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The Effects from Public Transportation on Property Values: A Closer look at Scituate, Hanover, and Norwell, Massachusetts

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Abstract
Prior studies have expressed the value of location in real estate, but more recent studies have explored the influence that public transportation has had on housing prices. Access to public transportation is understood to increase the value of homes. Easier access to public transportation allows for shorter and more convenient commutes into or within cities. However, other studies have found that proximity to public transportation can also have adverse effects on property values. This paper investigates whether the implementation of the Greenbush Commuter line in Massachusetts in October 2007 increased the housing prices in Scituate, Ma--the furthest town from the city of Boston and the last stop on the Greenbush Line. Using a difference-in-difference model, we examine housing prices in Scituate, MA before 2007 and after 2007 and compare these changes to housing prices in two similar towns in Massachusetts that did not implement a commuter line. Our results indicate that the implementation of the Greenbush Commuter line in 2007 did not have a statistical difference between the housing prices in Scituate, Ma before 2007 and housing prices in Scituate, MA after 2007. These results are not consistent with our hypothesis that housing prices in a town that implemented public transportation would increase. This inconsistency may be due to the fact that proximity to public transportation can have negative externalities that lead to adverse effects on housing prices and lessen the positive effects from public transportation.

Keywords
public transportation, housing prices, Greenbush

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Introduction

When deciding where to purchase a home, people take many factors into consideration. Two of the main factors that future home buyers consider are almost always related to the cost of living and the level of accessibility needed to travel freely from one place to the next. These concerns often revolve around the size of the property, the distance to the nearest city, as well as the location of the home relative to the closest form of public transportation. Access to public transportation can play an important role in people's decision because many people rely on public transportation to get to and from work. Public transit is heavily relied upon because it is cheap, reliable, and the local schedules are often constant and uniform on a daily basis. However, public transportation also has its shortcomings. Evans (2016) mentioned that the presence of public transportation can increase the level of construction or infrastructure in a town, can add noise pollution, and can augment the level of congestion, which are all negative externalities that come along with the existence of a public transit stop.

The Greenbush Commuter line is a branch of the Massachusetts Bay Transportation Authority that is used by residents of the South Shore region of Massachusetts. The 27.6-mile line runs from downtown Boston, Massachusetts through the towns of Braintree, Weymouth, Hingham, Cohasset, and Scituate, with ten stations along the line. These stations include: South Station, JFK/UMass, Quincy Center, Weymouth Landing/East Braintree, East Weymouth, West Hingham, Nantasket Junction, Cohasset, North Scituate, and Greenbush. The Greenbush line was shut down in 1959 after running for 100 years and was not reinstated again until 2007.

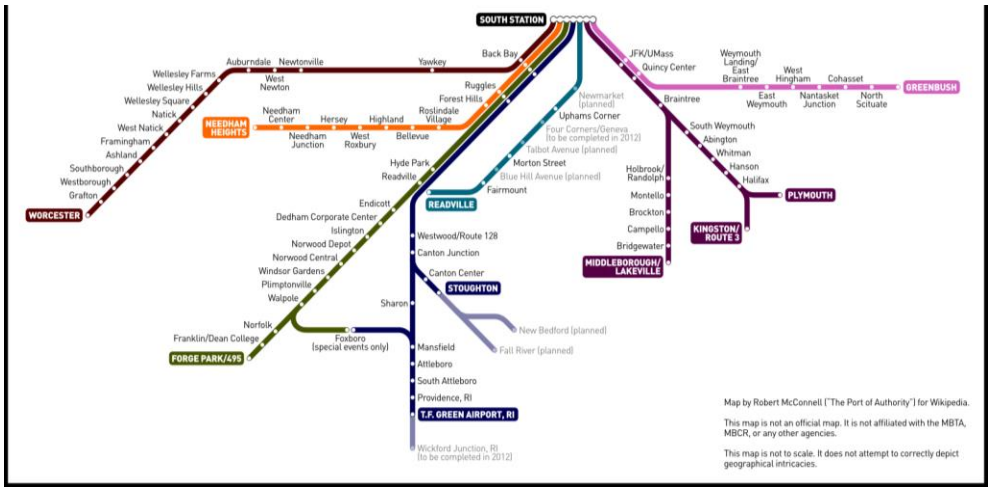


Figure 1: Map of all MBTA commuter lines

Talk of the restoration of the train station started in the early 1980s, approximately 30 years after the train was shut down. In 1985, the governor at the time voiced his support for the proposal of the passenger line. However, there were many concerns expressed by the residents of Scituate. Some residents were worried about the train ruining the character of the town, about congestion and safety, and about the increased noise level. Residents also worried that these negative externalities would decrease the property values of the homes in Scituate. These concerns made it more difficult to pass the proposal. In order to alleviate these concerns and gain public support, the MBTA agreed to soundproof the homes and businesses located near the railroad tracks--the homes most affected by the noise. Despite much political opposition, the construction of the Greenbush Commuter line finally began in 2003 and, after 4 years, on October 31, 2007, the line was once again opened to the public.

Thus, this poses the question: do the benefits of a public transit stop outweigh the negatives by increasing property values in Scituate, MA after the implementation of a commuter rail line? Our research aims to answer this question by analyzing the implementation of the Greenbush Commuter Rail line, in October 2007, in the town of Scituate MA. We seek to examine property values in Scituate, MA both prior to and after the implementation of the railroad stop to see if they were affected either positively, negatively, or if at all. We used a difference-in-difference model to compare the housing prices in Scituate, MA both before and after the implementation of the railroad stop to housing prices in two nearby towns, Hanover and Norwell, MA that did not implement a railroad stop over the same period of time. It is hypothesized that housing properties in

Scituate, MA will experience more significant increases in property value over this time period than property values in Hanover and Norwell, MA due to the implementation of a railroad stop in Scituate. The next section of this paper will discuss previous work done on this topic, followed by a section on our empirical data, and results. Finally, this paper concludes with a summary of the findings and suggestions for future work in the field.

Literature Review

Public transportation brings numerous benefits to towns and cities in the United States and has been credited with inducing an overall better quality of life to towns as it allows transportation opportunities for people to get to work, is better for the environment, and is more cost effective and more affordable than driving. The benefits from public transportation bring us one step closer to solving the nation's economic, energy, and environmental challenges. These benefits lead us to expect that having public transportation increase the property values in towns with public transportation. Numerous studies have examined the effects that various types of public transportation have had on property values and how expectations can lead to higher or lower housing prices.

Expectations have an effect on pricing. Hamilton (1993) investigated how stock prices were affected after the EPA mandated that companies release their pollution data. He found that stockholders in companies with high levels of pollution experienced a negative, statistically significant return. These negative abnormal returns were attributed to stockholder's expectation that high TRI figures may lead to higher costs of operation because of potential scrutiny by regulators and environmentalists. Stockholders also expected these high pollution figures may result in loss of reputation and goodwill. As it relates to our study, consumer expectations about how public transportation will impact a town can lead to an increase in housing prices as people who are looking for a house may be willing to pay higher prices up front because they know that the implementation of public transportation will be beneficial to the town. Similarly, Walls, Gerarden, Palmer, and Bak (2015) looked at how energy efficiency features are capitalized into home prices in: the Research Triangle area in North Carolina, Portland, Oregon, and Austin, Texas. The authors found that residents in these cities are willing to pay premium prices for homes up front and willing to invest in these homes because they expect lower energy costs down the line as these houses have implemented more energy efficient appliances.

In Charlotte, North Carolina, Delmelle, Duncan and Yan (2012) examined the impact that a new light rail system had on single-family housing values in Charlotte, North Carolina, from 1997 to 2008. They found that before the rail system began operation, proximity to the future rail corridor had a negative

influence on home prices. However, when compared across the four time periods (pre-planning, planning, construction, and operation phase) housing prices started to increase as a result of light rail investment during the operational phase. As it relates to our study, Delmelle et al. found that these results suggest that accessibility to transportation improves the value of single-family houses.

Similarly, along the South Shore in Massachusetts, Evans (2016) looked at how proximity to public transportation affected property values before and after a new commuter rail line was implemented. Using a difference – in – difference model she examined the difference in property value changes between the houses near the train stop and the houses further from the train stop. Evans looked at eight houses at each of the ten different stops along the Greenbush Commuter line. However, unlike previous studies, she found no statistical difference between the changes in property values of near houses compared to far houses and argues that the benefits and consequences of the Greenbush line mitigate each other, which lead to no difference in the change of property values.

Our study is similar in that we are examining how public transportation affects property value, but it is unique in that we are focusing on the housing prices before and after the implementation of public transportation in one specific town, Scituate, Massachusetts, which is the furthest town from Boston on the Greenbush line. We are observing the change, if any, on the selling price of homes before and after the train was implemented. We address how expectations about the public transportation may have influenced housing prices before the train was operational by also looking at housing prices before and after the announcement of the Greenbush Commuter line. We use two nearby towns that did not implement a train as a control in order to determine if our results were unique to Scituate.

Data

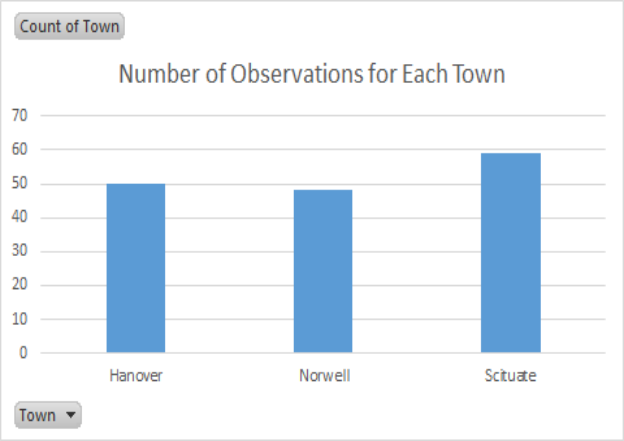
The data used for this study was collected from Zillow, a leading real estate and rental marketplace website dedicated to helping people buy, rent, and sell homes in their area. Zillow has data on each individual house. Examples of the data include: selling price, most recent selling date, previous selling date and prices, square footage, number of bedrooms, number of bathrooms, current estimate, acre size, and year built. Our data consists of 157 observations with 57 unique houses and on average each house has had three sales. A single observation is the selling price of the house, which also includes the address, the date sold, the distance from the closest railroad station, the number of bedrooms, the number of bathrooms, and the square footage of the home. The data is summarized in Table 1 below. The data is panel data that is organized at the

individual house level over a 27 year time period (1990-2017). When choosing which houses to examine, we first made sure that the house had been sold before 2007 and then after 2007. Additionally, in Scituate specifically, we looked at a collection of houses that were far (more than 1.5, 1.75, 2 miles) from the train station and chose a sample of houses that were close (less than 1.5, 1.75, 2 miles) to the train station. Google Maps was used to determine how far each household was from the train stations in Scituate. When choosing households in Norwell and Hanover, our main criterion was having the selling prices before 2007 and after 2007.

Variable	Observations	Mean	Min	Max
Distancefromtrain	157	6.939	.3	10
Valueofhome	157	471204.9	5000	1237000
Datesold	157	2006.752	1991	2017
Bedrooms	157	3.6114	1	5
Bathrooms	157	2.5764	1	6
Squarefootage	157	2681.433	555	662
Close	157	.127388	0	1
Close1	157	.184713	0	1
Close2	157	.21019	0	1
After	157	.4585987	0	1
Trainstation	157	.3757962	0	1

Table 1: Summary statistics for all data

Below is a bar graph that shows how many observations were obtained for each town. In obtaining our observations we tried to get an equal number for each town, but collected slightly under 10 more for Scituate than for Hanover and Norwell.



Figures 1, 2, 3, and 4 (below) are scatterplots that show how housing values have changed from 1990 to 2017. All the figures here indicate that there is a clear upward time trend in housing prices. Since this upward trend is not unique to Scituate, this increase in home values may be due to macroeconomic factors which we account for and address in the next section.

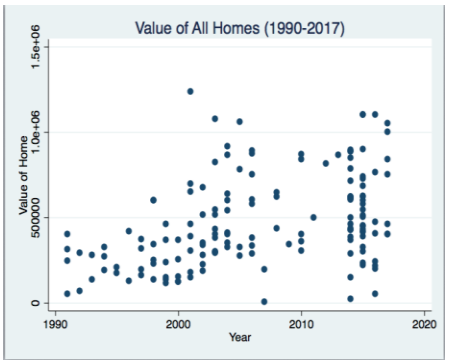


Figure 1: Scatterplot of All Home Value Observations

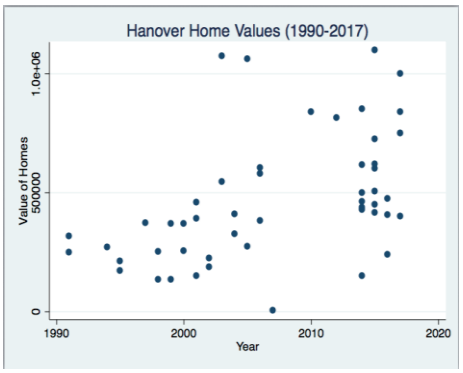


Figure 2: Scatterplot of Hanover Observations

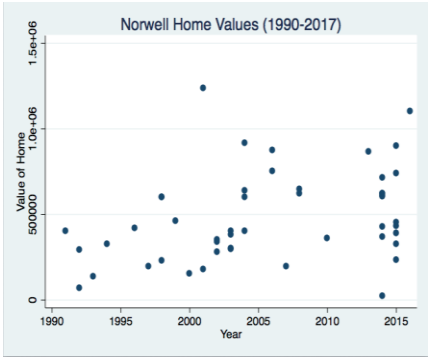


Figure 3: Scatterplot of Norwell Home Values

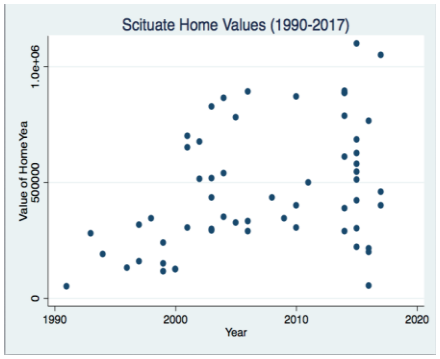


Figure 4: Scatterplot of Scituate Home Values

Ideally, we would have a greater overall number of observations for each town in order to have a more accurate representation of home values. Additionally, we would have accounted for houses that underwent renovations and expansions. If the value of these houses increased, these houses may attribute the increase in value to the new and updated features and less to the implementation of the train station.

Empirics

In order to analyze and identify whether or not there is any significant price change in the houses after the implementation of the Greenbush Commuter line in Scituate, MA numerous variations of the original model were used to examine the data. Each model evaluates different parameters in order to test whether or not certain models are too restrictive on the data. However, the models have only slight differences, which allows each model to capture small differences in the data, but overall convey results that address the main hypothesis. The various models also act as a robustness check for the experimental setup.

Model 1

The first model utilized is a difference-in-difference model that uses the town of Scituate, MA as the treatment group because this town implemented the Greenbush Commuter train stop in 2007, but Norwell and Hanover, MA act as the control group because these towns did not implement the Greenbush Commuter train stop in 2007. All of the data was included in this regression, and this model can be used to explain whether or not the variables accounted for below caused a statistically significant change in the property value for house i in time t.

$$(1) \qquad \delta it = \lambda_0 + \lambda_1 A + \lambda_2 C + \lambda_3 AC + \beta_4 S + \beta_5 R + \beta_6 B + \varepsilon$$

A is a binary variable with 0 being before the line started and 1 being after the line started, C is a binary variable with 1 being close (<1.5 miles) and 0 being far (>1.5 miles), AC will be an interaction term of after and close in regards to the home values in Scituate, MA, S is the square footage of the house, R is the number of bathrooms, and B is the number of bedrooms. This equation produces a coefficient for each explanatory variable, which indicates how each of the given variable affects the value of property i in time t.

Before moving forward and discussing the following models we would like to note that the next seven models will include multiple sets of parameters regarding the close and far variables. In *Model 1*, the variable close was defined as being less than 1.5 miles. In all of the future models we will use this set of parameters along with two more parameters for the variable close: C_1 and C_2. This time, C_1 is a binary variable with 1 as close (<1.75 miles) and 0 as far (>1.75 miles). We will also account for the parameter change regarding the interaction term of *after* and *close*. Instead, AC_1 will multiply *after* with $close_1$. Furthermore, C_2 is a binary variable with 1 being close (< 2 miles) and 0 being far (> 2 miles).

Similarly, AC_2 will multiply *after* with $close_2$. All other variables remain unchanged from Model 1.

Models 2,3,4

The next three models act as a robustness check for *Model 1* mentioned above. *Model 1* found little statistically significant evidence regarding price changes on property values in Scituate, MA due to the implementation of the Greenbush line Commuter Rail train stop, except for the variable *after*. However, this variable could have produced a statistically significant coefficient for many reasons beyond that of the implementation of the train stop. Thus, we decided to account for other exogenous macro economic changes by including the variable GDP. Therefore, *Models 2,3,4* are exactly the same regressions as *Model 1* except *Models 2,3,4* also include the variable GDP. All other variables remain unchanged from *Model 1*. Results from Models 2,3,4 are shown in the Appendix.

(2) $$\delta it = \lambda_0+\lambda_1 \mathrm{A}+\lambda_2 \mathrm{C}+\lambda_3 \mathrm{AC} + \beta_4 \mathrm{S} + \beta_5 \mathrm{R} + \beta_6 \mathrm{B} + \beta_7 \mathrm{GDP} + \varepsilon$$

(3) $$\delta it = \lambda_0+\lambda_1 \mathrm{A}+\lambda_2 \mathrm{C}_1+\lambda_3 \mathrm{AC}_1 + \beta_4 \mathrm{S} + \beta_5 \mathrm{R} + \beta_6 \mathrm{B} + \beta_7 \mathrm{GDP} + \varepsilon$$

(4) $$\delta it = \lambda_0+\lambda_1 \mathrm{A}+\lambda_2 \mathrm{C}_2+\lambda_3 \mathrm{AC}_2 + \beta_4 \mathrm{S} + \beta_5 \mathrm{R} + \beta_6 \mathrm{B} + \beta_7 \mathrm{GDP} + \varepsilon$$

Models 5,6,7

These next three models used also act as a second robustness check for *Models 2,3,4.* Instead of defining the *after* variable as 2007 or later we decided to define *after* as 2002 or later. We made this change because Scituate's town government announced the implementation of the commuter rail train stop in the year 2002, but it wasn't until 2007 that the commuter rail was actually built and operational. We considered the potential that people may have taken the 2002 announcement into consideration and that some of the home value price changes may have begun after the announcement, but prior to the actual implementation of the stop in 2007. All other variables remain unchanged from *Model 1*.

Using *Models 2,3,4* described above, we used Stata to run regressions and analyze the data. Tables 2,3,4 (see appendix) show that the variables *after*, *square footage of the house*, and *GDP* are all statistically significant for *Models 2,3,4*. The estimated coefficient for the variable *after* is positive and significant at the 5% level for all three models. This result suggests that there may be a correlation between the implementation of the Greenbush Commuter Rail train stop and the property value. However, the *after* term is rather coarse. The *after* term is coarse because it does not actually account for events that occur within each given year.

Therefore, we need further evidence to back up this claim. For this reason, we decided to include GDP to help mitigate this problem.

Model 2 indicates that as the square footage of the house increased by 1 foot, there is approximately a $102.00 increase in the price of the property and for a one trillion dollar increase in GDP there is approximately an $18,176 increase in the price of a property, holding all else constant. Unfortunately, none of the other variables were statistically significant. Although, we understand that there has been an upward trend in housing prices in the recent years, there is not strong enough evidence to attest the price increases to the implementation of the commuter rail in Scituate, MA. *Models 5 and 6* have slightly different coefficient estimates for the square footage and GDP variables, but both models are consistent with the upward trend in housing prices due to increased square footage and yearly GDP.

Model 8

$$\delta it = \lambda_0 + \lambda_1 \mathrm{A} + \lambda_2 \mathrm{C} + \lambda_3 \mathrm{AC} + \beta_4 \mathrm{S} + \beta_5 \mathrm{R} + \beta_6 \mathrm{B} + \beta_7 \mathrm{GDP} + \beta_8 \mathrm{FE} + \varepsilon \quad (8)$$

Our final, and primary model is *Model 8. Model 8* is quite similar to *Model 2* except *Model 8* also accounts for fixed effects across the three towns of interest: Scituate, Norwell, and Hanover, MA. This fixed effects variable controls for differences that could play a role in determining housing prices that are unique to each individual town. After including this variable, we found that *Model 8* has the same statistically significant variables as our previous models (*after, GDP, and square footage*), which indicates that the potential for unique individual town effects did not influence the results of *Models 1-7*.

Model 8 (fixed effects)	
squarefootageofthehouse	99.45529 **
	(34.4007)
after	79561.76*
	(45493.76)
gdp	25815.83*
	(9293.641)
Hanover	29994.68
	(142235.2)
Norwell	-40419.89
	(121252.6)
North Scituate	-78410.98
	(58641.41)
n	157
R2	0.4674
Adjusted R2	0.4230

*significant at 10%
** significant at 5%
*** significant at 1%

Table 5: Regression results from model 8

The results do not support the hypothesis that there is a positive relationship between the implementation of the Greenbush Commuter Rail train stop in Scituate, MA and housing prices. Despite the fact that we see an upward trend in housing prices after the train stop was implemented, the evidence does not suggest that the actual implementation of the train stop in Scituate, MA caused an increase in the housing prices. While these results may be surprising, there are many factors, both positive and negative, that could have counteracted each other. For example, the addition of the train stop adds a convenience and reliability feature to the town. However, similar to the findings of Evans (2016), the positive nature of the convenience and reliability aspect could be assuaged by the potential increase in noise pollution, congestion, and increased construction.

While the results may not have supported our hypothesis that the implementation of the Greenbush Commuter Rail train stop added value to the home prices in Scituate, the robustness of our findings are strong. Nine models were used in an attempt to encompass all potential variables that could influence the data, and after running all nine regressions, minimal statistical significance was found. One possible criticism of this study would be that only 157 observations were included. Thus, the sample size was not as large as an ideal dataset.

Conclusion

While many believe that public transportation brings reliability, consistency, and ease for traveling to and from a town, which is often looked at as positive attributes, our results indicate that the benefits from the commuter rail were not strong enough to have a positive effect on housing prices. However, our results do indicate that there is a positive trend in housing prices due to the increasing GDP over the years. The housing market is an industry in which there are a tremendous number of variables that play a role in the valuation of each individual house. There may be two houses of similar size in a town with a train stop, but one house may be much more expensive due to a myriad of different factors. Although, our models include some of the most widely accepted factors that contribute to a given house's value, future research should consider adding more variables to account for influences like renovations, appliance grades, and property acreage to ensure that all changes in housing prices are attributed to the correct variable of interest. Potential future researchers could also send out surveys to households in various towns and ask questions regarding how important public transportation was when deciding what town to live in. These surveys could help determine the actual level of significance that public transportation plays when households are determining where to live in comparison with other important factors like public schools and public parks. This future research may find that the inclusion of public transportation in a town may be lower on the scale of importance for households when determining how to weigh the benefits of certain factors over others.

Appendix

Model 2 AC	
squarefootageofthehouse	102.1709 **
	(34.14459)
after	105424**
	(37355.02)
gdp	18176.51*
	(4840.714)
n	157
R2	0.4587
Adjusted R2	0.4256

*significant at 10%
** significant at 5%
*** significant at 1%

Table 2: Regression results from model 2

Model 3 AC2	
squarefootageofthehouse	104.703 **
	(35.373)
after	111467.3**
	(38757.77)
gdp	18528.61***
	(4907.242)
n	157
R2	0.4551
Adjusted R2	0.4218

*significant at 10%
** significant at 5%
*** significant at 1%

Table 3: Regression results from model 3

Model 4 AC2	
squarefootageofthehouse	104.703 **
	(35.373)
after	111467.3**
	(38757.77)
gdp	18528.61***
	(4907.242)
n	157
R2	0.4551
Adjusted R2	0.4218

*significant at 10%
** significant at 5%
*** significant at 1%

Table 4: Regression results from model 4

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