Valencia Street bicycle lanes (27 businesses interviewed out of a total of 122 in the study area for a response rate of 22%)	65% of businesses perceive the general impact on business and sales of the bicycle lanes has been positive; 65% perceive no impact on the availability of customer parking and 15% perceive a positive impact on its availability; 44% perceive a positive impact for economic revitalization; 37% perceive a positive impact on sales with no businesses perceiving a negative impact
Fiets Beraad [14]	2011	*Cyclists Spend as Much in Supermarket as Motorists*	Report for Fiets Beraad	Review of local research project involving interviews of shoppers at 4 suburban supermarkets in The Netherlands	Cyclists visit the supermarket 3.2 times per week and spend about 50 euros per trip, while drivers visit 2.5 times per week and spend more than 50 euros per trip; the weekly share of customer turnover is approximately 48% cyclists and 52% drivers
Fleming, T., S. Turner, and L. Tarjomi [15]	2013	*Reallocation of Road Space*	Report for the New Zealand Transport Agency	Survey of retailers (in-person and mail) and shoppers (offered to customers by businesses after completion of a sale) in 3 central city locations and 6 arterial shopping areas in New Zealand (144 retailer surveys out of 547 total shops for a response rate of 26%, 1744 shopper responses)	Transit riders, pedestrians, and cyclists spend less per trip than drivers but shop more frequently; Cyclists spend only $4 less per trip than drivers in central city locations

Author(s)	Year	Title	Publication Type	Methods, Data Source, Location	Key Findings
Flusche, D. [7]	2013	*Bicycling Means Business: The Economic Benefits of Bicycle Infrastructure*	Report for Advocacy Advance	Review of local sources, reports, and peer-reviewed articles	Summarizes findings relating to cycling and economic impacts, including spending and customer levels, in Chicago, IL, Hattiesburg, MN, Long Beach, CA, Memphis, TN, Portland, OR, Washington, DC, and other locations
Forkes, J. and N. Smith Lea [20]	2010	*Bike Lanes, On-Street Parking and Business - Year 2 Report: A Study of Bloor Street in Toronto's Bloor West Village*	Report for The Clean Air Partnership	In-person surveys of businesses and pedestrians in Toronto, ON on Bloor St between Kennedy Ave and Jane St (96 businesses out of 158 in the study area for a response rate of 61%, 510 pedestrian responses)	Customers who usually do not drive to the neighborhood are significantly more likely to spend over $100 per month than customers who usually drive
Lee, A. [29]	2008	*What is the Economic Contribution of Cyclists Compared to Car Drivers in Inner Suburban Melbourne's Shopping Strips?*	Graduate Student Report (University of Melbourne)	Intercept surveys of visitors in Melbourne, AUS near the Lygon Court Shopping Centre about spending and travel patterns (1020 responses); Public space mapping	Cyclists spend less per trip than drivers and have shorter trip durations; Authors speculate that cyclists visit study area more frequently; 67% of public space in the study area is allocated to cars, versus 3% for cyclists
Losapio, R. [30]	2013	*Is Capital BikeShare Good for Business: Initial Evidence from the Dupont Circle Area in Washington, D.C.*	Graduate Student Report (Virginia Tech)	In-person surveys in Washington, DC at 121 businesses (retail, entertainment, and restaurant) within 0.25 miles of a Dupont Circle bikeshare station (92% response rate from random sample of 131 businesses out of 602 businesses in study area)	11% of businesses observed an increase in daily traffic related to Capital Bikeshare; 13% of businesses perceived a positive impact on sales; 39.0% of businesses considered their location positive in relation to Capital Bikeshare

Author(s)	Year	Title	Publication Type	Methods, Data Source, Location	Key Findings
McCormick, C. [31]	2012	*York Blvd: The Economics of a Road Diet*	Graduate Student Report (UCLA)	Merchant (in-person) and customer (intercept) surveys in Los Angeles, CA on York Blvd between Eagle Rock Blvd and Figueroa St on two sections (section with road diet and section without road diet) (100 businesses out of 250 in study area for total response rate of 40%, and 25 customer responses from each road section for a total of 50 responses)	Most merchants and customers in both road sections perceive neutral or positive impacts of road diet; Merchants assume more customers drive than is reflected in customer surveys
Meisel, D. [24]	2010	*Bike Corrals: Local Business Impacts, Benefits, and Attitudes*	Graduate Student Report (Portland State University)	Online survey in Portland, OR to businesses within 0.5 blocks of a bike corral (43 responses out of 132 businesses surveyed and 248 total businesses in study area for a survey response rate of 33%)	Support for bike corrals was widespread; On average 24.8% of customers were perceived to be cyclists; Demand for bike parking appears to be increasing
Metropolitan Washington Council of Governments [37]	2010	*A Regional Bike-sharing System for the National Capital Region*	Grant Application (USDOT TIGER II)	Review of local conditions and information sources	Cycling investments make "good economic sense as a cost effective way to enhance shopping districts and communities, generate tourism and support business."
New York City Department of Transportation [25]	2012	*Measuring the Street: New Metrics for 21st Century Street*	Report for the New York City Department of Transportation	Review of a cross-section of recent street design projects in New York, NY to achieve 3 goals (design for safety, all users, and great public spaces)	49% fewer commercial vacancies in Union Square North, compared to 5% more borough-wide; 172% increase in retail sales in Pearl Street area, compared to 18% borough-wide;

Author(s)	Year	Title	Publication Type	Methods, Data Source, Location	Key Findings
					71% increase in retail sales on Fordham Road, compared to 23% borough-wide
O'Connor, D., J. Nix, S. Bradshaw, and E. Shiel [16]	2011	*Report on Shopper Travel Behaviour in Dublin City Centre*	Conference Paper (Irish Transport Research Network 2011 Proceedings)	Intercept survey of pedestrians in Dublin, IRE on Grafton and Henry Streets in the Dublin City Centre (1,009 total responses); In-person survey of store managers (60 total from the study area)	Pedestrians and cyclists spend lower amounts per trip but visit the area more often than drivers; Businesses over-estimate the share of customers arriving by car
Popovich, N. and S. Handy [17]	2014	*Bicyclists as Consumers: Mode Choice and Spending Behavior in Downtown Davis, CA*	Conference Paper (Transportation Research Board 93rd Annual Meeting)	Online surveys in Davis, CA, in 2009 and 2010, of residents regarding spending behavior (total of 2,043 responses for a response rate of 20.4%; subset of 1,677 responses used in the analysis)	Cyclists spent lower amounts per trip but shopped more frequently than drivers, leading to comparable spending across the two groups
Rowe, K. [38]	2013	*Bikenomics: Measuring the Economic Impact of Bicycle Facilities on Neighborhood Business Districts*	Graduate Student Report (University of Washington)	Analysis of retail sales data based on case studies in Seattle, WA of Greenwood Ave North and NE 65th Street Neighborhood Business Districts after installation of bicycle facilities	Bicycle facilities and loss of automobile travel lanes and car parking did not result in negative impact on retail sales
Schoner, J., R. A. Harrison, and X. Wang [27]	2012	*Sharing to Grow: Economic Activity Associated with Nice Ride Bike Share Stations*	Graduate Student Report (University of Minnesota)	Trip data for all 116 Nice Ride stations in the Twin Cities, MN, as of 2011, and surveys of businesses (in-person) and users (online) (29 businesses out of 68 businesses affiliated with Nice Ride and/or in station areas identified in a spatial sample for a response rate of 43%, 1,197 users out of 3,693 total	Station activity is positively associated with food-related businesses and job accessibility; Businesses have generally positive attitudes toward Nice Ride; Users often travel to spending destinations; Some new trips likely occur due to Nice Ride

Author(s)	Year	Title	Publication Type	Methods, Data Source, Location	Key Findings
				surveyed for a response rate of 32%)	
Sinnett, E., K. Williams, K. Chatterjee, and N. Cavill [32]	2011	*Making the Case for Investment in the Walking Environment: A Review of the Evidence*	Report for Living Streets	Review of local sources, reports, and peer-reviewed articles	Investments in walking environments have significant economic impacts; Economic contributions of pedestrians have been underestimated; Study in Bristol, UK showed businesses underestimated share of shoppers arriving by transit, cycling, and walking
Smart Growth America [26]	2013	*Benefits of Complete Streets: Complete Streets Stimulate the Local Economy*	Report for Smart Growth America	Review of local sources, reports, and articles	Investments in transit, walking, and cycling can stimulate local economies; Summarizes findings from Dallas TX, Cleveland OH, Chicago IL, New York NY, San Francisco CA and others; Cites "green dividend" concept of local spending due to money saved from less driving
Stantec Consulting Ltd [33]	2011	*Vancouver Separated Bike Lane Business Impact Study*	Report for the City of Vancouver, BC and Additional Partners	Stakeholder surveys of businesses regarding economic impacts in bike lane corridors and adjacent comparison corridors in Vancouver, BC (total response rate of 32%); Exit surveys of customers	Businesses attributed losses in sales and profits to bike lanes, but minimal sales data provided by businesses indicated losses were not as high as reported; Most customers did not change their shopping patterns as a result of the bike lanes

Author(s)	Year	Title	Publication Type	Methods, Data Source, Location	Key Findings
Sustrans [34]	2003	*Traffic Restraint and Retail Vitality*	Report for Sustrans	Review of local sources, reports, and peer-reviewed articles	Reference to studies in Graz, Bristol, Leicester, and Edinburgh on tendency for businesses to overestimate share of customers arriving by car and correspondingly support increased car parking
Sustrans [35]	2006	*Shoppers and How They Travel*	Report for Sustrans	Overview of study of business impacts of VIVALDI "showcase" bus routes in Bristol, UK, comprised of interviews with 126 retailers and 840 customers	Retailers overestimated share of customers arriving by car; Retailers attributed losses in business to bus routes, but most customers reported no change in shopping patterns; Investments in the walking environment should be effective at attracting customers
Sztabinski, Fred [18]	2009	*Bike Lanes, On-Street Parking and Business: A Study of Bloor Street in Toronto's Annex Neighborhood*	Report for The Clean Air Partnership	In-person surveys of businesses and pedestrians in Toronto, ON on Bloor St between Spadina Ave and Bathurst St (61 businesses out of 110 in the study area for a response rate of 55%, 538 pedestrian responses)	Customers arriving by walking and cycling shop more frequently and spend more per month than customers arriving by automobile or public transport
Tolley, R. [19]	2011	*Good for Business: The Benefits of Making Streets More Walking and Cycling Friendly*	Discussion Paper (National Heart Foundation of Australia)	Review of local sources, reports, and peer-reviewed articles	Traffic calming and facilities for pedestrians and bicyclists are associated with increased retail spending, higher visitation frequencies, and longer dwell times

Author(s)	Year	Title	Publication Type	Methods, Data Source, Location	Key Findings
Wang, X., G. Lindsey, J. Schoner, and A. Harrison [39]	2012	*Modeling Bike Share Station Activity: The Effects of Nearby Businesses and Jobs on Trips to and from Stations*	Conference Paper (Transportation Research Board 92nd Annual Meeting)	Trip data for all 116 Nice Ride stations in the Twin Cities, MN, as of 2011 (mean annual trips per station of 3,749)	Station activity positively associated with food-related businesses and employment, but not general retail establishments

METHODS

CaBi Station Selection

The data for this analysis of the economic benefits of bikesharing are derived from users and surrounding businesses at Capital Bikeshare stations in five Washington, DC neighborhoods. The CaBi network is extensive, with over 2,500 bicycles at more than 300 stations, and annual membership increased 683% between March 2011 and March 2014, from a total of 6,267 to 42,839 [40]. The system is spread across numerous neighborhoods that feature differences in terms of commercial activity, proximity to transit, socio-demographics, and other factors.

The following criteria guided our sampling of CaBi stations. First, we sought to generate a sample representing different areas of the city. Second, we sought to control for the effect of proximity to MetroRail by including both a station near MetroRail as well as additional stations outside the typical MetroRail walkshed. Third, we sought to focus on areas with many businesses close to bikeshare and many bikeshare drop-offs and pick-ups. Our sample included the following stations (see also Figure 1).

- **Dupont Circle** (Location: Massachusetts Ave & Dupont Circle)
- **Georgetown** (Location: C&O Canal & Wisconsin Ave NW)
- **Logan Circle** (Location: 14th St NW & Rhode Island Ave NW)
- **Adams Morgan** (Location: Adams Mill Rd NW & Columbia Rd NW)
- **H Street** (Location: 13th St NE & H St NE)

The Dupont Circle bikeshare station had the highest level of activity in the entire CaBi system during the 2nd Quarter of 2013, is located next to a MetroRail station, and was studied by LoSapio [30] in her analysis of the economic impacts of bikeshare on businesses. Because of the high volume of bikeshare usage at this station, we anticipated a high yield for survey responses. In addition, the other four stations were chosen from a sub-sample of CaBi stations outside the typical MetroRail walkshed, estimated to be a 10-minute (or 0.5-mile) walk based on the existing street network and a pace of three miles per hour. This walkshed measure fits within relevant estimates that vary from one-fifth to one-half mile [41, 42]. We chose stations outside the typical MetroRail walkshed to control for the presence of MetroRail and its potential effect on local businesses.

The four stations outside the MetroRail walkshed were chosen based on high levels of bikeshare activity and a high number of businesses within 0.1 miles of the station, as well as locations within different Washington, DC neighborhoods. In particular, we identified these stations using trip data for CaBi from the 2nd Quarter of 2013 along with the ReferenceUSA business database and the North American Industrial Classification Codes 44 (Retail Trade), 71 (Arts, Entertainment, and Recreation), and 72 (Accommodation and Food Services). We chose to include stations with high commercial activity, as opposed to those located in residential areas, in order to generate a sample suited to investigating the effects of bikeshare on local businesses at the bikeshare station level.

204 **FIGURE 1 Capital Bikeshare Station Sample in Relation to Streets and MetroRail Stations**
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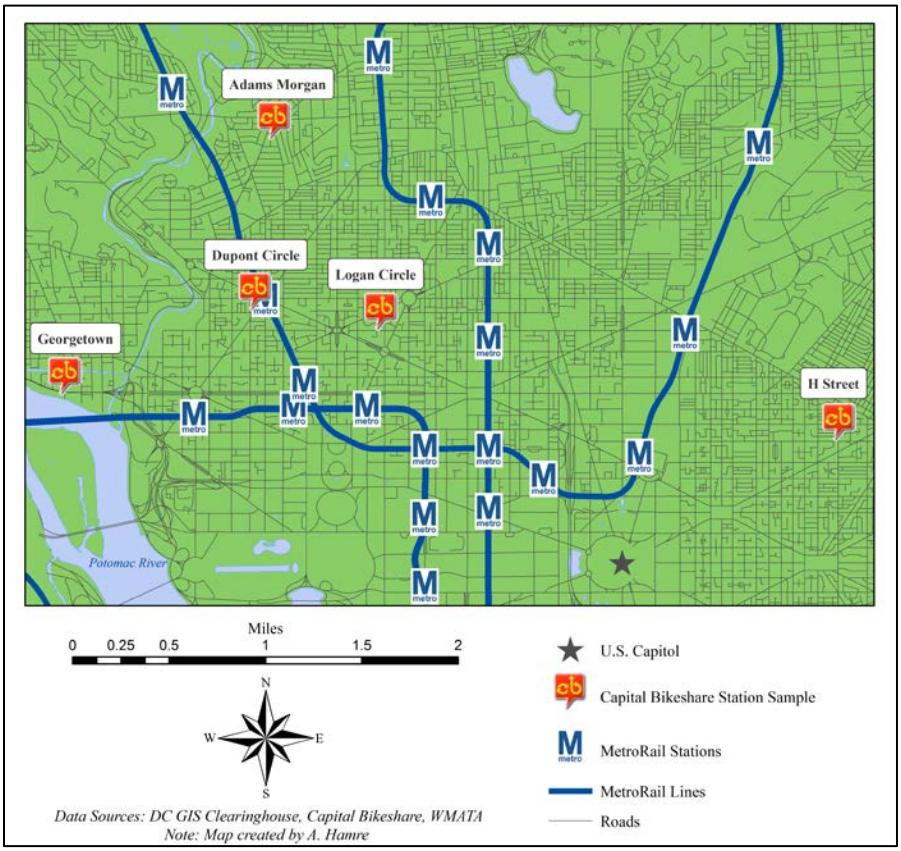

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User and Business Surveys

For the user and business surveys we worked with Virginia Tech graduate students to design the surveys and to collect the data. The user survey investigated motivations for using CaBi and the spending patterns of CaBi users surrounding CaBi stations. The user survey contained a total of 23 questions and relied on the intercept method of approaching users as they returned bikes to stations. The surveys were conducted in 2-4 hour shifts over four weekends (Friday afternoon through Sunday) in October 2013 at the five CaBi stations selected for our analysis. The survey focused on spending after the most recent CaBi trip, but also included questions regarding the frequency of trips to the area and use of the CaBi system. We collected the data on Friday afternoons and weekends, when discretionary trips were more likely and commute trips were less likely. We anticipated a higher participation rate from non-commuters, due to fewer time constraints on discretionary trips. In addition, we expected that surveying on weekends would result in a higher share of CaBi users going to spending destinations.

The business survey contained a total of 22 questions and relied on in-person impromptu (unscheduled) interviews with staff (owners, managers, and other staff) at local businesses. The surveys were conducted over five weeks in October and November 2013 at businesses located within a narrow radius (0.1 miles) of our CaBi station sample. We obtained an initial list of 326 businesses in this radius using the North American Industrial Classification System codes for Retail Trade, Arts, Entertainment, and Recreation, and Accommodation and Food Services [43]. With the survey, we collected information from businesses about their perceptions of the impact of the CaBi system.

We used simple descriptive statistics and appropriate bivariate analysis techniques to investigate the relationships between independent variables and stated or perceived economic impact as reported by users and businesses. Details about the analysis techniques are provided in the sections below.

RESULTS

User Survey

Our user survey yielded a total of 333 responses, with an approximate response rate of at least 50% per station and shift. In comparing the demographic profile of users in our sample to the demographic profile of users in the CaBi Member Survey, we found many similarities [23]. Most users in our sample were young (67% under the age of 35) and male (65%), while nearly all respondents (94%) had earned a bachelor's degree. A small share of our sample (10%) lived in a household with an income less than $35,000, while over 25% reported living in a household with an income above $125,000. Most (66%) of the users in our sample were annual members of CaBi.

Users were motivated to use CaBi due to shorter travel times (73%), enjoyment (42%), exercise (41%), and lower travel costs (25%). In addition, most users (66%) reported traveling to a spending destination (e.g. food-related, retail, or entertainment). Users traveling to spending destinations spent varying amounts, with 65% planning to spend between $10-$49 and 29%

planning to spend over $50. Respondents indicated that spending would occur nearby the CaBi station, with 34% reporting spending would occur within 2 blocks of the station and an additional 45% indicating spending would occur within 4 blocks.

One in six respondents (16%) reported making a new or "induced" trip (i.e. without the CaBi station, they would not have made their trip to the area), while 78% would have made the trip regardless of CaBi, and 6% were unsure of the influence of the CaBi station on their decision to visit the area. Of those respondents who reported making an induced trip, 19% would have stayed home and not traveled to another commercial area. Over one in five (23%) users reported being likely to spend more during the trip because of CaBi (compared to arriving by another mode), while 67% indicated they were likely to spend the same amount or were unsure. Table 2 provides a summary of key results from the user sample.

TABLE 2 Summary of Select 2013 Virginia Tech Capital Bikeshare User Survey Results

User Survey	**%**	**N**
Top reasons for using CaBi		
Travel Time	73%	333
Enjoyment	42%	333
Exercise	41%	333
Travel Costs	25%	333
Share of Users Traveling to Spending Destination	66%	333
Spending Less Than $10	6%	198
Spending $10-$49	65%	198
Spending $50 or More	29%	198
Spending Within 2 Blocks of Station	34%	190
Spending Within 4 Blocks of CaBi Station	45%	190
Spending Greater than 4 Blocks/Did Not Know	22%	190
Share of Users Making New/Induced Trip	16%	326
Share of Users Making a Trip Regardless of CaBi	78%	326
Share of Users Spending More Because of CaBi	23%	260

In addition to the results presented above on the user sample as a whole, we investigated the significance of a series of bivariate relationships between user characteristics and economic effects. In particular, we focused on whether new trips, trips to spending destinations, new trips to spending destinations, or spending levels varied across a series of user characteristics. Table 3 summarizes the dependent and independent variables analyzed, along with their level of measurement and definition.

295 **TABLE 3 Description of Dependent and Independent Variables for User Survey Bivariate**
296 **Analysis**

Variable	Description
New/Induced Trip (Dependent Variable)	Nominal, (New/Induced Trip =1 vs Not a New/Induced Trip=0)
Spending Trip (Dependent Variable)	Nominal, (Spending Trip=1 vs Not a Spending Trip=0)
Spending Level (Dependent Variable)	Ordinal, 3 categories (Less than $10, $10-$49, $50 or More)
New Trip with Spending (Dependent Variable)	Nominal, (New/Induced Trip to Spending Destination=1 vs Not a New Trip to Spending Destination=0)
Annual Member (Independent)	Nominal, (Annual Member=1 vs Daily or Monthly Member=0)
Cyclist Type (Independent)	Nominal, 4 categories (Strong, Moderate, Curious, Not a Cyclist)
Education (Independent)	Nominal, (Bachelor's Degree & Higher=1 vs Less than Bachelor's=0)
Gender (Independent)	Nominal, (Male=1 vs Female=0)
Income Level (Independent)	Ordinal, 4 categories (<$35K, $35K-$74,999, $75K-$124,999, >$125,000)
Joined for Fun (Independent)	Nominal, 1/0 (Joined for Fun v Did not Join for Fun)
Joined to Save Money (Independent)	Nominal, (Joined to Save Money=1 vs Did not Join to Save Money=0)
Number of CaBi Trips (Independent)	Interval-Ratio (Number of CaBi trips in Previous Month)
Station (Independent)	Nominal, 5 stations (Adams Morgan, Dupont Circle, Georgetown, H Street, Logan Circle)
Trip by CaBi b/c of Cost (Independent)	Nominal, (Made trip by CaBi because of cost=1 vs Did not Make Trip Because of Cost=0)
Trip by CaBi b/c of Speed (Independent)	Nominal, (Made trip by CaBi because of Speed=1 vs Did not Make Trip Because of Speed=0)

297

298 We performed statistical tests to evaluate the significance of the bivariate relationships.
299 Specifically, because all of our dependent variables were either measured on the nominal or
300 ordinal level of measurement, Chi^2 tests were appropriate. In a few instances, cell frequencies
301 were small, casting doubt on the reliability of Chi^2 tests. In these instances, we also used Fisher's
302 Exact Tests. However, the outcomes of the statistical tests did not vary between Chi^2 and
303 Fisher's Exact Tests in any of those instances. Thus for brevity, we report all Chi^2 p-values in
304 Table 4, even though some are based on Fisher's Exact Test. In addition, we also calculated
305 appropriate measures of bivariate association to evaluate the strength and direction of the

relationships. Specifically, we used Cramer's V for the nominal dependent variables and proportional reduction in error ("PRE") measures for the ordinal dependent variable (spending level), and we used Lambda for the nominal independent variables and Gamma for the ordinal and interval/ratio independent variables. Table 5 summarizes the results of our analysis of these bivariate relationships.

Income level had significant positive relationships with induced trips, spending levels, and new/induced trips with spending. Joining CaBi to save money had a significant positive association with induced trips. In addition, induced trips varied significantly by station area, with the Dupont Circle and Georgetown stations reporting the highest shares of new trips and H Street reporting the lowest share. For spending trips, we found a significant association with station area, with Georgetown and H Street reporting the highest shares of spending trips and Logan Circle reporting the lowest. Joining CaBi for enjoyment and taking the trip by CaBi because of cost savings had a significant association with spending level. Finally, new trips with spending had a significant association with station area, with Dupont Circle and Georgetown having the highest shares and H Street the lowest.

TABLE 4 Summary of User Survey Bivariate Relationships

Independent Variables	**Dependent Variable**			
	Chi^2 p-value			
	New/Induced Trip	Spending Trip	Spending Level	New Trips With Spending
Annual Member	>0.10	>0.10	>0.10	>0.10
Cyclist Type	>0.10	>0.10	>0.10	>0.10
Education	>0.10	>0.10	>0.10	>0.10
Gender	>0.10	>0.10	>0.10	>0.10
Income Level	***0.060***	>0.10	***0.019***	***0.017***
Joined for Fun	>0.10	>0.10	***0.070***	>0.10
Joined to Save Money	***0.025***	>0.10	>0.10	>0.10
Number of CaBi trips	>0.10	>0.10	>0.10	>0.10
Station	***0.049***	***0.000***	>0.10	***0.033***
Trip by CaBi b/c Cost	>0.10	>0.10	***0.099***	>0.10
Trip by CaBi b/c Speed	>0.10	>0.10	>0.10	>0.10

(Note: significant p-values (<.1) in bold)

Business Survey

Our business survey yielded a total of 140 responses out of the initial list of 326 total businesses in the survey area, for an overall response rate of approximately 40%, with variations across station areas, from approximately 24% in Adams Morgan to 51% in H Street, as well as business

type, from 17% for non-food and non-retail businesses to 51% for food-related businesses and 63% for retail businesses.

Most businesses were aware of the CaBi system (88%), and 32% of respondents reported having experience using the system. Table 5 shows that while most businesses did not know if CaBi had any effect on the customer traffic levels, approximately 10% perceived an increase in overall customer traffic due to CaBi. One in five businesses attributed a positive impact on sales to CaBi, 36% reported a neutral impact, 43% were unsure, and 1% perceived a negative impact. Most businesses (70%) indicated CaBi had positively impacted the surrounding area, while another 7% reported a neutral impact.

Most businesses (59%) indicated they would like to see CaBi expand. Regarding public space tradeoffs, 22% of businesses indicated they would have a positive reaction to replacing sidewalk space with a CaBi station and 29% would have a positive reaction to replacing car parking space, while 26% would be neutral regarding sidewalk space and 32% would be neutral regarding car parking space.

TABLE 5 Summary of Select 2013 Virginia Tech Capital Bikeshare Business Survey Results

Business Survey	**%**	**N**
Impact of CaBi on Overall Customer Traffic		
Increased	10%	133
No Change	28%	133
Decreased	1%	133
Unsure	61%	133
Impact of CaBi on Overall Sales		
Positive	20%	133
Neutral	36%	133
Negative	1%	133
Unsure	43%	133
Impact on the Surrounding Area		
Positive	70%	133
Neutral	7%	133
Negative	2%	133
Unsure	22%	133
Would Like CaBi to		
Install New Stations	59%	138
Remove Existing Stations	1%	138
Neither Install Nor Remove Stations	27%	138
Unsure	13%	138
Reaction to Replacing Sidewalk Space With CaBi		
Positive	22%	138
Neutral	26%	138
Negative	52%	138
Reaction to Replacing Car Parking With CaBi		
Positive	29%	136
Neutral	32%	136
Negative	39%	136

In addition to the results presented above on the business sample as a whole, we investigated the significance of a series of bivariate relationships to identify correlates of perceived economic effects. In particular, we focused on whether business perceptions of CaBi's impact on sales, perceptions of overall changes in sales, support for installing more CaBi stations, and support for replacing car parking with CaBi stations varied across a series of business characteristics. Table 6 summarizes the dependent and independent variables analyzed, along with their level of measurement and definition.

TABLE 6 Description of Dependent and Independent Variables for User Survey Bivariate Analysis

Variable	Description
CaBi Impact on Sales (Dependent, Independent)	Nominal, Perceived Impact of CaBi on Sales (Positive, Neutral, Negative, Don't Know)
Overall Sales (Dependent)	Nominal, Perceived Change in Overall Sales in Previous 12 months (Increased, No Change, Decreased, Don't Know)
Install More CaBi Stations (Dependent, Independent)	Nominal, (Interested in Seeing More CaBi Stations Installed=1 vs No Change or Interested in Seeing Stations Removed=0)
Car Parking Change (Independent)	Nominal, (Perceive Replacing Car Parking for CaBi Positively=1 vs Perceive Replacing Car Parking for CaBi Negatively or Neutrally=0)
Station (Independent)	Nominal, 5 stations (Adams Morgan, Dupont Circle, Georgetown, H Street, Logan Circle)
Business Type (Independent)	Nominal, 3 categories (Retail, Food-Related, Other)
Business Size (Independent)	Ordinal, 4 categories (1-9 workers, 10-19 workers, 20-29 workers, >30 workers)

We performed statistical tests to evaluate the significance of the relationships. We used the same methodology and testing procedures as explained in the user survey section. Table 7 summarizes the results of our analysis of these bivariate relationships.

We did not find significant variation regarding business perceptions of CaBi's impact on sales across station areas, business type, or business size. Perceptions regarding overall sales significantly varied across station areas, with the highest share of businesses perceiving increased sales in Georgetown and the lowest share in Dupont Circle. We found a significant and positive relationship between support for installing more CaBi stations and perceived impact of CaBi on sales. Finally, we found a significant and positive association between support for replacing car parking with CaBi and perceived impact of CaBi on sales (at the 10% level) as well as support for installing more CaBi stations.

TABLE 7 Summary of Business Survey Bivariate Relationships

Independent Variable	**Dependent Variable**			
	Chi^2 p-value			
	CaBi Impact on Sales	Overall Sales	Install More CaBi Stations	Car Parking Change
Station Area	>0.10	***0.064***	>0.10	>0.10
Business Type	>0.10	>0.10	>0.10	>0.10
Business Size	>0.10	>0.10	>0.10	>0.10
CaBi Impact on Sales	NA	>0.10	***0.023***	***0.078***
Install More CaBi Stations	NA			***0.030***

(Note: significant p-values (<.1) in bold)

5. Discussion and Conclusions

Our analysis of five Capital Bikeshare station areas suggests that bikeshare stations may have significant economic benefits, based on the intentions and perceptions of users and businesses surveyed in this study. Both users and businesses perceive monetary and non-monetary benefits. For users, these benefits take the form of lower travel costs and time savings, with most users (73%) motivated to use CaBi because cycling was faster than other modes and 25% motivated because using the system offered monetary savings. For businesses, these benefits take the form of increased customer traffic and sales and perceived positive impacts on the surrounding area, with 20% of businesses reporting a positive impact on customer sales and 70% stating a positive impact on the area.

Our user survey suggests that CaBi stations are encouraging new trips and new spending, and the results of our business survey support this finding. While at least some of the trips and spending reported by users are likely to be redistributive (i.e. shifting trips and spending from another location), a portion of the trips and spending appears to be induced. About one in six users made a new trip because of the presence of the CaBi station, and 19% of those traveling to the area regardless of CaBi reported increased spending due to their use of CaBi. It seems that at least a portion of the travel cost savings for CaBi users may be getting spent at businesses surrounding stations.

The bivariate analysis of our user survey suggests there is no difference in the rate of new trips, spending trips, spending levels, and new trips to spending locations based on annual membership status, cyclist type, education, gender, number of recent CaBi trips, or stating speed as the reason for choosing CaBi. Economic theory suggests that income is associated with spending patterns, and we found this holds for CaBi users as well, with household income positively associated with new trips, spending at higher rates, and new trips with spending in the area surrounding the bikeshare station.

The bivariate analysis of our business survey suggests there is no significant difference across station areas, business types (e.g. retail, food, other), and business size in perceived impacts of

CaBi on sales, support for the installation of more CaBi stations, or support for replacing car parking with CaBi stations. Moreover, we found that businesses with a perception of positive impacts on sales support expansion of the CaBi system and reallocation of space toward CaBi. Similarly, businesses that support expansion of the system were more likely to support reallocation of space away from car parking and toward CaBi. Together, these findings suggest that bikeshare operators seeking to expand their bikeshare system should start near businesses that perceive positive impacts on sales, and operators seeking to replace car parking with CaBi stations may find this most feasible near businesses that support expansion of the system as a whole.

Direct comparison of our findings to those of other studies examining the economic effects of cycling should be undertaken with caution, due to variations in factors such as station sampling, study area geographies, and respondent demographics. With that in mind, we note that our findings are consistent with a number of findings presented in other recent studies.

Our findings regarding top motivations for joining CaBi are slightly lower, but largely consistent with those given in the most recent CaBi annual member surveys: 73% in our sample vs. 85%-91% of annual members state travel time as a reason; 25% in our sample vs. 46%-52% of annual members identified travel costs [22, 23].

Our study also lends support to the recent findings that suggest cycling facilities attract customers to nearby businesses. We found that 63% of users traveling to spending destinations planned to spend $10-$49, which is higher than the $7-$14 estimated spending per trip found by Schoner et al [27]. Our finding regarding the close proximity of spending near CaBi stations (a combined total of 79% of users traveling to spending destinations intended to visit a business within 2 or 4 blocks of the station) is consistent with the recent CaBi annual membership surveys, which indicated 83%-85% of users were more likely to visit businesses near bikeshare stations [22, 23].

Our findings regarding new travel and new spending in relation to bikesharing are consistent with other recent estimates. While our finding that 16% of users made induced trips is higher than the upper range of 13% given by Schoner et al [27], it is within the range of 9%-25% reported by Capital Bikeshare [22, 23].

Our study is also consistent with recent findings of overall positive perceptions of bikesharing and cycling among businesses, but mixed perceptions regarding impacts on sales and mixed support for reallocating space toward bikesharing. Both Schoner et al [27] and the present study found more support among businesses for replacing car parking with bikeshare stations than for replacing sidewalk space. However, we found a higher level of support in our five Washington, DC neighborhoods than was found for the Minneapolis/St. Paul area (29% in our study vs. 17% in their study for car parking and 22% in our study vs. 8% in their study for sidewalk space). Our results were also largely comparable to LoSapio's [30] analysis of the Dupont Circle neighborhood (10% of businesses perceived increases in daily traffic in our study vs. 11% in her study, and 20% perceived increases in sales in our study vs. 13% in her study).

Our bivariate analysis found a positive correlation between perceived impact of CaBi on sales and support for both system expansion and the replacement of car parking with bikeshare. Future studies could further investigate factors that influence support for the reallocation of space toward bikesharing; it could be that more accurate perceptions by businesses of the travel patterns of their customers could lead to greater support for bikesharing and cycling in general.

Our study design warrants several caveats. We collected data during a single time period, and our station selection criteria provided us with a sample characterized by high commercial activity. Our data are therefore not able to capture changes over time or across the entire CaBi system. In addition, we relied on a single bikeshare station near a MetroRail station; future studies could collect more data co compare the effect of proximity to MetroRail. We also limited data collection for users to weekends to focus on discretionary trips, so our analysis may not relate to all trip types (e.g. commuting) and days of the week. Our results also rely on the comprehension of our survey participants and their stated (rather than revealed) behavior and perceptions. Finally, our methodology did not capture spending information across modal groups—excluding pedestrians, drivers, and transit users.

Overall, we find evidence that bikesharing can benefit both users and businesses by enabling new trips and spending. Users and businesses both reported monetary and non-monetary benefits from CaBi. In addition, we found mixed support for the reallocation of public space among businesses, but a majority (61%) that would react positively or neutrally to the replacement of car parking with a CaBi station. Our study may inform ongoing debates surrounding the effects of bikesharing in relation to local businesses.

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