Impact of a Light Rail Extension on Residential Property Values

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Abstract: This paper analyzes the effect of an extension of a light rail on residential housing prices. Previous work has examined a new light rail line or upgrades to existing infrastructure, however, the following is the first examination of an extension using a hedonic pricing, repeat-sales analysis. The repeat sales analysis uses houses sold twice in Bayonne, New Jersey – once before the 2008 announcement of a southern extension to the Hudson-Bergen Light Rail to 8th Street in Bayonne, and once after the opening of the station in 2011. Our results show that a one-minute decrease in walking distance to the light rail station causes about a 0.21% to 0.25% increase in annual price appreciation relative to unaffected properties in Bayonne (i.e., properties further from the station). Using the reciprocal of distance to estimate the gradient effect, we find the effect of the new station on property price appreciation largely disappears at distances further than a 12 minute walk (0.6 miles) to the station. These findings are consistent with work on the impact of light rail in general, which says the utility of increased transit options is expressed as revealed preferences (RP) in housing prices surrounding rail stations with the closest properties seeing the largest impacts.

I. Introduction

In an attempt to reduce the problems associated with traffic congestion and the spur economic development, a series of U.S. cities have built light rail transit systems.[1] Proponents of these systems contend that the economic development benefits typically follow from improved access of low-income workers to employment opportunities (Vock, 2015). Garrett (2004) claims that light rail reduces pollution and increases property values. Of course, rapid transit lines (metro or commuter) provide similar benefits. However, light rail can be constructed at 20% of the cost of a metro line (UITP, n.d.).

These arguments served as the justification to build the River Line – a light rail line that provides service between Camden and Trenton, NJ (primarily central New Jersey). The thirty-four mile line with twenty-one stations began offering service in 2004. In FY 2014, the line provided an average of over 9,000 trips on weekdays, and total annual ridership was just under 2.9 million trips (NJT, 2015). Like light rail in general, Hammond (2013) reports that New Jersey development officials and CEOs see the line as an important part of their economic development strategy to increase labor mobility.

These benefits have also provided the justification for extending the line into downtown Trenton. Currently, the northern terminus of the line is at Trenton Transit Center. The location of the terminus leaves riders with a mile walk, or an additional bus ride to reach downtown Trenton where the New Jersey State House, other state government, and private employers operate. An extension would cut commuting time into downtown Trenton while

[1] Light rail is a style of mass transit combining characteristics of trams (streetcars) and trains. They are characterized by primarily street-level “trains” of multiple cars with exclusive right-of-way on their tracks (UITP, n.d.).

also giving area residents better access to Camden. Trenton only has a system of buses to provide intra-city public transportation, but the added station on the light rail could provide a benefit for the 84,000 residents as well as outside commuters (Census, 2014).

This paper will evaluate the economic impact of a light rail extension into downtown Trenton. Given the growing light rail system in the US and abroad, it is important that we evaluate the payoff of extensions. For example, Formby (2014) reports that the DART light rail system in Dallas is currently adding a 2.6 mile extension to the Blue Line with two additional stations, and the Dallas transit authority wants to add an additional line as well.

To measure the effect of a new River Line station, we use the extension of the Hudson-Bergen Light Rail (HBLR) line to the 8th Street Station in 2011 as a baseline. We examine the effect on property values as way to gauge the value of the line because a significant literature on urban amenities shows the value of enhanced transport opportunities will be capitalized into property values (i.e., hedonic pricing).

The HBLR is a 20-mile light rail line that primarily runs parallel to the Hudson River in the northern New Jersey counties of Hudson and Bergen. The line has 24 stations (see Figure 1), an average weekday ridership of 45,000, and annual ridership of 13.8 million. At the time of the extension, ridership on the HBLR was 12.4 million rides per year. One year after the extension, ridership increased 900,000 or by 7.3% to 13.4 million rides per year. Annual ridership for both the Hudson-Bergen Light Rail and the River Line can be seen in Figure 2; the River Line provides a base line to demonstrate that the increase in ridership on the HBLR for 2012 was not due to a statewide exogenous factor on ridership, but was likely the result of the extension (NJT, 2012).

To assess the impact of the extension to HBLR, we will compare pre-station-announcement and post-station-opening real sale prices of the same houses (repeat-sales) for homes near the 8th Street Station extension. The HBLR was selected as an appropriate comparison because it is similarly situated in a New Jersey metro area with ridership of roughly the median number of trips for all light rail systems in the United States (American Public Transportation Association, 2015). To develop the framework that follows, we examine previous work on repeat-sales.

II. Literature Review

A significant body of research examines the economic effects of transit lines (Bartholomew and Ewing (2011); Debrezion et al. (2007); Kim and Lahr (2014); Chatman et al. (2012); Hess and Almeida (2007); Grimes and Young (2013); Bowes and Ihlanfeldt (2001); Werner et al. (2016); Baum-Snow and Kahn (2000); Kim et al. (2007)). Bartholomew and Ewing (2011) provide a review of older research on the effects of transit and increased pedestrian access on property values. The review focuses on hedonic pricing studies that attempt to show revealed-preference (RP) for new transit developments. They find that there is a primarily positive effect on housing prices with the addition of new transit options. The evidence for this point is best shown in Debrezion et al. (2007) in their meta-data analysis of the effect of transit developments on real estate prices. The meta-dataset contained 73 previous studies of hedonic pricing effects of transit, 52 of which focused on residential housing prices. The overall effect for residential properties was a 1.9% increase in housing prices for each 250 meter increase in proximity to the station with an effect of 6.2% for houses within a quarter of a mile from the station. Using a subset of 26 data sets, they find on

average a 2.5% increase percent per 250 meters, and a 7.6% effect within a quarter of a mile for light rail stations.

Bartholomew and Ewing (2011) also show that: 1) the type of rail (including frequency, length, location, and local traffic patterns) has a large impact on housing prices, 2) distance to the central business district (CBD) has a negative relationship with the effect of transit lines on property value (i.e., the closer to the CBD the greater the positive effect of a new transit system on property value), 3) there can be a “disamenity” effect because of negative externalities of train stations (additional noise, pollution, and/or crime reduces property values), but the effect is smallest for light rail, and 4) the greater the density of development the greater the positive impact of the rail. However, the papers included in Bartholomew and Ewing (2011) as well as Debrezion et al. (2007) do not assess the impact of extensions to light rail nor do they focus on New Jersey, but rather examine cases across multiple countries.

By contrast, Kim and Lahr (2014) focus on New Jersey. They analyze the opening of the Hudson-Bergen Light Rail (HBLR) using a hedonic model with residential repeat-sales. The HBLR is a light-rail system operating in northern New Jersey, which opened in 2000. Kim and Lahr set out to measure consumer valuations over the entire HBLR by analyzing houses that sold prior to the announcement of the line, and comparing them to sales (inflation adjusted) after the opening of the line. In addition to the basic repeat-sales methodology, Kim and Lahr included independent variables for aerial distance (as the crow-flies) and network distance (using the streets) using a gradient approach for the network distance variable. The analyses also included a series of socio-demographic variables. They found that light rail increased house prices by an average annual rate of 18.4% with the effect decreasing by one

percent for every fifty feet further from the station. At a distance of ¼ of a mile, the effect disappeared.

Similarly, Chatman et al. (2012) examine the economic effect of the opening of the River Line. Like Kim and Lahr (2014), the model used a repeat sales model with the logged ratio of the most recent sale price divided by the oldest sale price as the dependent variable. The model included a series of distance variables to account for the spatial relationships that would be of interest in determining price appreciation affects (i.e. closest commuter rail, bus station, highway, and major CBDs). Additionally, the model included demographic variables similar to Kim and Lahr (2014). However, this study differed from Kim and Lahr (2014) in that this study controlled for property characteristics including bedrooms, bathrooms, renter occupied, lot size, age of home, etc. as well as analyzing the line using repeat-sales. Additionally, the study analyzed distance from whistle-blowing points to test whether there was a negative effect associated River Line noise.

Surprisingly, the analysis concluded that there was a negative effect associated with the River Line in the five-mile radius around new stations. The research found that while low-income and smaller houses near the new stations did benefit from the line, properties farther away from the station faced a decline in housing value. Chatman et al. (2012) characterized this as transference of value from properties further from the station to properties nearer the stations. Interestingly, the net change in value was negative as the decrease in value slightly exceeded the corresponding increase. The measured increase occurred after the rail was operational. During the construction phase, proximity to the line was associated with negative externalities of building (i.e. noise, material delivery, additional traffic) decreased property

values. The authors surmise that residents expected the line to increase traffic and crime which contributed to the lower values once ground was broken on the line.

Importantly, Chatman et al. (2012) included properties within a five-mile radius of the station, a range far greater than many other studies. Additionally, this work analyzed sales in 112 municipalities and along the entire length of the thirty-four mile line, which includes areas with lower density population.

However, other mediating factors may affect the link between property values and rail lines. For instance, Hess and Almeida (2007) examine the Buffalo light rail and track the effects of the line on property values twenty years after it had commenced operation. Like Trenton, Buffalo is a city experiencing stagnant growth. For Buffalo, they found that the effect of light rail on property prices is more pronounced near stations surrounded by higher income residential properties. In this same vein, Kim and Lahr (2014) found that household income had a positive, albeit minimal, effect on property appreciation. However, appreciation was greater at stations farther from the CBD. Taken together, these two findings raise questions. If the goal of the proposed extension in downtown Trenton is to bring outside commuters into the CBD, and Trenton has a median household income of half the average NJ income, an extension of the River Line into downtown Trenton may have a limited impact on property values (City Data, 2013). These unique characteristics of the proposed extension make it extremely difficult to determine the exact effects will be, and make it necessary to conduct a more focused analysis to see the effects of extensions in particular.

Comparing an extension to a new line does not account for the pre-existence of rail service. However, an analysis of an upgrade to an existing line accounts for this effect. Grimes and Young (2013) research the property price appreciation attributable to upgrades on

the Auckland's urban passenger rail "Western Line" in 2005. Grimes and Young focused on appreciation due to the announcement of the upgrade – they assumed rational homeowners who would immediately recognize the value of the transit upgrade. They use a straightforward quadratic regression with distance and distance squared as the only two independent variables. The analysis shows a positive effect from the upgrades with the magnitude of the effect getting greater as the distance to the station decreased. However, some of the stations show a negative effect at very close proximity to the station. While there are obvious differences between this study and an extension on the River Line (passenger vs. light rail; full line upgrade vs. extension; Auckland vs. New Jersey), this study does support the view that changes to a rail line can add value.

While the studies mentioned earlier show that light rail raises property values, the mechanism through which access causes rising property values is unclear. Bowes and Ihlanfeldt (2001) investigated what causes new rail stations to affect property values; particularly whether reduced commuting costs or attracting retail caused any increase in value and whether negative externalities or increased criminal activity caused any decrease in value. The paper examined the MARTA system in Atlanta and tested models for hedonic pricing (the benefit of easier commuting access), crime density, and retail employment density. The conclusions provide evidence for what most studies intuitively find; the direct effect of increased access is greater than the negative effects of a rail station and greater than the indirect benefit of retail development. Furthermore, the indirect benefit of retail on property appreciation is greater than the negative effect of crime except for property very close to the rail station in low-income neighborhoods near the CBD (i.e., in crime-prone areas a light rail station concentrates the crime which reduces property values). Bowes and Ihlanfeldt also

conclude that these effects on property appreciation are far from certain and vary with the specific income, distance to CBD, and distance to the station.

While most studies evaluate light rail by examining property prices, there are other methods to assess the economic impact of light rail. Werner et al. (2016) examine the effect of a new light rail from the perspective of ridership – whether there is an overall increase, decrease, or just shift of passengers from alternate public transit to the new light rail. Their review of five new light rail stations found an increase in the overall number of trips taken on public transport. Ridership rose because of commuters' revealed preference for higher quality and faster transport (relative to bus transport). While these findings do not allow us to directly infer the impact of an extension to the River Line, Werner et al. (2016) demonstrate the multitude of effects light rail can have on a local economy. Similarly, Baum-Snow and Kahn (2000) found in five cities (Atlanta, Boston, Chicago, Portland, and Washington) that urban rail upgrades had a positive impact on overall ridership with working professionals aged 20-32 accounting for the increase. However, this effect was minimal because the study was examining only upgrades to existing lines. These two precedents show that a new line or upgrading an existing line both increase the usage of the rail system.

Indeed, adding transit options may increase the value of the existing transit options. Kim, Ulfarsson, and Hennessy (2007) find that if there is direct bus service to a light rail station, it increases ridership on the light rail and on the bus system. The specifics of a bus system in Trenton would dictate the actual increase in ridership, but it is interesting to note that a light rail extension if instituted in coordination with bus routes could increase the amount of public transit passengers overall and decrease the amount of car commuting in the city. Additionally, Kim et al. analyzed patterns of pedestrian activity around light rail stations.

While the industry standard average walking distance from light rail station is about 0.25 miles, the average walking distance was 760 meters, or .47 miles for the St. Louis MetroLink. This suggests that property at a greater distance from the station will still have the potential to see price appreciation. Finally, this study found that park and ride lots can increase ridership if the line is in an area where car density is already high. In Trenton, 77% of workers already drive to work. Thus, it stands to reason that commuters in Trenton would attach high values to a park and ride (City Data, 2013).

In sum, there is a significant amount of research on property appreciation due to rail, but there has been little investigation into the effect of a rail line extension. The following analysis addresses the shortage. This work will not be a definitive answer to how a light rail extension will affect Trenton because as the last few researchers have demonstrated, there are many ways the extension can change a city, but it will be a good starting point.

III. Hudson-Bergen Light Rail Background

The idea for the Hudson Bergen Light Rail originated in 1984 as part of the smart growth plan to decrease traffic congestion while enhancing transit options in northern New Jersey. The $2.2 billion line links cities along the Hudson River waterfront in primarily Hudson County, NJ – stretching 20 miles with 24 stations from Bayonne to North Bergen through seven municipalities (Figure 1). The line is operated through a public-private partnership by New Jersey Transit (NJT) and Washington Group International as a “proof-of-payment” (ticketing is enforced by spot checks rather than a formalized ticket-checking process) line with a one-way ticket priced at $2.25 and a monthly pass $70 (NJT, n.d.). The HBLR was designed as the first ever design-build-operate-maintain (DBOM) system in the

nation, which means that NJT provided the funding for the line, but Washington Group is responsible for DBOM (this aligns incentives so both parties work towards long-term viability for the project) (NJT, n.d.).

The success of the line can be seen in Figure 2 with the large annual ridership being driven by commuters along the densely populated line. The Bayonne section of the line is of particular interest for us because of our examination of the 8th Street extension. Bayonne used to be home to a port, refineries, and significant rail yards, but since World War II these industrial areas have closed or significantly decreased activity; the closing of a naval terminal in 1995 exacerbated the downward trend. As the southern tip of the Hudson County peninsula, Bayonne is relatively isolated and as such had lower quality transit options into Manhattan prior to the HBLR. Due to this geographical disadvantage, the Census Bureau 2005-2009 American Community Survey (ACS) found that Bayonne had the highest percentage of seniors in Hudson County with 14.2% of the population being categorized as a senior.

IV. Methodology and Data

To investigate whether a light rail extension to 8th Street in Bayonne for the southern terminus of the HBLR had an effect on property appreciation we used a repeat sales methodology. Following the repeat-sales model used in Kim and Lahr (2014), Chatman, et al (2012), and Grimes and Young (2014) we examined houses in Bayonne that had been sold once before the announcement of the 8th Street extension on April 18th, 2008 and again after the station opened on January 1st, 2011. In this manner, we hope to capture the revealed preferences of consumers for the light rail extension while controlling for other factors that might influence house prices. The interim period between announcement and opening is

excluded from the analysis because the actual construction of the line affects properties differently (construction nuisances are not constant for all properties). This may affect the conditions of the natural experiment we want to observe. Additionally, since the station was built in a relatively short period of time, there were only 1108 house sales that fit our criteria (explained below) in Bayonne during that period.

The data for the repeat sales analysis was generated from an Open Public Records Search System (OPRS) managed by New Jersey's Monmouth County. The initial search of transactions brought in over 14,000 housing sales that took place between November 2000 and September 2015. November 2000 was chosen as the earliest date to match the window of time used in the similar repeat-sales analyses (at least 5 years and up to 8) and because the database did not have any earlier sales transactions. Similarly, September 2015 was the most recent data published. The data does not include any specifics on the houses themselves; it includes only transaction date, assessed value, and sale price. Each transaction was coded by the address and lot number – this way we had a unique identifier for each property even if they were apartments at the same address (i.e. Apartment A at Lot 1 and Apartment B at Lot 2 at 123 Main St. were counted as unique properties).

We then separated the data into pre-announcement, construction, and post-opening groups. All transactions with sale prices of less than $15,000 were not included in the analysis. We dropped these transactions because they were not arms-length transactions. That is, the home was sold at a discount that did not reflect the market value of the property (e.g., a parent sells a home to a child for $1). Additionally, observations with missing information were deleted from the data set. After these edits, we had 4,417 pre-announcement house sales,

1,108 construction stage sales, and 2,006 properties that were sold after the 8th Street Station opened.

Next, we matched the data points to find the houses that had sold at least once prior to the announcement and at least once after the opening of the station (repeat-sales). From this analysis, we found 463 properties that were classified as repeat-sales. The repeat-sales covered all of Bayonne, NJ. To measure the effect of the new station, we then identified the houses for which the new 8th Street Station would be the closest rail station (if there was another rail station closer than the effect of a new station would be negligible). We were finally left with 153 repeat sales. Of the original 153, we dropped nine observations.

Of the nine, three data points were for apartment buildings, which we dismissed because they reflect commercial deals rather than residential sales; one was a short sale, one was an industrial complex (again a commercial deal with more valuation considerations then a residential sale), one was a for a whole city block (the redevelopment of the land undermined the validity of a repeat-sales analysis), one was for a lot that could not be found on Zillow.com or Google Maps, one because the second sale price was for only 46% of assessed value whereas the initial sales was for 176% of assessed value (the median was 215% of assessed value). The last property was excluded because the second sale price was $20,000 or only 18% of assessed value. On this basis, we concluded that the sale was not an arms-length transaction.

This left us with 144 repeat-sales to use for our analysis. Figure 3 shows a map of our data points (the 8th Street Station has the green marker and the 22nd Street Station has the blue marker).[2]

We then mapped the distance for each house from the 8th Street Station and the next closest station, the 22nd Street Station as well as the distance to the closest bus line. We calculated the distance to the light rail stations in both minutes and tenths of miles using the fastest walking route that Google Maps suggested. Distance to the closest bus line was calculated as a straight line path to the road that the bus runs on because the exact location of the nearest bus stop could not be identified since buses in Bayonne have intermediate stops between the stops listed on the official schedule.

We then found the difference between the distance to the 22nd Street Station and the 8th Street Station to create the variable "Improvement" to measure how much the new rail station increased transit accessibility. Lastly, we created a variable of the reciprocal of distance (in minutes) to the 8th Street Station. We did this to determine how effects of an extension decrease as the distance to the station increases. This method is known as the gradient affect for measuring appreciation, and allows us to see more detail and determine the radius of effect for the light rail extension. We used these variables as independent variables in our regression model with the annual percent change in sale price as the dependent variable.

The dataset generated from the OPRS Database contained dates and prices for each sale; we used these sale prices (deflated for inflation using the BLS NY/NJ CPI_U for housing with 1980 as the base year) to calculate annual percent change. Consequently, our

[2] https://www.mapcustomizer.com/map/RepeatSalesMap

dependent variable is: $[(\text{inflation adjusted price in year T})/(\text{inflation adjusted price in year t})]^{[1/(T-t)]}$.

Our model does not include any variables for house characteristics. We do not need to include such controls because the nature of a repeat-sales analysis compares a house against itself, so comparisons are only made between identical properties. Additionally, we did not include any municipal characteristics because all of our observations are in the same town; the analysis can be thought of as a natural experiment where the methodology eliminates the need for fixed effect, dummy, or other control variables.

V. Results

Table 1 below shows the summary statistics for our independent variables (reciprocal of distance to the 8th Street Station in minutes, Improvement, distance to 8th Street Station in minutes) and our dependent variable (annualized property appreciation). The properties in our data set ranged from 3 to 19 minutes away from the 8th Street Station, while Improvement ranged from -5 minutes (meaning the property was closer to the 22nd Street Station) to 18 minutes. The average distance to the 8th Street Station was 9 minutes and 20 seconds, while the average improvement was 13 minutes and 15 seconds.

For annualized price change, a value of one means that after adjusting for inflation the price of a property did not change. However, in our dataset annualized price change has an average value of 0.958. This means that the average house lost 4.2% of its value each year between the first and second sales. This reflects that the pre-announcement housing sales were prior to the Great Recession and the housing market collapse, while the second sale is after the

collapse. At the extremes of our dataset, there was a house that lost 16.8% of its value each year and one that gained 14.1%.

Using the variables mentioned above, we estimate the impact of the light rail station on property values using both ordinary least squares with robust standard errors (OLS) and robust regression (screening using Cook distance to remove outliers and then doing Huber and biweight iterations in sequence). It is important to note that due to the design of the robust regression procedure, the R-squared of the model is not reliable so is therefore not reported. Our results are summarized below in Table 2.

In the first two specifications, we regressed annualized price change on distance to the 8th Street Station in minutes and Improvement. The first specification uses OLS and finds that a one-minute decrease in walking distance to the light rail station causes a 0.21% increase in annual price ($p = 0.083$). Improvement was not statistically significant. The robust regression reported in column 2 of Table 2 shows a similar result; a one-minute decrease in walking distance to the light rail station causes a 0.25% increase in annual price ($p = 0.044$). Improvement remained statistically insignificant.

In an effort to define the gradient effect of this relationship, we ran specifications three and four using the reciprocal of distance to the 8th Street Station instead of just distance to the station. The third specification uses OLS and finds a coefficient of 0.144 for the reciprocal of distance from the station. This estimate implies that a property 4 minutes from the light rail station shows 0.72% more annual appreciation than a property 5 minutes from the station ($0.25 – 0.2 = 0.05$; 0.05×0.144) ($p = 0.04$). The fourth specification uses robust regression and finds a coefficient of 0.154 for the reciprocal of distance from the station. This estimate implies that a property 4 minutes from the light rail station shows 0.77% more annual appreciation than a

property 5 minutes from the station (0.25 – 0.2 = 0.05; 0.05 × 0.154) (p = 0.028). This appreciation diminishes each minute further from the station until at 12 minutes the effect largely disappears. The effect of moving from 11 minutes to 12 minutes is a difference of only 0.1% in annual appreciation. We consider these houses to be practically unaffected by the new station.

During our testing we also included distance to the nearest bus line. Including this variable caused the reciprocal of distance to the 8th Street Station to become insignificant. Upon further investigation, we found that distance to the bus line and distance to the 8th Street Station showed a significant positive correlation coefficient (r = 0.35). However, neither of the local bus lines that traverse Bayonne experienced service or route changes during the period of our natural experiment, which means that access to the bus line would already have been internalized in the price of the houses.

VI. Conclusions and Implications

In this study we demonstrate that an extension to a light rail causes higher property appreciation. Properties nearest the new station show the largest increase in value. Using a specification in which property price appreciation is a linear function of distance from the new light rail station, we find that a one-minute decrease in walking distance to the light rail station causes about a 0.21% to 0.25% increase in annual price appreciation relative to unaffected properties in Bayonne (i.e., properties further from the station). To determine the gradient effect of this relationship, we run additional specifications that estimate the effect of the reciprocal of distance from the station on property price appreciation. These estimates implies that a property 4 minutes from the light rail station shows 0.72% to 0.77% more annual appreciation than a property 5 minutes from the station. This appreciation diminishes each minute further from the

station until at 12 minutes (0.6 miles) the effect largely disappears. Using our gradient approach, we found a larger area would be affected by the new station than some similar studies; Kim and Lahr (2014) found the effect dissipated after ¼ of a mile. However, our findings are still less than the five miles that Chatman et al (2012) reported. We believe these differences can be explained because Kim and Lahr (2014) were testing on the heavily urbanized region of the HBLR (with close transit alternatives), while Chatman et al (2012) were looking at the River Line which has a less dense route (and therefore higher car proliferation) and this study looked at the extension into southern Bayonne, an area with fewer transit options than other areas along the HBLR; we believe that our increased range of effects is a byproduct of the more lightly urbanized area that is southern Bayonne.

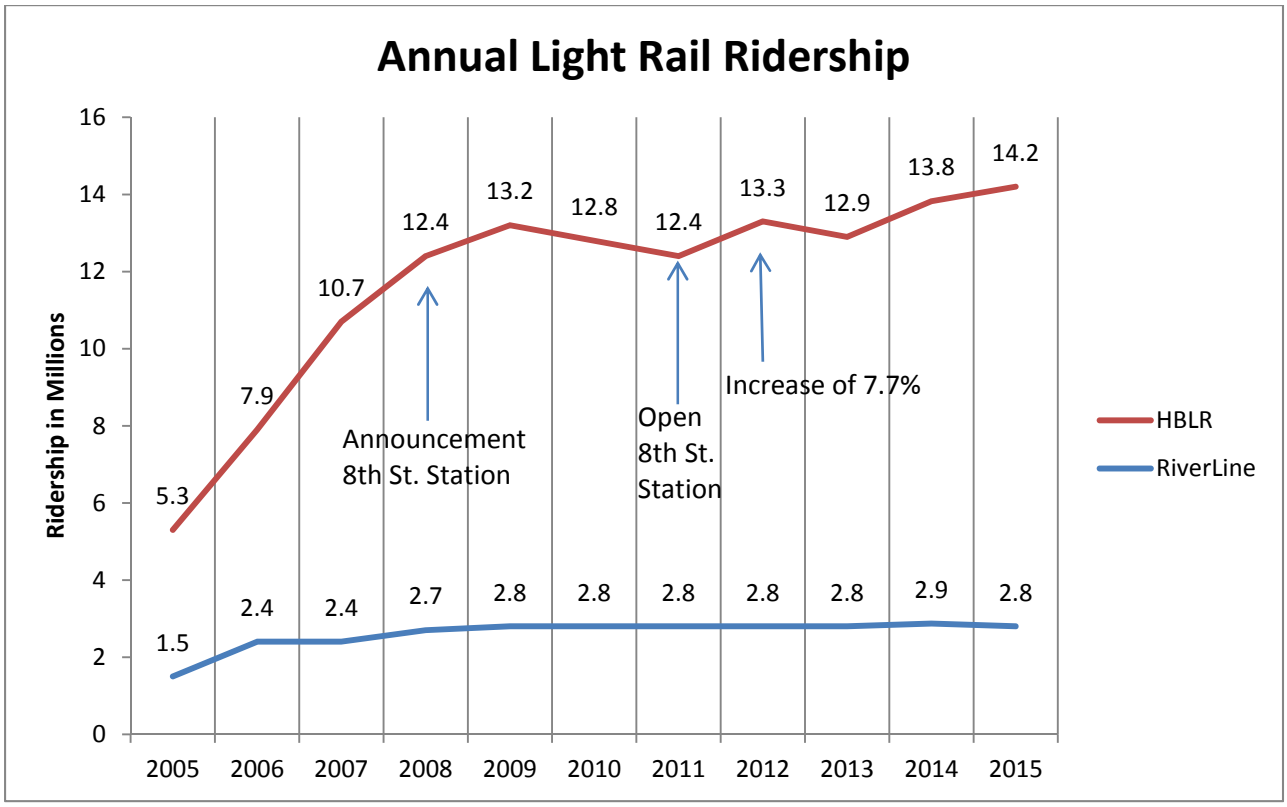
This study was conducted with other light rail extensions and particularly the River Line in mind. We wanted to know if there is a history of light rail extensions, specifically in New Jersey, resulting in greater property values as consumers reveal their preference for greater transit accessibility. We are able to answer yes, with a few qualifications. For the River Line, besides the commonality of New Jersey, the River Line and HBLR are different in regards to the demographic served; the River Line traverses an area with relatively sparse population, while the HBLR serves one of the busiest commuter areas of the country. However, it is beyond the scope of our work to compare Bayonne to Trenton or any other city that is considering a light rail extension. Lastly, while our research indicates that an extension is associated with increased ridership, we have not proven causality so it is necessary to explore these findings more to see if there is a systematic benefit in ridership.

To address some of the questions that our analysis raised, future research is necessary. For instance, does the extension story change when specific house characteristics are included?

Chatman et al (2012) found that low income houses near the station had the largest appreciation and such detail only becomes apparent when specific knowledge about the properties is known. Additionally, further research should be conducted to see if the effect differs depending on the characteristics of the area in which the extension is built. Finally, more research into the interaction of all available transit options and consumer preferences is an important step to better understanding consumer preferences.

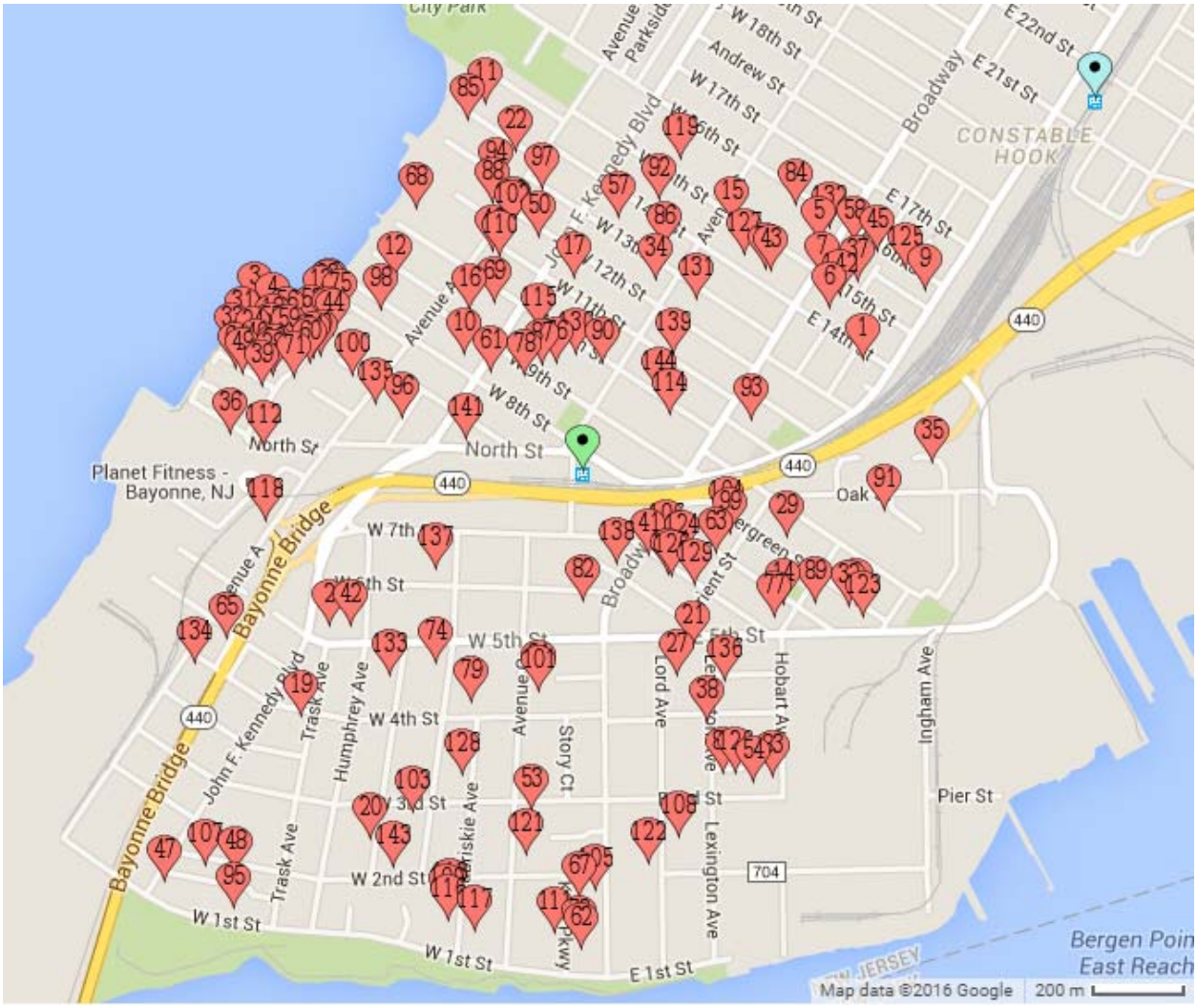
Figure 1: Map of the Hudson-Bergen Light Rail Service Area

Figure 2: Chart of annual ridership on the Hudson-Bergen Light Rail and Riverline



*Generated from NJT Annual Reports

Figure 3: Map of Repeat-Sales with the 8th Street Station marked in green, and the 22nd Street Station marked in blue



*Generated from https://www.mapcustomizer.com/map/RepeatSalesMap

Table 1.Means and Standard Deviations

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Distance_8th_Mins[a]	144	9.33	3.19	3	19
Distance_8th_Recip[b]	144	0.125	0.0582	0.0526	0.333
Improvement[c]	144	13.3	5.36	-5	18
Annualized Price Change[d]	144	0.958	0.0491	0.832	1.14

[a] = Measured as minutes to walk to the 8th Street Station using the suggested Google Map directions

[b] = The reciprocal of Distance_8th_Mins (i.e. [1 / Distance_8th_Mins])

[c] = Distance to the 22nd Street Station minus the distance to the 8th Street Station for each observation measured in minutes

[d] = Annualized price change in house price measured by [(inflation adjusted price in year T) / (inflation adjusted price in year t)] $^{[1 / (T-t)]}$

Table 2: Regression Results Summarized

Variables	Model 1: robust standard errors	Model 2: robust regression	Model 3: robust standard errors	Model 4: robust regression
Distance_8th_Mins	-0.00219* *(0.00128)*	-0.00255** *(0.00126)*	----------	----------
Distance_8th_Recip	----------	----------	0.144** *(0.0696)*	0.154** *(0.0693)*
Improvement	0.000268 *(0.000764)*	0.000172 *(0.000748)*	0.000139 *(0.000769)*	0.0000409 *(0.000752)*
Constant	0.975*** *(0.0165)*	0.975*** *(0.016114)*	0.938*** *(0.0136)*	0.937*** *(0.0131)*
Observations	144	144	144	144
R-squared	0.0214	----------	0.0300	----------

Notes:

Standard errors in parentheses

* denotes significant at the $p < 0.1$, ** denotes $p < 0.05$, *** denotes $p < 0.01$

a = Measured as minutes to walk to the 8th Street Station using the suggested Google Map directions

b = The reciprocal of Distance_8th_Mins (i.e. [1 / Distance_8th_Mins])

c = Distance to the 22nd Street Station minus the distance to the 8th Street Station for each observation measured in minutes

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