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The Modern Streetcar in the United States

Do Cities Have the Information Needed to Make Informed Choices?

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The rapid resurgence of streetcars in U.S. cities in the last 20 years has not been accompanied by studies which substantiate their claims of promoting economic development in an urban area. While conducting such a study is beyond the scope of this paper, I discuss how such an analysis could be carried out. Furthermore, using ridership, population, and fare data for cities with modern streetcars I predict ridership over time and estimate the elasticity of demand.

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Executive Summary

Streetcars have made a comeback in cities in North American in the last several decades; there are now over 45 cities operating, building, or planning streetcars. The majority of these streetcars are viewed primarily as catalysts for economic development, rather than as a means of public transportation. However, the streetcar's claim of promoting development is backed by surprisingly little evidence.

Although carrying out an analysis of the impact of streetcars on economic development is beyond the scope of this paper due to problems with data availability, methods of performing such an analysis are discussed. This includes a list of cities with modern streetcars, potential indicators of economic development, as well as control variables which should be included. In addition, ridership, population, and streetcar fare data was collected for six cities with modern streetcars: Kenosha, WI, Portland, OR, Tacoma, WA, Little Rock, AK, Tampa, FL, and Seattle, WA. Using this data, I predict ridership over time and estimate the price elasticity of demand. These results can be used to help cities set their fare rates and understand potential ridership.

This analysis shows that demand for streetcars is price-inelastic at -0.33. As fare increases, ridership decreases slowly and steadily, and as population increases, ridership increases. Cities should use this information to understand that setting a higher fare will increase their revenue. In addition, similarly sized cities can use mean ridership to predict their own streetcar ridership. The analysis contains several limitations, such as a small sample of cities as well as problems with data availability. This method can be repeated with a larger sample if data can be found on ridership in order to estimate a more accurate elasticity of demand. In addition, the discussion of development indicators and other factors can be used to conduct a comprehensive empirical analysis of the impacts of streetcars on economic development.

Introduction

Although streetcars were vital additions to growing North American cities in the early 1900s, after World War I, rising costs, the need for large investments in maintenance, and growing automobile ownership caused them to be replaced with the more economical cars and public buses (Encyclopaedia Britannica). A few of these streetcars, also called trolleys, have remained in operation, notably the systems in New Orleans, Philadelphia, Boston, San Francisco, and Toronto, but most cities ripped up the tracks and embraced new technology. However, Portland's opening of the first "modern" streetcar in 2001 has spurred a nation-wide trend. There are now over 45 systems running, under construction, or in planning in North America. The majority of these streetcars are not being built primarily for the purpose of providing public transportation, but rather as part of a development oriented transit plan, as they are seen as a development catalyst. The urban renewal efforts occurring in many cities as well as the federal government's promotion of these systems through its Small Starts capital funding program has helped lead to the streetcar's popularity in the last couple of decades. However, there is a surprising lack of empirical evidence indicating that the high cost of construction and operation is justified by the streetcar's impact on economic development within these cities. A thorough analysis of these effects should be undertaken in order to help cities determine whether a streetcar is a better investment than other forms of public transportation given scarce public funds. Furthermore, cities need to have information on the demand for a streetcar in terms of ridership as well as how the fare affects the number of riders, which this paper will analyze.

Literature Review

In attempting to determine the impact of streetcars, it is first important to make a distinction between the light rail systems some cities have recently been building and the new streetcars. According to the Transportation Research Board (TRB), which is sponsored by the Federal Transit Administration, trolleys run at street level on embedded rails in a downtown area making frequent stops, nearly every block, while light rail systems connect much larger areas such as suburbs and downtown centers, stopping only once a mile at most. Streetcars are also much slower, running at less than 12 miles per hour, and cost less to construct than light or commuter rail systems (2010). In addition, unlike light rail, many streetcars are not intended to be used primarily for commuter transit. For example, Tampa's streetcar does not begin operation on weekdays until 11 a.m., which is too late for residents heading to work (Brown, 2013). Kenosha's streetcar has a seasonal schedule, running seven days a week starting after 10 a.m. most seasons, but operating weekends-only during winter (downtowntrolley.org). An analysis of streetcars as a public transportation mode shows that there is significant variation between systems, and that New Orleans, one of the oldest streetcars in the United States, outperforms cities with modern streetcars in several ways. The New Orleans streetcar is better integrated with other modes of transportation as measured by the transfer rates from one system to another, sees continually increasing ridership, from 4.7 million in 2008 to 6.6 million in 2011, operates faster than other streetcars, and has the highest load factor, meaning most streetcars are full. It operates more like a light rail system than a streetcar in that its main function is as a transit service (Brown, 2013). In contrast, the author writes that he had difficulty obtaining data on streetcar service from several cities, suggesting that many streetcar agencies "do not really view the streetcars as primarily transit service but instead view them more as development catalysts or as devices used to serve tourists and shoppers” (Brown, p. 59, 2013). If this is that case, Brown notes that public transit funds should not be used to build or operate them, as they currently are (2013).

There are several explanations for the sudden growth of streetcars. The trend can be partially attributed to Portland’s example; the city claims to have received more than $3.5 billion in new construction from its initial $103 million streetcar investment (O’Toole, 2013). However, empirical studies of streetcars’ effects on the built environment, which includes changes in property values, retail sales, employment, and other economic measures, are nonexistent, so it is possible that Portland’s example may not be applicable to other cities (TRB, 2010). In fact, in order to evaluate the value premium, which is the increase in economic activity and property values created by the streetcar, one must control for changes in policies, such as zoning, which allow for greater density of development, as well as for subsidies or tax breaks given to developers along the streetcar route (TRB, 2010). These policy changes can have a positive impact without a streetcar system. In Portland’s Pearl District, $435 million in subsidies were given to developers and that district realized $1.3 billion in development. However, in a neighboring, similarly sized area, also along the streetcar line, no subsidies were given and $17.6 million of development occurred (O’Toole, 2013).

Furthermore, Portland’s example has not shown an increase in jobs in the downtown area. Although the population grew by 14 percent between 2001, when the trolley began operation, and 2010, the number of downtown jobs increased by only 0.3 percent. The growth of housing in some districts along the line led to more people being able to walk or bike to work, but in the same time period those who took public transportation decreased by 15 percent (O’Toole, 2013).

Portland's own study of the relationship between the streetcar and economic development found that after 1997, when funding for the streetcar was secured, 55 percent of all new development in streetcar neighborhoods occurred within one block of the streetcar, and this development was high-density, almost 90 percent of what was allowed by zoning. However, the report also notes that the city set its policies and regulations such as zoning and height limits to support high density land use while planning for the streetcar, as well as using other incentives to encourage development in these areas, such as public-private development agreements, investments in pedestrian areas, and urban renewal districts (E.D. Hovee & Co., p. 22, 42-3, 2008). The report itself states that it cannot assert causality between the high-density development and the streetcar, as it is a case study, and that alternate incentives have been necessary to enhance the streetcar's impact; however, public focus remains on the supposed success of the streetcar itself (E.D. Hovee, 2008). The TRB agrees, noting that even before securing funding for the streetcar line in 1997, other development trends in Portland such as rising land costs, a real estate boom for condominiums in downtown Portland, and demand for denser development could have led to these changes irrespective of the streetcar (p. 20, 2010).

Along with bringing economic benefits, streetcar advocates also claim that streetcars have a higher capacity than buses, lower annual operating costs, and are more environmentally friendly. These arguments can also be refuted depending on specific factors; for example, while trolleys do a have a higher passenger capacity than buses, they cannot run as often per hour for safety reasons (O'Toole, 2013). When it comes to operating costs, Brown found significant variation across the cities, with some streetcars having higher operating costs per trip than buses, and others lower (2013). This does not account for the much higher capital expenses for a streetcar compared to a bus, however. Furthermore, there is no evidence that streetcars use less electricity or cause less air pollution than buses. In 2010, cities with streetcars reported using an average of 4,164 British thermal units (BTU) per passenger mile, compared to 4,040 BTU's per passenger mile for transit buses (O'Toole, p. 14, 2013). Again, this is ignoring the high energy requirements needed for initial construction of the streetcar system. Cities which are concerned about pollution also have the option of buying hybrid-electric buses, as Lexington has done, which are more expensive than regular buses but still less costly than a streetcar system (kentucky.com, 2010). Furthermore, the TRB notes that none of the streetcar representatives from the 13 cities surveyed in their report cited environmental goals as a key factor behind streetcar development (p. 10, 2010).

Another promotional force for streetcars is the federal Small Starts grant program which provides up to $75 million in funding for transit projects which cost less than $250 million. This program can exclude larger and more expensive light rail projects, so cities began to consider streetcars. In addition, several cities received federal funding for their streetcars through the 2009 stimulus bill, including Cincinnati, Atlanta, Dallas, and Tucson (O'Toole, 2013). Receiving this funding from the Federal Transit Administration does not require cities to compare the cost-effectiveness of a streetcar to other alternative forms of public transit, or to project costs more than 20 years into the future, avoiding the majority of maintenance costs, which can be 50 to 100 percent of the original construction costs (O'Toole, 2013).

There are several more distinctions between popular belief about streetcars and actual evidence. The TRB interviewed representatives of streetcar systems and found that almost all of them believe their trolley had a direct, positive effect on the built environment, especially in creating new development and increasing property values, although they could cite few or no studies to confirm this. In addition, only a small number of cities considered other forms of transportation besides a trolley in the planning phase, claiming that people, especially tourists, are more willing to ride streetcars than buses. This claim has also not been empirically proven (2010). In fact, Peter Rogoff, head of the Federal Transit Administration said “it turns out you can entice even diehard rail riders onto a bus if you call it a ‘special’ bus and just paint it a different color than the rest of the fleet” (O’Toole, p. 16, 2013). Furthermore, the TRB found that secondary changes which should occur along with improved public transportation, such as reduced need for parking or more investment in sidewalks or bike lanes which have been observed alongside light rail systems, have occurred in few cities with streetcars (2010).

Cities have also been confronted with the challenge of predicting ridership before streetcar construction. Tampa and Little Rock have both seen a decrease in ridership in the last several years, and Salt Lake City, which just opened their streetcar at the end of 2013, has averaged only 781 of the expected 3,000 riders per day (Lee 2013). In order to justify the construction and operation costs of a streetcar, cities need to have an accurate picture of how many people want to ride the streetcar, and how high they can set the fare in order to increase revenue without sharply decreasing ridership.

Data and Methodology

It is clear that cities are often making the decision to invest in a streetcar with misleading or ambiguous information, and at best, a lack of evidence. Empirical analysis on the impact of streetcars on economic development is needed. The TRB suggests several indicators of streetcars' impacts including land value, lease rates, increased pedestrian traffic counts, increased sales at existing businesses, increased employment, and increased lodging occupancies (p. 5, 2010). There are currently 16 cities in North America which have begun operation of streetcars in their downtown area within the last 25 years, which could be used as part of time series panel data to study streetcar development impacts. These cities are: Dallas, TX, Nelson, BC, Memphis, TN, Vancouver, BC, Astoria, OR, Kenosha, WI, Portland, OR, El Reno, OK, Tampa, FL, San Pedro, CA, Tacoma, WA, Little Rock, AK, Seattle, WA, Savannah, GA, San Diego, CA, and most recently, Salt Lake City, UT.

The existence of value premiums, or increases in property values, housing prices, and office and residential rent, has been studied in relation to other forms of transit, with mixed results. Some studies have found that properties closer to transit stops have realized value premiums as high as 32 percent, while others have found negative impacts on property values due in part to the noise of transit, like light rail (TRB, p. 6, 2010). Furthermore, any study of streetcar impacts based on value premiums must include controls for other factors commonly affecting value premiums, such as traffic congestion, real estate market and business conditions, changes in zoning which allow for denser development, government policies which promote or incentivize development, and government investment in infrastructure which promote pedestrian environments. Other studies could focus on retail sales and job growth within walking distance of the streetcar, as well as the number of visitors to a city before and after streetcar construction. However, changes in zoning, investments to create pedestrian-friendly areas, and government promotion of development such as tax breaks and subsidies awarded to businesses that locate along the streetcar route must also be considered in this case. The success of a streetcar in promoting development in an urban area may also be affected by the presence of other forms of public transportation. For example, a city with an existing light rail system which can move people from outside the city to the downtown area may see more ridership, and therefore more development, than a city which has no such system. The time and effort needed to collect all this information may explain why no such study has been conducted. Cities often do not collect statistics such as population, jobs, retail sales, and property values within smaller areas, such as downtown or neighborhoods within downtown. Instead, this data may be collected through examining census tracts or each property or block individually. For these reasons, case studies have been the preferred method of examination; however, case studies alone do not provide the evidence necessary for cities to make informed decisions about their own investments.

Although the data necessary to conduct the desired study on the impacts of streetcars on economic development is not available or cannot be collected within the available timeframe, there is enough information to conduct an analysis of another important streetcar aspect: ridership. Some cities charge a fare to ride the streetcar while others offer free service. The fares they set have often increased over time. Using fare and city population, I determine the demand for streetcars. Data on population comes from the census bureau, while fare and ridership figures are more difficult to collect. The website railwaypreservation.com offers basic information on most North American streetcar systems, such as the years in which they were built or extended, the length of track, as well as some fare data. In addition, a few cities responded to my requests and reported their ridership figures as well as fare changes over time. In other cases, fare and ridership information were gathered from a variety of news articles over time. This research led to data on ridership, population, and fare rates in six cities:

1. Kenosha, Wisconsin: Kenosha is a small city with a population of 99,350 in 2010. Their streetcar began operation in 2000. The trolleys look like old-fashioned streetcars, called heritage trolleys, and run on a 2 mile track. The fare started out as $0.25 and has increased over time to $1. It operates weekends only during winter and seven days a week other seasons, but not during commuting hours. In addition, Kenosha has a light rail system running to Chicago with connections to the streetcar.
2. Portland, Oregon: Portland, with a 2010 population of 585,416, has operated a modern-looking streetcar since 2001. Several extensions have led to a total track length of 7.35 miles. It runs seven days a week including during commuting hours and is also connected to Portland's extensive light rail system. Although service has been free for the majority of the route, a fare of $1 was implemented in 2012.
3. Tampa, Florida: Tampa had a population of 336,945 in 2010 and has operated the TECO Line Streetcar System since 2002. It operates heritage trolleys on a 2.7 mile track which was extended once in 2010. It operates seven days a week but not during commuting hours and charges a $2.50 fare.
4. Tacoma, Washington: Tacoma, with a population of 198,411 in 2010, began operating its modern streetcar in 2003 on 1.6 miles of track. There is no cost to ride the streetcar, which operates seven days a week including commuting hours and connects to a light rail system.
5. Little Rock, Arkansas: Little Rock had a population of 193,976 in 2010 and has run the heritage River Rail Streetcar since 2004. The fare has increased to $1 in that time and the track has been extended to a total of 3.4 miles. The system operates seven days a week including during commuting hours.
6. Seattle, Washington: The modern Seattle South Lake Union Streetcar began operation in 2007. Seattle had a population of 610,409 in 2010. It operates on 1.3 miles of track seven days a week including during commuting hours. The fare is $2.50 and the streetcar also connects to a light rail system.

These cities portray the diversity of streetcar systems within the United States. The collected data was used to estimate the demand for streetcars based on fare and population. In addition, the price elasticity of demand was estimated. These results can be used to help cities set their fare rates and understand the potential ridership.

Analysis and Results

The model predicting ridership is estimated as:

$$\log R_{it} = \alpha_1 F_{it} + \alpha_2 P_{it} + \alpha_3 C_{it} + \varepsilon_t$$

where the dependent variable, logR, is the log of ridership. The logarithm produces a better fit and positive fitted values for ridership. The α's are estimated coefficients; F_{it} represents the fare in a city i, year t. The city-year is the unit of observation, meaning an individual city in a particular year. P_{it} is the population in city i, year t. C_{it} represents the fixed effect of a city in city i, year t. The fixed effect controls for the many fixed unmeasured differences between cities that remain constant over time. All other unmeasured differences which vary over time are included in the disturbance.

Summary statistics are presented below. Population was gathered for each city starting in 1990 in order to measure differences before and after the streetcar was in operation. Fare was available for all years in which there was a streetcar, and ridership was found for many but not all of those years.

Table 1. Summary Statistics

	Mean	Std. Dev.	Min	Max
Population (N=226)	447,612.6	337,023.3	81,355	1,300,000
Ridership (N=58)	924,648.7	1,193,083.0	38,825	4,078,639
Fare ($) (N=118)	0.74	0.76	0.00	2.50

In addition, Table 2 presents summary statistics for the 58 city-years in which ridership data was available. Population appears to be lower for the years in which there is ridership data, but fare is not significantly different.

Table 2. Summary Statistics N=58

	Mean	Std. Dev.	Min	Max
Population	310,195.7	188,668.4	93,427	634,535
Ridership	924,648.7	1,193,083.0	38,825	4,078,639
Fare ($)	.77	.88	0.00	2.50

The results of regressing log ridership on the population, fare, and fixed effect of cities, presented in Table 3, produce an r-squared of 0.97, indicating that 97 percent of variance in ridership is explained by the included variables, including the fixed effect of cities. The log of ridership rather than linear ridership was used for three reasons. First, by performing a Boxcox test, the results show that the power is -0.66. If the relationship were linear, this result would be close to 1.0, while a logarithm has a power of 0. Some cities had a fare of zero, which cannot be estimated using a log, but elasticities can still be computed. Finally, using a log will ensure that ridership predictions are always positive, as they should be.

The model finds a positive relationship between population and ridership: for every increase of 100,000 in city population, ridership increases by 1.5 percent. The results also show that there is a normal downward sloping demand curve for streetcars. As the fare increases by $1, ridership decreases by 43 percent. As the mean of the fare data is $0.77, this means that more than doubling the fare only leads to less than a 50 percent decrease in ridership. This is confirmed by the price elasticity of demand calculation. The elasticity shows how much a change in price affects the quantity demanded. In this case, price elasticity of demand is calculated using the derivative of the fare, which is -0.43 multiplied by the average fare, 0.77, resulting in an elasticity of -0.33. This elasticity confirms that streetcar ridership is price-inelastic, and by raising the fare, cities will increase their total revenue, as most people will continue to ride the streetcar. The cities used in this analysis had fares ranging from $2.50 to free, representing a wide variance. $2.50 is a very high fare; in fact, in Tampa and Seattle, the fare of $2.50 is higher than the bus fare, and it is unlikely that any city would impose a fare higher than this (Brown, 2013). In addition, these fares are also consistent with the fares in cities not included in the sample. For example, the streetcars in Dallas and Savannah have free fare, the fare in Memphis is $1.00, and the fare in San Diego is $2.50. This wide variance makes it possible to be confident in the elasticity result.

Portland was chosen as the base case as it has the most ridership observations of all the included cities. This means that the ridership results from each city will be compared to Portland. Other things equal, Seattle is the only city which had fewer riders than Portland, by 1.4 percent. This equates to about 6,714 people, or 1.5 percent of the mean population of 447,612. Tacoma had the highest ridership compared to Portland, at 4.2 percent, or about 18,799 people. Some cities which have been operating their streetcar longer or were able to report more years of ridership data, such as Kenosha, Portland, and Tacoma, likely have more accurate results than cities like Seattle or Tampa, which could not report as many years or ridership data. However, in each case the coefficients were highly statistically significant.

These six cities include two cities which do not operate their trolley full time, Kenosha and Tampa. The average coefficient of these cities is 2.73, not significantly different from the average of the cities which operate streetcars full time, 2.94, indicating that this difference does not have a large influence on ridership. In addition, four of the cities have streetcars connecting to light rail systems, Kenosha, Portland, Seattle, and Tacoma. Since it is probable that light rail complements streetcars, the average coefficients of these cities were also calculated. Their average coefficients equal 7.5, much higher than the average for cities without light rail, Little Rock and Tampa, at 3.66. This relationship might be related to other fixed effects, but likely indicate that light rail is an important factor in the success of streetcars, perhaps because the light rail connects the streetcar lines to many more possible destinations.

Table 3. Predicting log Ridership

N=58 R-squared=0.9737	Estimate
VARIABLES	(std. error)
Population (1,000,000s)	15.0893***
	(2.2145)
Fare	-0.4304***
	(0.1154)
Kenosha	3.1411***
	(1.0787)
Little Rock	2.5873***
	(0.9288)
Seattle	-1.4475***
	(0.2111)
Tacoma	4.1945***
	(0.8183)
Tampa	2.3234***
	(0.6813)
Constant	6.4340***
	(1.2607)

***p<0.01; ** p<0.05; p<0.10
Note: estimates are regression coefficients predicting ridership;
Portland is the constant

Conclusion and Limitations

The results of the analysis provide a clear picture of the demand equation for streetcar ridership. As fare increases, ridership decreases slowly and steadily, and as population increases, ridership increases. These results have external validity for other cities trying to predict ridership on their streetcar or set their fare. While the fixed effects of cities not included in the data set would be assumed to be zero, these results could be estimated using a few years of data on ridership. Cities with populations comparable to the city populations in this data set could also use mean ridership to estimate their own potential ridership. In addition, cities operating streetcars free of fare or in the process of determining what fare to charge for a future streetcar should not be hesitant to set a higher price. Since the demand for streetcars is inelastic, increasing the fare will lead to more revenue for the city. This study also has some limitations, however. For example, although the sample includes six diverse cities in terms of population, geographic location, streetcar characteristics, and other factors, a larger sample would better predict demand and elasticity. If ridership from more cities could be obtained this analysis could be repeated with a larger sample to estimate these more accurately. Furthermore, the inability to collect ridership from some of the streetcar operators themselves necessitated the need to find ridership figures reported elsewhere, such as newspaper articles. This raises questions as to the quality of data, as some of these figures were rounded or could have been inaccurately reported.

The study of the true impact of streetcars has been plagued by limitations, however. The process of finding or creating the data necessary to make a comprehensive model would be extremely tedious and time consuming. In the efforts to find data on downtown areas containing streetcars, many cities responded that they do not collect data on population, jobs, or retail sales and tax revenues within their downtown area. However, in order to isolate the impact of the streetcar from other factors this as well as other information on government policies must be collected. The complications involved with collecting this and other data prohibit a comprehensive analysis of the impact of streetcars on economic development, at least for now. However, such studies should be carried out and may be more feasible as more and more cities complete their streetcar projects. In the meantime, cities should be cautious when making the decision to invest in a streetcar. At the very least, when looking to improve public transit, the cost-effectiveness of streetcars should be compared to alternative forms of public transit, and when seeking economic development, cities should be aware of the factors affecting development and evaluate the predicted impact of streetcars against other possible development programs, including all costs incurred, as other development strategies might be employed at the same time.

Resources

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