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The Rent is Too Darn High: Evidence from Washington, DC's Capital Bikeshare Program

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ABSTRACT

Using data gathered by the District of Columbia, I measure the effects of housing prices in DC on the locations of Capital Bikeshare Stations. Since its operation in 2010, Bikeshare has grown rapidly in popularity among residents and tourists. I focused the influence of real estate values on the locations of Capital Bikeshare and found that land use values do have a significant effect on the location of Capital Bikeshare. Said effect is amplified when applied to Metrorail because of the market demand for real estate proximate to major heavy rail transit, which outweighs the demand for cycling in the District.

INTRODUCTION

In many major cities around the world, whether as a method of exercise or a mode of transportation to work or school, riding a bicycle is common. In some cases, cities have gone to great lengths to create a whole set of policies and accommodations for people who choose to cycle. Bicycle sharing has become popular in recent years due to its convenience. The concept is simple: after paying a small fee, one can pick up a bike from a docking station that holds many bikes and ride it to the destination, then drop off the bike at any docking station within the system. Capital Bikeshare encourages users to utilize established bicycle lanes and wear proper head protection. Therefore, Capital Bikeshare can be treated as a public transportation network: a system that allows multitudes of users to travel from point to point after paying a small fee, with stations that are able to serve a large number of people.

Washington, District of Columbia (DC) is no different in this respect. The city's relatively flat geography in the downtown area (near the historical monuments and museums), small size (approximately 64 square miles in total land area), and long straight roads make the United States capital an ideal environment for cyclists. According to the District of Columbia Department of Transportation (DDOT), the District currently has four miles of protected bicycle lanes, 56 miles of bicycle lanes, and another 55 miles of separated multi use trails (DC Sustainability Plan, 2013, p. 83).

In August 2008, Washington, DC launched its first bicycle sharing system, named Smartbike DC. During the two years before Capital Bikeshare began its operations 1,600 riders joined Smartbike DC. On September 20, 2010 (Capital Bikeshare, 2018), Capital Bikeshare (often abbreviated to CaBi) was launched as a joint effort by DC, Montgomery County (Maryland), Arlington County and Alexandria (Virginia) to revitalize the idea of sharing bicycles for a small fee. This new system has since grown to 500 bicycle sharing locations with 4,300 bicycles and 2.1 million trips taken to date. Many cities soon afterwards launched their own services, including New York City and San Francisco.

The business model for Capital Bikeshare is simple: a private company with multi-jurisdictional government oversight to create a public-private partnership. It is an affordable way to travel between two points that are cycling distance from each other. Prices start at $2.00 for a single 30-minute ride between docking stations (paid with a credit or debit card – no cash payments accepted). Any ride that lasts for longer than 30 minutes incurs additional fees – these fees are set on a graduated scale based on the extra time. There are also 24 hour passes for $8 per day or annual memberships for $85 per year available depending on how long the user plans to be in the DC metropolitan area. These price points have gained favor among both locals and visitors alike for their affordability and convenience, and as a result, DDOT has since announced plans in September of 2015 (approximately three years after the debut of Bikeshare) to expand the system to include other areas of DC (mostly in the areas Southeast of the United States Capitol and the Anacostia River) and portions of the surrounding counties in Maryland and Virginia. This business decision stems from the desire of Capital Bikeshare to reach markets where other transportation options may be too inconvenient or expensive -

Metrorail (the heavy rail transit system controlled by the Washington Metropolitan Area Transit Authority - also known as WMATA) does not reach everywhere in the DC metropolitan area.

My research focuses on locational determinants of Capital Bikeshare stations – when treated as public transportation stations akin to the Washington, DC Metrorail system. I am finding out whether or not more expensive land values contribute to more Bikeshare stations being constructed in said areas. The necessity of this analysis lies in the final outcome: the government of Washington, DC (in its effort to promote sustainability on many facets) wants to promote Capital Bikeshare as both a transportation service and a healthy alternative to driving. It is worth noting that while Capital Bikeshare is certainly useful for short trips that last fewer than 30 minutes, the intentions of the DC government is not to totally phase out Metrorail in favor of Bikeshare, but supplement existing public transport networks. Having said that, determining the location of a Capital Bikeshare dock requires a lot of variables to be considered. On a broader scale, this study answers questions of why businesses and services locate where they are with respect to the land values.

Using explanatory variables that account for characteristics (such as age, area occupied, transaction cost) on both residential and commercial real estate in the city of Washington in the year 2010 (the year Bikeshare was initiated) to avoid possible simultaneity biases in data, I analyze the effects of said characteristics on the distance to the nearest Bikeshare station. The dependent variable would hence be the distance to the nearest Bikeshare station – shorter distance would imply denser coverage since if there are many stations within a short distance to many buildings – residential or otherwise – that would imply an increase in density. Overall, the likelihood of Bikeshare locating near expensive real estate is higher. On a more specific note, Bikeshare locates closer still near expensive real estate close to a Metrorail station. After all, since Metrorail predates Capital Bikeshare by a few decades, the prices of real estate have increased due to increased demand for housing near the Metrorail (an important amenity for many Washington residents).

LITERATURE REVIEW

The following is a literature review of work on the topic of bicycle sharing, the usage of bicycles, and public transportation. The first source provides information on the bicycle sharing system in Zhongshan, China. The second resource is helpful in gauging the highest instances of bicycle usage in a major city – Seattle, WA. The third article is a study examining the effect of expanding public transportation in an already busy area – Singapore's MRT (Mass Rapid Transit) – on real estate values. The fourth source is Capital Bikeshare's expansion plan and how it informs this particular analysis.

Expanding Bicycle-Sharing Systems: Lessons Learnt from an Analysis of Usage

In an effort to better understand the dynamics of bicycle sharing in an urban area, a group of economists, Ying Zhang, Tom Thomas, M. J. G. Brussel1, M. F. A. M. van Maarseveen, researched bicycle sharing usage in Zhongshan, China to explore the impact of expansion of the usage on the system in their paper, *Expanding Bicycle-Sharing Systems: Lessons Learnt from an Analysis of Usage.*

These economists consulted a few studies, most notably Vogel, who found that in Vienna, the usage during peak hours on weekdays and the weekends were different, which might be associated with the activities in the neighborhood (Chen, Zhou, & Sun, 2017, p.2). For example, peak weekday trips might suggest a neighborhood of mostly commercial businesses and the riders may be using public bicycles for commuting to work. Weekend peak trips could signify more recreational use, as many bicycle sharing trips are taken to tourist attractions or other recreational places such as pubs or museums. All of these factors combined could indicate the neighborhood characteristics based on the estimated purpose of the trip taken.

The study was conducted for a bicycle-sharing system in Zhongshan, China using trip data from March 2012, 2013, and 2014. They examined the changes in both users (UserID) and the system usage by comparing March 2012 with March 2013, and comparing March 2013 with March 2014. In this study, they consider the changes in the system as a whole and in the spatial distribution of demand before and after the system expansion. This would in essence create a differences-in-differences model that can avoid simultaneity bias.

The highest usage measured was in the center of the city, where the majority of the population is located (urban density is highest). In general, expanding the original system not only extended the original users' ability to reach new areas but also attracted new users to the bike-sharing system. Adding new stations in the areas where demand or density of stations is high can attract both new users and original users. On the other hand, adding new stations in areas further away from the city center with a lower density of stations is mainly useful for new users.

I will use this study in my analysis of Capital Bikeshare. Specifically, I will analyze using quantitative methods the extent to which the location of Bikeshare stations is correlated with land use values. The demand for the bike sharing may be characterized by the amount of urbanization an area has gone through, thus detailing and following Alonso's standard urban model (for the purposes of this study, I use only data from the District of

Columbia). I follow the same method and use 2010 data. This can help me avoid simultaneity bias with samples as part of a difference-in-difference model – modeling the interaction between the operational debut of Capital Bikeshare and the transaction costs of real estate before and after the installation of the Bikeshare system.

Built environment determinants of bicycle volume: A longitudinal analysis

Three researchers Peng Chen, Jiangping Zhou & Feiyang analyzed the implementation and usage of bicycles in Seattle, WA in their paper *Built environment determinants of bicycle volume: A longitudinal analysis*. Their analysis attempts to answer some very important questions in regards to policy making, bicycle route planning, road safety improvement, municipal investment, and maintenance priorities (Chen, Zhou, & Sun, 2017 p. 656).

Collecting data from the Seattle DOT from January 2011 to September 2015, the researchers used geographical and statistical analysis to analyze the correlation between the geography of the city and bicycle usage. Due to its urbanized land use, the downtown area of Seattle should see more wide uses of bicycle usage. For land use mixture and mountainous terrains, the results of this study are consistent with previous findings. Areas with a more mixed land use (Chen, Zhou, & Sun, 2017 p. 657) and a higher percentage of water bodies (areas around lakes and reservoirs are flatter) are positively associated with greater bicycle counts, while a hilly terrain is negatively correlated with bicycle counts (Chen, Zhou, & Sun, 2017 p. 657). The bicycle count data emphasizes observations clustered in urban centers (Chen, Zhou, & Sun, 2017 p. 659).

This article will inspire my research by adding a dimension to the usage analysis: the terrain of Washington, DC. Keeping in mind that the land use in Washington, DC is very diverse (despite its tiny area), taking into account the terrain might prove useful to gauging the locational determinants. Ostensibly, highly urbanized areas of the city might see a denser cluster of Bikeshare stations due to the favorable geographical features. Since land values change depending on the geography and the level of use, it would provide valuable insight on how this changes the dynamic of the locations of Bikeshare stations.

Network Expansion of Public Transport

The third document pertains to a broader perspective of public transportation with respect to land values. After all, treating Capital Bikeshare like a public transportation system is a logical tactic due to its regulation by DDOT and daily maintenance routines. With that in mind, I consulted the work of Eric Fesselmeyer and Haoming Liu, economists at the National University of Singapore, in their article *How much do Users Value a Network Expansion? Evidence from the Public Transit System in Singapore*.

This article is particularly useful since it directly studies the expansion of a public transportation network with increasing ridership and convenience, as it relates to the value of the land it serves. The study measured accessibility to the subway against the transaction costs of apartment rent (thereby signifying the true value of the real estate) before and after the construction of the subway. This is shown in the methodology employed by many economists such as McMillen and McDonald's research on Chicago's L Train – the elevated heavy rail run by the Chicago Transit Authority (Fesselmeyer & Liu, 2018 p. 1-2).

By essentially creating a difference-in-difference model, the effect of the network expansion can be appropriately captured on the residential real estate market. A difference-in-difference model takes collected data and emulates a research experiment (akin to a laboratory test) using a "treatment" group and control group. The idea is to calculate the effect of said treatment on an outcome. In this particular difference-in-difference model, the researchers used price as the dependent variable and the MRT (Singapore's Mass Rapid Transit) expansion as the "treatment" variable. The main independent variables are observable apartment characteristics such as number of rooms, distance to Central Business District, and age of the apartment. I will attempt to recreate this model but in reverse. By designating the accessibility to Bikeshare as my dependent variable, and the land values as my independent variable, I can capture the effect of expensive real estate (both commercial and residential) on the location of Capital Bikeshare. While this may seem like simultaneous equation bias, I will control for this bias by only using housing data that records transactions in 2010, the year that Bikeshare started. By no means is this a perfect scenario, but it highlights the characteristics of the diverse neighborhoods of Washington, DC and whether or not DDOT is likely to expand operations in some neighborhoods over others.

DC Department of Transportation of Capital Bikeshare Expansion Plan

The District of Columbia Department of Transportation uses similar metrics to gauge the locations of their Bikeshare stations. Some goals of Capital Bikeshare's market study for its proposed expansion of operations are simple: ensure Bikeshare is a valued part of DC's transportation system for all users, and leverage Bikeshare to promote a thriving community. (DDOT, Bikeshare Development Plan, 2015). Each of those two points cover a different perspective of the hypothesis. It is important to note that these factors are meant to encourage more usage, which in turn would lead to more Bikeshare docks.

The first point states that Bikeshare initially is not meant

to be a primary means of transportation (although it can serve as such for a large population of DC residents), but rather a quick and easy way for people to travel from their home to a Metrorail station to continue the commute. Bikeshare's convenience also makes it very appealing for tourists (hence the denser distribution in downtown DC close to major monuments and museums). To that end, Bikeshare is planning to expand its accessibility to Metrorail stations, particularly those in newly developing areas such as Shaw and the Navy Yard. As far as residential areas that are feasible, the newly developing Southwest Waterfront and other transit points south of L'Enfant Plaza (all newly developing as well) are target areas for Bikeshare.

This trend of development could become a big determinant of location due to its growing potential in many facets – new housing developments (residential apartments and commercial real estate) are attracting residents, and with a lot of corporations and firms locating in the Southwest Waterfront and the Navy Yard, it makes sense to install more Bikeshare docks that enable both commuters and tourists. Figure 1 shows the spatial distribution of the Capital Bikeshare usage. The majority of usage is in the areas where tourism distribution is high such as the National Mall and Southwest Waterfront (calculated by using a GPS tracker from dock of origin to where it was docked).

The second point stresses the importance of Bikeshare for commuters. Foggy Bottom, Downtown DC, Federal Center, NoMa, and Navy Yard have adequate coverage in terms of Bikeshare station distribution – referencing Figure 1, there are high ridership trends in those particular neighborhoods. However, other major employers such as Capitol Hill do not have a dense distribution of Bikeshare stations compared to the aforementioned areas. To that end, the currently growing areas of employment for many businesses in DC could prove to have a residual effect on the residents in those neighborhoods in DC, as the aforementioned neighborhoods do contain both commercial and residential real estate that are developing. Effectively, the land use that has been determined for that area of DC may see an increase in the instances of usage for Capital Bikeshare.

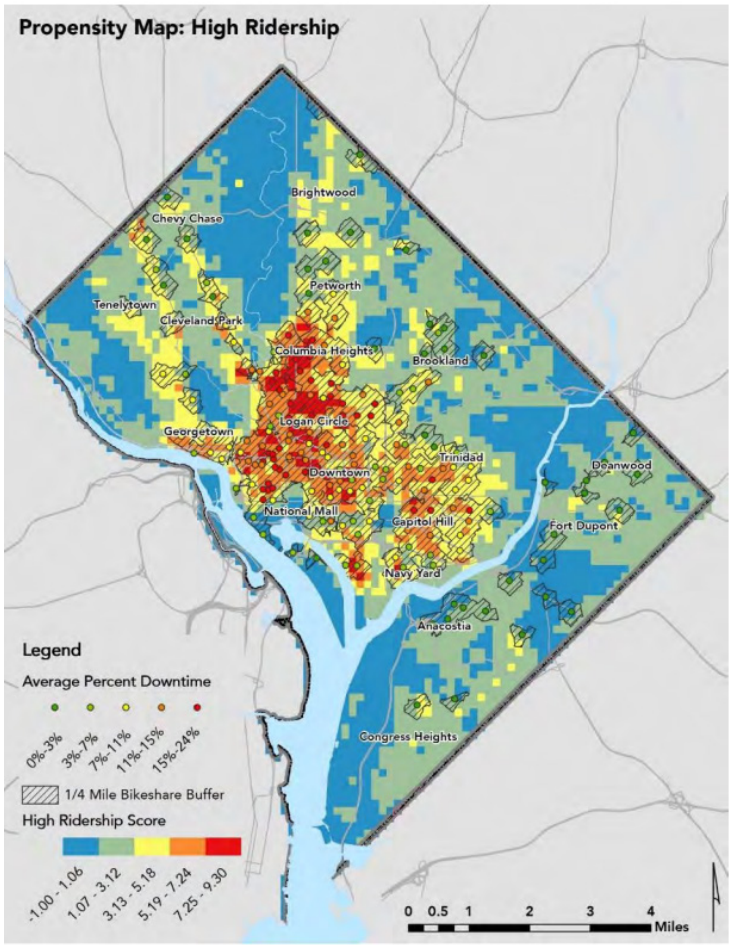

FIGURE 1. *Spatial Distribution of High Ridership. Note how the densest areas of ridership is within the center of the city close to downtown DC and the Waterfront just on the Southwestern tip of DC; these are shaded in orange and red. Source: DDOT*

Variable	Obs	Mean	Std. Dev.	Min	Max
Price	2,221	$546,809.60	$402,337.80	$57,000	$2,850,000
Land Area	2,221	3,048.40	2,459.08	288.00	25,329.00
Age	2,221	75.50	31.70	0	203

TABLE 1. | *Descriptive Statistics for DC Residential Real Estate*

Variable	Obs	Mean	Std. Dev.	Min	Max
Price	166	$12,600,000	$30,600,000	$65,000	$216,000,000
GBA	166	38,306.46	72,938.39	452.00	413,082.00
Age	166	74.99	32.26	0	177

TABLE 2. | *Descriptive Statistics for DC Commercial Real Estate*

DATA

The data is derived from three different sources: DC Housing, Capital Bikeshare locations, and the Washington Metropolitan Area Transit Authority. The District of Columbia, for the interest of keeping public records, keeps information about all housing in its jurisdiction. Many characteristics are recorded and publicly available, such as year built (going back pre-1993, year remodeled (modified so that we treated remodeling as a binary variable – 1 for yes, 0 for no), structure, gross building area, census block, number of bathrooms, kitchens, fireplaces, heating/air conditioning units, coordinates, etc.

I will collate computer assisted mass appraisal real estate data with Bikeshare and Metrorail stations from the GIS office of Washington, DC. Using GIS mapping and statistical analysis software, I intend to run thousands of proximity calculations from calculating linear distances between the coordinates of the buildings and the Bikeshare stations, and the distance between Bikeshare stations and Metrorail stations. After collating these datasets and cleaning up unnecessary variables and observations, I analyze the data accordingly. I use commercial and residential real estate data as a thorough measure of the real estate market.

Some descriptive statistics follow and it is important to note the definitions of the variables. Distance refers to the distance calculated from the building (commercial or residential) to the nearest Bikeshare station, price refers to the price when the building was sold, gross building area (GBA)/land area refers to the total area the building occupies as measured in square feet, and age refers to the age of the building in years.

HYPOTHESIS AND EMPIRICAL MODEL

Given the existence of over 500 Capital Bikeshare docks in the Washington, DC metropolitan area, including but not limited to the District of Columbia itself, Arlington County, Alexandria (areas in Virginia), Montgomery and Prince George's County (areas in Maryland), I intend to analyze the effects of real estate prices on the location of Capital Bikeshare docks. The hypothesis for this study is Capital Bikeshare stations are located near more expensive real estate (by transaction price) – both commercial and residential real estate to capture the full cycling experience (cycling to and from work or destination); this effect is magnified when it comes to measuring the effect of Metrorail and expensive real estate. The empirical model below illustrates such things:

$$ln(d_i) = \alpha_0 + \alpha_1 ln(p_i) + \alpha_2 m_i + \alpha_3 X_i + \varepsilon_i$$

- $\ln(d_i)$ is the calculated distance from the closest Bikeshare station to the building
- p_i is the price of the residence at time of selling
- m_i represents the month the house was sold, respectively
- X_i represents observable characteristics such as age, land area, number of units, proximity to a Metrorail station, etc.

The rationale behind the first model is to assess

whether or not Capital Bikeshare stations are located near expensive buildings. The second model would assess whether or not Capital Bikeshare stations are located close to both expensive buildings and Metrorail stations. Using a log-log regression and estimating the R^2, I estimate the correlation between the land use values and Bikeshare. The logarithm of distance would be a more realistic measure of proximity due to its nonlinear nature; the logarithm of price would be a measure as a percentage rather than single units.

A highly positive value (greater than one) for the coefficient of the real estate price would suggest that the location of the Bikeshare station would locate farther away from the expensive buildings – shown by Figure 2a. The same logic applies for when I add the Metrorail station locations. In that particular case, we would see more stations located in the wealthier areas of the city and close to Metrorail stations. On a related note, if the coefficient of the real estate price is measured to be between zero and one (shown by Figure 2b), the impact of prices on the distance on Capital Bikeshare stations will show a positive correlation, but with diminishing marginal returns. In other words, an increase in the percentage of price of land will show an increase in the distance of the closest Bikeshare station that will soon level off as the price reaches a certain (large) amount. Conversely, a negative coefficient would suggest the impact of the dependent variable is also negative, which would essentially affect the final locational choice for the Bikeshare station – shown by Figure 2c.

Comparing buildings sold at 2010 as an instrument would solve the simultaneity problem because there was no Bikeshare usage at that time, while keeping in mind the cost in terms of later housing price growth, I am viewing this from the perspective of Bikeshare, focusing on the effects of real estate values on the location of the stations. Empirically, if we see an increase in the unit price of real estate, the distance from the closest Bikeshare station to the house should decrease. This would essentially produce a negative coefficient for the price variable in the regression model. A percentage increase in usage should also see a decrease in real (nonlinear) distance since Capital Bikeshare considers a lot of usage at the docks an important factor.

One major adjustment in the model is taking the census-blocks into account. The US Census Bureau for reporting purposes partitions neighborhoods into blocks, and in DC, that process is no different. In my regression models to create a uniform neighborhood characteristic, I treat this census block grouping as a large dummy variable set in a regression. This leads to the assumption that the census block groupings do not change over time. Keeping this constancy will create a more consistent analysis.

The basis of this particular model stems from Alonso's work in land use and zoning, which produces the bid-rent curve (Coblentz, *Alonso, William, location and land use*, 1964). Consulting Figure 3, the vertical line marks the central business district, the land use is color coded in that retail (can be substituted for services such as banks, offices, universities) in black, manufacturing in white, residential in gray.

This model considers a few assumptions:

- a monocentric city: the central business district is the city center – no other centers exist.
- a featureless plain: geographical landmarks such as rivers and mountains do not exist.
- "no central planning": the city and the buildings are all placed at their locations due to market forces. (Carrillo, 2017).

According to Alonso's standard urban model, a major metropolitan city will have a lot more activity near the center (assuming the city has one center), so areas close to the center of the city, in this case Washington, DC (around the area close to the White House and National Mall) would have more Bikeshare stations. Figure 2 would also illustrate the resulting higher values of real estate due to the high density of Bikeshare activity in the downtown area of the city. However, in many cases major cities (including Washington, DC) have multiple centers of activity, which stretches the limits of this particular model, but the logic and theory still apply to those city centers.

One final point that should be addressed is the date

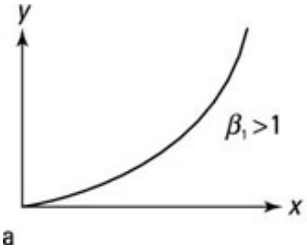

FIGURE 2a. *Visualization of the log-log model when the coefficient of the independent variable is greater than one*

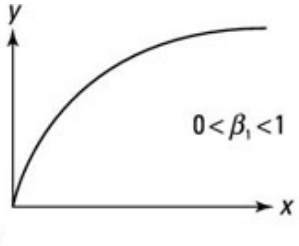

FIGURE 2b. *Visualization of the log-log model when the coefficient of the independent variable is greater than zero, but less than one*

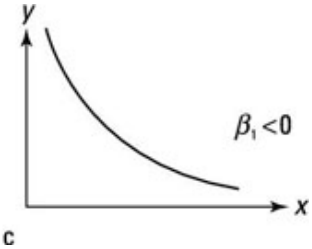

FIGURE 2c. *Visualization of the log-log model when the coefficient of the independent variable is negative*

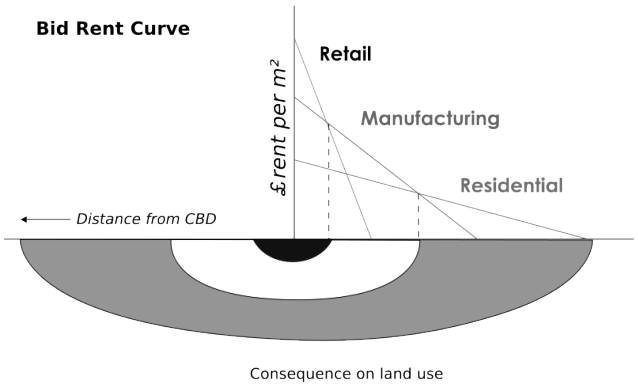

FIGURE 3. *Alonso's Bid-Rent Curve. Note that CBD stands for "Central Business District."*

Capital Bikeshare began operations. The dataset itself does not provide the individual installation dates for the Bikeshare stations. For simplicity, I will presume that all Capital Bikeshare stations in Washington, DC began operations on September 20, 2010. The use of the home values sold before and after the dates of the initial operation of Capital Bikeshare would help model the behavior of further expansion since the usage of Bikeshare should be concentrated where there is a lot of usage consistently. Ostensibly, my analysis only focuses on the usage of the Bikeshare stations as a result of real estate values. Since usage data is collected from the dates mentioned going forward in time, it makes sense to use said dates as part of the difference-in-difference model.

RESULTS

To understand the results, the following data dictionary is as follows:

- log(price) – the price as a logarithm function to capture magnitude as a percentage
- Month – the month the building was sold in (1 to 12)
- GBA – Gross Building Area (sum total of all building spaces – living and working)
- Land Area – the amount of land a building takes up – measured in square feet
- Age Category – represents the relative age of the building – the larger the number represents an older building
- Living GBA – sum total of all living spaces
- Grade – variable that denotes the condition of the building by realty standards
- Number of Units – number of real estate units a building has
- Number of Rooms – number of rooms in a building – includes domicile and work rooms
- Metro – a binary variable with a value of 1 for real estate's close (within half a mile) proximity to a Metrorail station, 0 if not

Models one and three measure the effect of real estate values of residential and commercial real estate respectively with respect to Capital Bikeshare only, while models two and four include the effect of real estate values of residential and commercial real estate respectively with the "Metro" binary variable. The intended effect of models two and four is to compare the effect of the high real estate values versus the proximity to Metrorail. It answers the question of whether Capital Bikeshare is more likely to locate closer to high value real estate that is close to Metrorail (or that Metrorail is not that much of a contributing factor).

DISCUSSION OF RESULTS

Consulting the results from Table 1, the R^2 values for both final models one and two are .981, which suggests an excellent fit of the model with the observed data. This would imply a positive result from the regression process, and that the empirical results are significant. If we consider just the Bikeshare station and the housing values, we would see that a single increase in percentage in the residential real estate value would have a very small decrease (.04 mile) on the distance located. Stated differently, the Bikeshare distance would decrease very slightly. Having said that, such a coefficient estimated coupled with the R^2 value of this regression proves that to a marginally significant extent, land values have an effect the placement of Bikeshare stations. Referencing my data and DC's small size could potentially explain the R^2 value.

Table 2 tells much of the same story, with the commercial real estate having a larger effect – R^2 values for models three and four are .998, with a negative coefficient estimate for price of -0.01 miles observed from a given building. This means that Capital Bikeshare would on average locate 0.01 miles closer for any given percent increase to the real estate value. This supports my hypothesis: that there is little effect on the land use values on Capital Bikeshare alone, but the negative coefficients translate into smaller walking distances to the Capital Bikeshare station. More stations within close proximity to buildings leads to denser distributions of Capital Bikeshare stations and higher ridership in the area.

This brings up the next element: the effect of Metrorail

VARIABLES	Model 1	Model 2
log(price)	-0.0356	-0.0352
	(0.0377)	(0.0374)
Metro		-0.0925*
		(0.0560)
Month Sold	-0.00590**	-0.00604**
	(0.00281)	(0.00282)
GBA	-8.03e-06	-8.34e-06
	(3.20e-05)	(3.19e-05)
Land Area	-2.22e-06	-2.48e-06
	(7.29e-06)	(7.30e-06)
Age Category	4.27e-05	4.60e-05
	(0.000741)	(0.000743)
Number of Units	-0.0266	-0.0270
	(0.0307)	(0.0304)
Rooms	0.00858	0.00841
	(0.00899)	(0.00899)
Constant	-1.035**	-1.022**
	(0.476)	(0.474)
Observations	2,221	2,221
R^2	0.981	0.981

TABLE 3. *Regressions for residential real estate to Bikeshare (models 1) and Metro stations (models 2) Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

VARIABLES	Model 3	Model 4
log(price)	-0.112	-0.118
	(0.0921)	(0.105)
Metro		-0.0329
		(0.183)
Month Sold	0.0447	0.0451
	(0.0334)	(0.0347)
Living GBA	-7.38e-06	-7.22e-06
	(6.97e-06)	(7.28e-06)
Age	-0.00333	-0.00314
	(0.00653)	(0.00697)
Number of Units	0.00918	0.00901
	(0.00836)	(0.00869)
Grade	-0.0142	-0.0140
	(0.0137)	(0.0143)
Constant	0.275	0.336
	(0.941)	(1.088)
Observations	98	98
R^2	0.998	0.998

TABLE 4. *Regressions for commercial real estate to Bikeshare (model 3) and Metro stations (model 4) Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

on the locational determinants of Capital Bikeshare. The estimated coefficient is -0.09, which would imply a percent increase in the value of residential real estate would result in a 0.09 mile decrease between the Bikeshare and the Metrorail station; commercial real estate has a slightly smaller measured effect of -.03 (a .03 mile decrease between the distance of the Metrorail station and the building). This would imply that a combination of high land value coupled with the availability of Metrorail would have a significantly higher impact on the locational choices for Capital Bikeshare – the measured effects are twice, if not three times as high. This helps suggest that the effect of Metrorail on Bikeshare is far higher; both Metrorail and Bikeshare are complementary goods that serve to increase the aggregate usage of public transportation in the District of Columbia.

Overall, the effects of high land use value combined with the Metro in the grand scheme of things are integral in determining the locations of Capital Bikeshare. This says nothing of the fact that Capital Bikeshare wants to locate close to Metrorail stations to take advantage of the increasing land values. Thus, it evidences my hypothesis that Capital Bikeshare is taking advantage of high real estate values.

CONCLUSION

There are several threats to validity in this research that warrant discussion. Chief would be the simultaneity problem that Capital Bikeshare may affect real estate prices as opposed to the reverse. While this is a valid reasoning, particularly when viewed as a public transport good, such as the effect of the new Silver Line for the Metro on the imminent rise of home values due to increased demand. However, the land use zoning laws in DC have

been determined long before 2010. One would then infer that the subsequent values of the land would help determine the location of the Capital Bikeshare stations. To circumvent this concern, I used observations of real estate sold in 2010 only. This is not a perfect metric, but it does at least tell a marginally relevant story.

A noteworthy initiative by DDOT is the planned expansion into the less healthy parts of Washington, DC. Areas in Washington, DC with needs for more access to Bikeshare due to the relative obesity and other health related factors are target areas for development; one in three children in the District are at risk of obesity; one in three people in the District are also at risk of hunger (DC Sustainability Plan, 2013, p. 28-29). Since Capital Bikeshare indeed has taken a multifaceted approach to expanding the system for public good, public health and ease of access to public services is important, as seen in Figure 4, wherein lies the concentration of a lot of public services in the Columbia Heights neighborhood (shown to be empirically true) and the relative lack of access in the Southeast Quadrant east of the Anacostia River. With those two major areas developing at an increasing rate, Capital Bikeshare might see the appeal for locating more docks in those areas due to higher land values. In short, Capital Bikeshare's endgame for development and expansion really is about locational equilibrium and its strategy to be an integral part of Washington, DC's transportation infrastructure.

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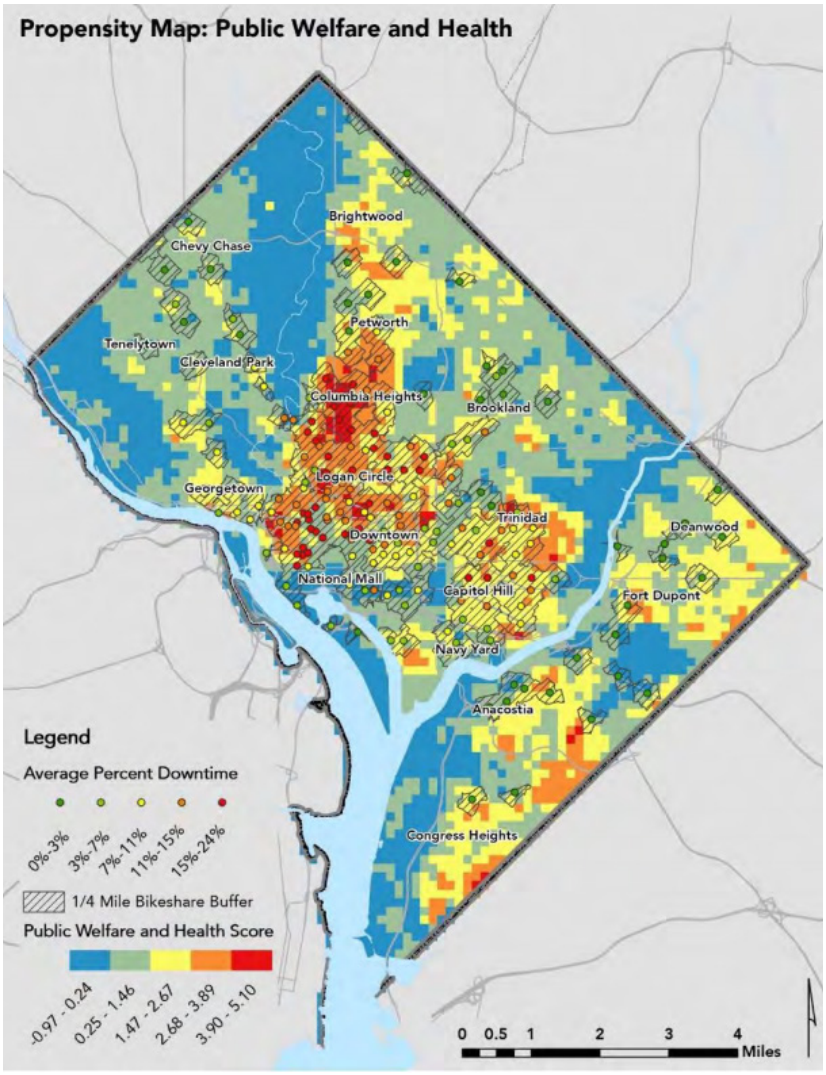

FIGURE 4. *Public welfare propensity map of Washington, DC. Notice the high concentration of public welfare in the Columbia Heights neighborhood and surrounding areas. Source: DDOT*

About the Author

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Mentor Details

This article was prepared with mentorship from Professor Donald Parsons.

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