Research Proposal:

Real Estate Hedonic Pricing Valuation Method of Various Modes of Public Transportation

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Synopsis:

Public transportation is an important part of a city's ecosystem. Providing low-cost commutes, traffic relief, and climate conservation, an effective transit network has many positive externalities on a local community. This analysis gives municipal, county, and state leaders the chance to make an informed decision on how much of a taxpayer budget should be spent on investments into buses and railways. In this case, Portland has a large public transportation network with buses, trains, and streetcars, which allows for comparison in consumers' willingness to pay for each mode of transit.

This proposal outlines an experiment to use the hedonic property pricing method (HPM) to study how changes in public transportation availability affect local housing prices. With a subset of transaction level data of home sales in a pre-specified timeframe, difference-in-difference analysis can monitor changes in price trends after significant investments or changes to the public transit infrastructure. Also, regression analysis can be used to reveal causal relationships between each mode of transit and housing prices, as well as create models accounting for multiple local forms of transport.

Project Summary

Transaction level real estate sales data allows for a hedonic property valuation of public transportation. With control variables that describe various aspects of a home, the proximity effect of public transit stations can be isolated and estimated. Two relevant paths exist in the literature for analysis in this case.

The first option requires a point in time when major rail or bus stations are constructed or upgraded. Control and treatment groups can separate based on proximity within a pre-specified distance, which allows for divergent trends to be monitored in comparable listing prices through a difference-in-difference framework. The benefit of this technique is that there are a variety of testable different dates. One possible example is in September of 2001, when Portland Trimet began offering streetcar service to the Portland International Airport. Another date for contention is July of 2002, when several bus routes were improved to have more frequent service. [1] Besides construction of rail or bus stations, other factors that may cause a change in demand or supply of public transit can be considered. Take for instance November of 2007, when a local crime committed on public transportation resulted in an increased police force on commuter lines. A difference-in-difference can determine whether this had an impact on real estate, and further dissect the impact of public transportation through different circumstances and events.

The second method has the advantage of not being limited by contextual events or shocks. With geographic data for each major rail and bus station in Portland, regression analysis can outline the correlation between proximity to the nearest public transit node and the value of real estate. This option has the added benefit of flexibility not constrained by notable events, as well as more leeway in the timeframe chosen than the first method. Another reward of this route is in the comparisons between different methods of transportation and their hedonic property values. Multiple regressions can observe the impact that rails, buses, and streetcars have on their own, as well as in different combinations. To compare the hedonic valuation of different modes of public transit, hypothesis tests can be run to distinguish significant differences in coefficients between models.

Both methods conducted in a single report can give valuable insight not only into the current hedonic value of public transportation but can also define differences in impact based on the mode of transport.

[1] TriMet. (n.d.). Making history. Retrieved March 07, 2021, from https://trimet.org/history/timeline/index.htm

Research description

Motivation

Public transportation is an important public good that can serve many purposes in the United States. Primarily, it helps reduce traffic and provide commuting options for large portions of a city's population. However, over time usage of U.S. public transportation has been less and quality has been worse.[23] This has led to a gap in the success of US public transit as opposed to other comparable nations. In Germany, effective and coordinated policies have resulted in a transit network where citizens are "five times as likely as Americans to use public transportation." (Buehler, Pucher, 2012)

With political focus on other topics and an increased strain on our economy due to the coronavirus, federal funds are ever harder to acquire, which makes it more difficult for cities to gain assistance in these capital-intensive projects. This begs the question: how good of an investment is public transportation for a community? How do public servants argue whether limited resources should be spent on public transportation? This work adds to a community's cost-benefit analysis for increased investments in their bus and rail lines.

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[2] Stromberg, J. (2015, August 10). The real reason American public transportation is such a disaster. Retrieved March 07, 2021, from https://www.vox.com/2015/8/10/9118199/public-transportation-subway-buses

[3] English, J. (2018, August 31). Bloomberg.com. Retrieved March 07, 2021, from https://www.bloomberg.com/news/features/2018-08-31/why-is-american-mass-transit-so-bad-it-s-a-long-story

This study visits a Portland, a city with a long legacy of extensive public transportation infrastructure. Portland began using horse drawn versions of train cars to help people get around the city in 1872. Since then, the city has seen large population growth, ranking as the 26th most populous city with over a half million people living within its 145 square mile area.[4] To effectively manage this dynamic area, Portland transportation authorities have often used Transit Oriented Development (TOD). According to a report from the Center for Transit-Oriented Development, Portland has a successful history of compact city planning which encourages consistent use of the public transportation network, as well as improving the walkability of its various districts (Thorne et al. 2011).

There are many benefits associated with investment in Public Transportation. Reducing a community's reliance on single-passenger cars can reduce carbon footprints, traffic, and provide means for marginalized neighborhoods to compete in the modern economy are all effects associated with public transit.

Previous Research

The use of a hedonic pricing method (HPM), especially in the context of housing prices, is a widely used practice in studying the perceived benefits associated with a public good. For an overview of the history behind this technique, Chin and Chau (2003) provide two cornerstone entries in the previous literature. Each work treats a good's value as a combination of various characteristics associated with it. The first important paper, Lancaster (1966), focused on consumer choices regarding a class of good. Rosen (1974), on the other hand, claimed that

[4] "2019 U.S. Gazetteer Files". United States Census Bureau. Retrieved February 27, 2021.

consumers show the perceived utility associated with a characteristic based on the price of a good with that trait.

HPM's have a long history of being applied to a variety of topics. One common application is using the method to study the perceived impacts of natura amenities on property values. One example includes Netusil, et al (2010), where the sale prices of Portland single family residential units are used to estimate the demand for tree canopy.

Specific to public transportation, we can also find several examples of different iterations. Take for instance Manelici (2017), who uses terrorist attacks in London as a demand shock to study the impact on surrounding housing and rental prices. The author uses transaction level data around major public transportation nodes to study the impact of a demand shock in the form of the 2005 London bombings. Using the distance from the nearest hub, listings are separated into treatment and control groups with a pre-defined cutoff, then subjected to a difference-in-difference analysis. This allows us to study diverging trends between housing near and far from public transportation nodes.

Another form that HPM's can often take is that of a regression, such as in Mosaind et al (1999), as well as Chen et al (1997). Because houses are fixed in place, we can view the distance from a bus or rail station as an explanatory variable for housing prices, Specifically, proximity to a node gives us a measure for a resident's ability to access the public transportation network. By studying the relationship between the two metrics, we can get an estimation for how home-owners and renters view the benefits associated with living close to public transportation. A unique insight from these stories is that these nodes have both a positive accessibility effect and a negative nuisance one on local pricing, with the positive influence dominating the negative one.

Each of the three transit-focused papers mentioned above deserve special notice in this review, as they study the effect of public transportation on Portland real estate, and specifically observe the effects of Light Rail stations on local housing prices. The 1999 iteration is especially applicable to our study, as it incorporates both methods of HPM: Linear regression and proximity grouping.

The issues here are two-fold. First, these reports are over two decades old, meaning that the underlying effects associated with public transportation may have changed. Another aspect to consider is that each only used light rail stations, not bus lines or streetcars. Therefore, there is room for more insight regarding the current effectiveness of public transportation, but also comparing various options of travel.

Data

In this circumstance, an applicable dataset is the Zillow's Assessor and Real Estate Database (Ztrax). Within we can find the sale price of a listing and its address, as well as a variety of characteristics and statistics associated with a particular transaction and house. This information can be used for control variables to isolate the role of proximity to a station. For geo-spatial data on public transportation stations, we can use open data found on the official website of the City of Portland at portlandoregon.gov. This will provide a way to measure the distance of an address from its nearest station. In accordance with previous work in this field, this research will only consider single-family residential listings. Acquiring this data is a matter of requesting it online from Zillow's website, which according to a previous researcher takes around six months to fulfill.

Depending on the timeframes chosen, only a subset of the entire dataset will be required for this experiment. One possible time to consider is the years surrounding September 2001, when

new frequent service lines were added. Another option is November of 2007, following a crime on the MAX rail system increased police presence on these routes. This example has the added inquiry of whether the increased security outweighed the impact of negative effect from the transit's reputation. While by no means the final option, another is January 2016, after a payroll tax increased funding to Trimet in the aggregate. This iteration is especially suited for our difference-in-difference analysis.

Methodology

The tested hypothesis of this research is whether public transportation has a positive influence on local housing based on proximity. Two possible methods are mentioned regarding measurement of this effect. Each of the options use observational data on housing prices.

$$P_{ijt} = \alpha + \beta X_{ij} + \mu_{jt} + \gamma\tau_t + \delta\tau_t T_i + \epsilon_{ijt}$$

The first approach involves the creation of treatment and control groups via proximity to the nearest transit station. To do so, the methodology will be modeled on Manelici (2017). Here, P_{ijt} is the housing price in USD, a continuous variable which can be used with a log transformation if it fits the data better than a linear format. The subscripts i, j, and t denote an individual listing, zip code, and year sold. X signifies a vector of control variables associated with real estate characteristics. The variable μ_{jt} signifies the year fixed effect of zip code j in time t. τ_t represents the time effect of year t, with T_i a binary variable denoting membership in the treatment group. Finally, the ϵ_{ijt} represents the residual error term not described by the other metrics. The coefficient of importance in this context is δ, which gives the difference-in-difference impact of a house being within a particular distance of a transit station.

$$P_{ijt} = \alpha + \beta X_{ij} + \mu_{jt} + \gamma \tau_t + \lambda \theta_i + \epsilon_{ijt}$$

The second method involves a straightforward workflow of regressing housing prices on proximity to the nearest station of interest. However, in this case there exists the variable θ_i, which represents the distance from stations of interest, possibly expanded to include multiple station effects. The coefficients to take interest in are the set of λ's, which signify the effects of proximity to a public transit station.

Note that these models will give biased results, as each sale likely includes a different weight or combination of controlling metrics. However, they will give invaluable insight into the magnitudes, signs, and significance of the various impacts observed.

Key Innovations

With an extensive history of HPM methodology, as well as previous applications to our target municipality, novel innovations are not necessarily the goal. Instead, this report can be used as a new observation of historical data, checking in on baseline statistics gathered over 20 years ago. This method can also be applied to various modes of transportation. Whereas the forerunners to this experiment only observed the impact from Light Rail stations, we can expand the scope to include other forms of public transportation as well, including bus stations as well. Using both the treatment and regression methods, we can provide informative historical data for others in the future to observe how public transportation impacts change over time, as well as providing insight into how those effects have evolved since 1999.

However, a new insight from this work is the study of differences in hedonic valuation between various modes of transport. Previous authors focused on Portland's light rail system, which leaves analysis open on streetcars and bus routes. Comparing models that account for

different combinations of public transit options can allow for more detailed discussion as to which form of public transit is right for a community.

This research proposal outlines research that could make itself home in a variety of economic journals, specifically those associated with urban planning and government policy. Some examples include the Journal of Urban Economics, the Journal of Urban Planning and Development, and the Journal of Public Transportation.

References

Thorne-Lyman, A., Wood, J., Zimbabwe, S., Belzer, D., Breznau, S., Fogarty, N., Brennan, T., Tumlin, J., & Yake, C. (2011). *Transit-Oriented Development Strategic Plan / Metro TOD Program*. 1–84. http://www.reconnectingamerica.org/resource-center/books-and-reports/2011/transit-oriented-development-strategic-plan-for-portland-metro-tod-program/

Sanchez, T. W. (2008). Poverty, policy, and public transportation. *Transportation Research Part A: Policy and Practice*, *42*(5), 833–841. https://doi.org/10.1016/j.tra.2008.01.011

Al-Mosaind, M. A., Dueker, K. J., & Strathman, J. G. (1993). Light-Rail Transit Stations and Property Values: A Hedonic Price Approach. *Transporation Research Record*, *1400*, 90–94.

Manelici, I. (2017). Terrorism and the value of proximity to public transportation: Evidence from the 2005 London bombings. *Journal of Urban Economics*, *102*, 52–75. https://doi.org/10.1016/j.jue.2017.09.001

Ercan, T., Onat, N. C., & Tatari, O. (2016). Investigating carbon footprint reduction potential of public transportation in United States: A system dynamics approach. *Journal of Cleaner Production*, *133*, 1260–1276. https://doi.org/10.1016/j.jclepro.2016.06.051

Chin, T. L., & Chau, K. W. (2003). A critical review of literature on the hedonic price model. *International Journal for Housing Science and Its Applications*, *27*(2), 145–165.

Chen, H., Rufolo, A., & Dueker, K. J. (1998). Measuring the impact of light rail systems on single-family home values: A hedonic approach with geographic information system application. *Transportation Research Record*, *1617*, 38–43. https://doi.org/10.3141/1617-05

Buehler, R., & Pucher, J. (2012). Demand for Public Transport in Germany and the USA: An Analysis of Rider Characteristics. *Transport Reviews*, *32*(5), 541–567. https://doi.org/10.1080/01441647.2012.707695