An Empirical Investigation of an Indicator of Economic Efficiency in the Public Transportation Industry During 1994

by

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# Table of Contents

Lists of Charts and Tables ........................................................................................................... ii

## Chapter One: Introduction and Statement of Purpose
- Introduction ............................................................................................................................ 1
- Research Purpose .................................................................................................................. 5
- Organization of the Research ............................................................................................... 6

## Chapter Two: Research Setting
- Introduction ............................................................................................................................ 8
- Government Expansion .......................................................................................................... 8
- Governments Changing Role in Mass Transit ...................................................................... 9
- Typical Components of a Transit Authority’s Budget .......................................................... 17

## Chapter Three: Review of the Literature
- Introduction ........................................................................................................................... 18
- History of Public Transportation ......................................................................................... 18
- Economics of Mass Transit ................................................................................................ 18
- Fare as a User Fee .................................................................................................................. 29
- Arguments in favor of Subsidization .................................................................................... 30
- Arguments against Subsidization .......................................................................................... 33
- Results of Subsidization - the Farebox Ratio ...................................................................... 35
- Hypotheses .......................................................................................................................... 40

## Chapter Four: Methodology
- Introduction ........................................................................................................................... 41
- Research Design .................................................................................................................... 41
- Model ................................................................................................................................... 43

## Chapter Five: Analysis of Findings
- Introduction ........................................................................................................................... 47
- Correlation Matrix ................................................................................................................ 48
- Regression .............................................................................................................................. 48

## Chapter Six: Conclusion
- Introduction ........................................................................................................................... 52
- Summary ................................................................................................................................. 52
- Strengths and Weaknesses of the Project ............................................................................. 54
- Suggestions for Future Research ......................................................................................... 55

**Bibliography** .......................................................................................................................... 58
Listing of Charts and Tables

Charts
Growing Governments (2.1) ................................................................. 9
Gross Capital Expenditures for Railways and Utilities (3.1) ................................................................. 21
Transit Fares and Wages Vs the Operating Ratio (3.2) .................. 22
Transportation Price Indices (3.3) ......................................................... 24
Subsidies for Highway Construction (3.4) ...................................... 26
Transit Industry Performance (3.5) .................................................... 27

Tables
History of Mass Transportation (3.1) ............................................... 19
Correlation Matrix (5.1) ................................................................. 48
Regression Analysis of Farebox Ratio Model (5.2) ...................... 48
Chapter One

Introduction and Statement of Purpose

Introduction

Throughout human evolution, technological advancements bring change. The changes indelibly impact the quality of life for those living in the era. These improvements often erase an older technology or alter the typical mode of operation. The creation of bronze ushered out the stone age. The invention of the telegraph eliminated the need for the Pony Express, and similarly, the telephone erased much of the functionality of the telegraph.

The twentieth century technological advancements have grown exponentially. Not only are humans modifying their lots in life, but also they are directly affecting the environment in which they live. The changes of the twentieth century created new markets. Like the advancements that have preceded them, these twentieth century advancements are also not without corresponding market causalities. One of these causalities is privately-owned mass transit operators.

Long extinct are the urban neighborhoods of true convenience in most cities. Modern zoning and suburban planning have separated industrial areas from commercial and
residential areas. It is very difficult to find any neighborhood with these three necessities of modern life within walking distance. If one looks at any transportation modal split information provided by a metropolitan planning organization, to go to one's job or to buy groceries, some form of mechanized transportation is necessary.

While the urban landscape changed, so did the perception of government's role in the economic welfare of the country. In the United States, public spending accelerated in the late 1930s. In an effort to stem the suffering of American citizen during the Great Depression, the federal government implemented many programs. These programs, often referred to as the 'New Deal,' changed the perception of the general public on the role of government. The *laissez-faire* days of government non-involvement were over. Government was now viewed as responsible for the economic welfare of the nation. With the implementation of the Civilian Conservation Corps as well as the Tennessee Valley Authority programs, governments in America began to enter markets in which they had never before directly participated. This proliferation of direct government participation in previously private markets has continued.
Currently, in every major American metropolitan area, there exists some form of government transit authority. To maintain affordable urban transportation, government entities have usually taken the role of directly operating the service. In almost every urban transit system across the country, some form of subsidy is necessary to insure that the service is provided. Subsidies typically range from twenty-five percent to complete subsidization.¹

Urban mass transportation has existed in some form in the United States since the 1864.² Originally mass transit systems were viewed as beacons of progress, civic well-being and growth. In the late eighteen hundreds, the street car was beheld as the pinnacle of mass transit. A turn of the century city-dweller expressed the sentiment well,

If the streetcar could be made self sustaining, we ought as a matter of pride to have them. Nothing contributes more to give a city the appearance and air of general importance than streetcars.³

However, this belief in the importance of urban streetcars did not survive the advent of the internal combustion

² Walker, James Blaine. Fifty Years of Rapid Transit 1864-1917 (1918) p. 2.
³ As found in Analysis of Existing Transit Systems Austin Transit Study, Prepared by the City of Austin in cooperation with USDOT and the Urban Mass Transit Administration (UMTA) (1972) p. 5.
engine. The widespread use of the personal automobile changed the nature of mass urban transportation.

By the 1940s, the increasing use of the personal automobile, combined with low-interest, federal new housing loans, as well as other factors lead to the prolific increase of "urban sprawl" as well as "urban flight".4

Controversy in Modern Day Transportation Authorities

Across the country, controversial urban mass transportation issues have brought transportation providers and their policy makers into the media limelight. Stories abound, "Bus Drivers, Mechanics picket Metro" in Houston, Texas; "Filling the Subways with Pork" in New York; "BART Director Pleads Not Guilty Pryor" booked, released after arraignment extortion charges" reported in the San Francisco Chronicle; "VIA pays $3 million for a five-acre eyesore" in San Antonio. From BART in San Francisco to MTA in New York city, negative publicity seems to be the norm rather than the unusual.

4 These terms are defined in the Research Setting Chapter on page 12.
Research Purpose

The purpose of this research is twofold. The first is to examine the history of public transportation in the United States and set the basis for the current situation. The second purpose is an empirical investigation of one element of economic efficiency (the farebox ratio) of regional transit authorities and how this is effected by the environments in which the transportation agencies operate. The empirical research is explanatory and tests several hypothesis.

The model tests the six hypotheses. These hypotheses may suggest an optimal size or optimal parameter of operation exists to give the transit agency a more efficient or less subsidized level at which to operate. Depending on the results, the effects of diminishing return may outweigh the effects of economies of scale at some point of operation.

The model to be researched has the farebox ratio as a function of calculated city density, service area, service area population, operating expense, fleet size and average fleet age.
While some literature addreses the basic concepts of these transit terms, no previous research examines the relationship between the variables.

**Organization of the Research**

The research setting of the applied research project is discussed in Chapter Two. It presents information on the history of government expansion. It also furnishes the reader with a brief history of the urban mass transportation industry.

In the third chapter, the literature pertinent to the research topic is presented and discussed. The purpose of this chapter is to present literature that examines the history of mass transit subsidy as well as some basic economics associated with urban mass transit and subsidies. The conceptual framework also is presented, and terms are defined.

Chapter Four introduces the methodology to be used for analysis. It also presents the operationalization of the variables.

Chapter Five presents the findings of the research. Statistical analysis results are interpreted and discussed.
Chapter Six summarizes the findings and focuses on reasons why data may not have supported some hypothesis. Strengths and weaknesses of this research will be discussed as well as possible improvement for further study.
Chapter Two

Research Setting

Introduction

With special attention paid to the mass transit industry, this chapter provides information on the expansion of government. This chapter also describes historical changes in the mass transportation industry which began as private transportation companies and evolved to government subsidized entities.

Local Government Expansion

Excluding school districts, the number of governments in the United States has been growing this century. From the 1940s to the 1970s; municipal, town, and county governments have remained relatively constant in number. During the same time frame, special district\(^1\) governments have tripled and, in total number, surpassed all other forms of government, including school districts. Figure 2.1 illustrates the changing number of governments. School districts have been removed from this graph.

\(^1\) Special Districts are often the government units that operate as Transportation Authorities.
Government Changing Role in Mass Transit

Urban public transportation began in America in the 1800s. New York City was one of the first cities to experiment with public transportation. The experiment was a necessity created by the growing city's congestion. The earliest modes of urban transportation were typically mule-drawn or cable-drawn trolleys. The pre-existing problems with congestion and rising population are evidenced in a prediction from an anonymous futurist. Due to the rising number of residents in New York City as well as their reliance on private horse drawn carriages, he foresaw dire consequences. The congestion led this futurist to predict, ...

...New York City would be abandoned by the 1930s as unsafe for humans...the number of horses
necessary to haul all those people (7 million) around would result in a pile of horse manure that would pile to the third-floor window everywhere in Manhattan.²

Although his belief may have exaggerated the conditions, changes were necessary to circumvent this impending problem. One of the changes was the proliferation of mass transit systems. Unfortunately, the same problem that confronted individuals desiring to commute plagued early mass transit systems. There were limited numbers of routes to get citizens from one point to another. Without additional roadways, congestion among rival urban transportation companies would simply replace congestion from personal transportation.

It was then that government took its first steps toward regulating urban transportation. Laws were passed to prevent inefficient congestion among transportation providers.

The main purpose of the legislation was to insure an orderly extension of routes without unnecessary duplication, while at the same time ensuring that the resultant monopoly powers were not misused.³

² As found in Husted, Bill. "Futurist Can Peer Ahead on the Internet." Austin American Statesman 1996.
By passing legislation prohibiting the duplication of routes and restricting competition, the government practically gave transportation providers an effective monopoly. Any good required by most of the members of a community which has a limited number of suppliers, is subject to monopolistic abuse. In most cases, fixed fare pricing legislation was introduced to protect the public.

Unlike today, the turn of the century legislators designed regulations to protect the public, rather than to support the industry. "As far as public transport is concerned, much of the traditional justification for intervention has been based on the need to restrain the exercise of monopoly powers."\(^4\) Because of the abuses associated with monopoly power, legislation was passed. Not only was this legislation designed to protect the public from the monopolist powers held by the organizations, but also to insure a more balanced distribution of the routes.

The benefits of early mass transportation were easily seen. For example, fixed rail that was laid down could be a boon to any business. Much like an intersection of two

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major thoroughfares today, a nearby stop could provide customers with easy access to a business’s goods.

It was clear even then that transport investment impinged on so many spheres of life that the financial costs of a project would not necessarily reflect its true costs -or benefits- to the community.⁵

The impact of public mass transit on a community was so penetrating, the effects were difficult to measure. Mass transit regulations targeted at monopoly abuses, would not last through this century.

With the discovery of electricity, the electric trolley took the center stage of urban mass transportation. In Austin, Texas, the electric trolley was implemented in 1891, and it charged the same fare as the mule-drawn trolleys.⁶ The electric trolley dominated urban mass transit until after World War I, when the personal automobile began to allow many people freedom to travel widely, quickly and relatively inexpensively. The demand for mass transportation fell. The subsequent decline in ridership forced urban transit organizations to try to become more competitive. They were no longer the only option available to the public.

⁶ The fares were five cents. Analysis of Existing Transit Systems. Austin Transit Study, Prepared by the City of Austin in cooperation with USDOT and Urban Mass Transit Administration (1972) p. 5.
As transit agencies attempted to remain competitive with the convenient automobile, they expanded both hours of operation and numbers of destinations. These actions typically had the opposite effect.

Because of the increasing imbalance between peak and off-peak demand, efforts to expand service to compete with the automobile increased commuter patronage but reduced profit margins further.\(^7\)

This inability to adapt severely hampered the fixed rail system. By the 1950s, the failure of the private fixed rail trolley system was all but complete. Most transit authorities had begun to use buses.

During the 1940s, buses were commonplace among city streets. Because they did not run on a fixed rail, the buses offered more flexibility than the streetcars that had preceded them. If the community population moved within the city, changing a route no longer required that a track be removed and relaid. Mass transportation planners merely had to decide where the bus should go and what time it should be there. The ability to adapt afforded some longevity to the self-sufficiency of urban mass transportation. Due to this new found flexibility, mass transportation had once again

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become economically competitive with the automobile. But this deceptive competitive era would eventually end, primarily because the use of its main nemesis, the personal automobile, was spreading.

The important part of this competition is not solely the increasing numbers of automobiles, but the effect that the autos had on the urban landscape. Personal autos allow citizens more choices for the location of their residence. Moving to the suburbs to avoid crowded city neighborhoods, was often the choice of individuals who had the means to do so. This process is referred to as 'urban flight.'

'Urban sprawl' occurs as developers create new suburbs in formerly rural areas. These suburbs allow more individuals to leave the urban areas and lower the density of an urbanized zone. Both urban sprawl and urban flight have limiting effects on the efficiency of urban mass transportation. As population areas become less dense, it becomes less cost effective for a transit agency to serve that area.

In the book, *Bus Deregulation in the Metropolitan Areas*, authors Pickup, et al, refer to higher incomes leading to increased car ownership and use as the source of
a 'vicious cycle.' This cycle of increased traffic concentration leads to changes in the economics of bus operation. Ultimately, this cycle changes in the urban structure. The three impacts of this cycle are manifested in very different processes.

**Increasing congestion.** In the very short term there is increased congestion on the roads, slowing down buses more than cars, making them more unattractive.

**Changes to the economics of bus operations.** Over a slightly longer period of about a year, reduced demand puts financial pressure on operators, forcing them either to increase fares, or reduce service, or both. This makes the public transport service less attractive and drives away more passengers in the following year. Thus, 'cutting services in line with demand' is not a neutral response. A reduction in the vehicle miles run increases waiting times or walking distances for the remaining passengers.

**Changes to urban structure.** In the longer term, over ten years or more, the structure of towns change. The pattern of home and job locations and other activities disperse - much more difficult for a public transport systems to serve. Increasingly, cars become not only desirable, but necessary with a further boost to the spiral.8

In the United States, there was an extra catalyst that accelerated the changes in the urban structure. The Federal Housing Act (FHA) created loans only for new housing, not for remodeling. These loans made it more attractive for

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8 Pickup, Laurie; Stokes, Gordon; Meadowcroft, Shirley; Goodwin, Phil; Tyson, Bill; Kenny, Francesca. *Bus Deregulation in the Metropolitan Areas* (1991) p. 16.
homeowners to move out of the central city and build. In effect, the federal government subsidized urban flight and encouraged individuals to leave the urban areas.

The death stroke for private urban mass transportation came in 1964. In an effort to create better urban transportation, federal legislators passed the Urban Mass Transit Act (UMTA) of 1964. UMTA offered to subsidize 80% of mass transportation capital costs as well as a portion of the operating costs to localities.9 This act helped set up many regional transit authorities and create the type of system currently in place. Only the agency's name has changed; the Urban Mass Transit Administration (UMTA) also created by the act in 1964, is now titled the Federal Transit Administration.

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Typical Components of a Transit Authority's Budget

Similar to a commercial organization, a transportation agency has sources of income as well as expenses. The operating expenses may be separated into subcategories such as salaries/wages/benefits, materials and supplies, purchased transportation, and other operating expenses.

Unlike a commercial organization, a transportation agency typically has many different sources of income. Typically, these funds come from federal assistance, state funds, local funds and passenger fares. Passenger fares are the only major source of funds that are not some form of subsidy.

This chapter gave the reader some basic essentials regarding urban transportation in the United States. In the following chapter, an abbreviated history of urban transportation will be presented. Also in the following chapter, the changes of the urban form and its contribution to the inability of urban mass transportation providers to return profits will be explored.
Chapter Three

Review of the Literature

Introduction

The purpose of this chapter is to present literature that examines the history of the mass transit subsidy. The history of mass transit shows a trend of organizations moving from self-sustaining to becoming more dependent on subsidies. This chapter also examines reasons to subsidize and not to subsidize. The existence of the subsidy and the policies that sustain it have evolved over the last twenty years. The recovery ratio of mass transit agencies and the hypotheses surrounding this ratio are introduced.

History of Mass Transportation in the United States

In his book, *Urban Transit Policy*, David Jones separates the development of American urban transportation into eight distinct time periods. Each period, he states, is unique, from the politics to the urban landscape. His time period distinctions follow in Table 3.1:
Table 3.1

<table>
<thead>
<tr>
<th>Period</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>The horsecar era</td>
<td>1855-1890</td>
</tr>
<tr>
<td>Electrification and explosive growth</td>
<td>1890-1906</td>
</tr>
<tr>
<td>The era of punitive regulation</td>
<td>1906-1916</td>
</tr>
<tr>
<td>The era of wartime intervention</td>
<td>1917-1919</td>
</tr>
<tr>
<td>Transition from distress to decline</td>
<td>1920-1929</td>
</tr>
<tr>
<td>The buffeting of depression and war</td>
<td>1930-1946</td>
</tr>
<tr>
<td>The era of precipitous decline</td>
<td>1947-1960</td>
</tr>
<tr>
<td>The period of recovery without stabilization</td>
<td>1960-1980</td>
</tr>
</tbody>
</table>

Notably the longest period, the horsecar era, lasted thirty-five years 1855 to 1890. Some practices from this era still abound in current transit authorities policies. The flat fare is one of these relics.

...Many promoter sought a fixed fare so as to insulate their operations from political pressures for fare reduction. But, as a consequence, riders came to view a constant fare as a rightful entitlement.²

Although some transit operations, such as the ones in and around Phoenix, Arizona, adopted a zonal method of fare

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² Ibid p. 29.
charges, the flat fare is still the most common method of
charging passengers regardless of distance traveled

With the electrification of urban transportation
vehicles came rapid growth.

Promoters promised that consolidation of small
horse railways into larger traction syndicates
would produce economies of scale in management,
power generation, and operation, permitting the
rationalization of service in a fashion that would
simultaneously reduce costs and attract new
patronage.³

The amount of electrified trackage increased over 1600% from
1890 to 1902. As a percent of the total trackage,
electrified increased from 16% to 97%.⁴ According to David
Jones this period of expansion lasted approximately sixteen
years from 1890 to 1906. Figure 3.1 illustrates the steady
investment in street railways until 1908.

This investment in rail allowed individuals to move
further from work. “Many turn-of-the-century observers
viewed the inner city...as a social menace from which the
masses should make every effort to escape.”⁵ Urban flight
has it's roots in early rail.

⁵ Foster, Mark S. From Streetcar to Superhighway: American City Planners and Urban Transportation,
During the preceding expansion period, windfall profits were made, but during the trust-busting period of the Progressive era this would not go unnoticed. The era of punitive regulation lasted from 1906 to 1916. The regulations focused on restricting the monopoly powers that transportation systems inherently created. Despite these ordinances, it was during this period in 1908, rail transit ridership peaked.\footnote{Yago, Glenn. \textit{The Decline of Transit}, Cambridge University Press, New York (1984). p. 11.}

During the era of wartime intervention from 1917 to 1919, labor problems led to unionization. By 1920, street
railways ranked among the most heavily unionized industries with a level of union membership comparable to that found in mining and railroading." In turn, higher wages were successfully acquired but without corresponding increases in fares the operating ratio worsened.

Figure 3.2

Transit Fares and Wages vs the Operating Ratio


Not only was the worsening operating ratio a problem, but World War I made some policy makers wary of the insufficiency of the United States' transportation infrastructure. "Paralysis of the railroad system in responding to the logistics requirements of the World War I

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gives imperative to a national system of defense highways.\textsuperscript{8}

The development of a highway system would increase the mobility of individuals who purchased personal automobiles.

Although the period from 1920 to 1929 is referred to as the 'Roaring Twenties,' the 1920s were not spectacular for public transit. In Jones' fifth era, transition from distress to decline the automobile begins to play substantial role in the decay in the use of public transportation. Innovations in the manufacture of automobiles allowed for mass production and sale to the general public.

While mass production of automobiles lowered the purchasing cost, it became easier to establish a motorbus operation. Compared to the street railway companies, the motorbus companies of the 1920s had relatively carefree lives. "Driving, maintenance, and bookkeeping were family affairs, unencumbered by union agreements, craft specialization, or strict regulatory oversight."\textsuperscript{9}

Figure 3.3 shows the decreasing price index of purchasing and operating an automobile. It also illustrates


the increase of the transit fare index. This increase is especially interesting when the preceding graph is taken into account. Although the fare price index increased, the operating ratio still declined. It is important to note that the decreasing relative cost of the automobile afforded more people the opportunity to buy one. With an auto, workers were no longer bound to live within walking distance of their place of employment or a transit line that could provide access to employment.

Figure 3.3

Transportation Price Indices


During the period from 1930 to 1946, the United States experienced a depression and World War II. According to David Jones, these events had a buffeting effect on the
impending decline in mass transportation ridership. Public transportation ridership peaked in 1946, just after World War II.

Public transportation, more specifically railway transit, was also under direct attack. In 1937, there were 62 diesel buses being operated by transportation properties.

General Motors joined with an oil and rubber company to capitalize a transit management organization with the financing necessary to acquire failing streetcar systems and reequip them with diesel buses. The holding company thus formed-National City Lines- eventually acquired some 100 distressed street railways and converted them to diesel bus operation. By 1940, 75 U.S. transit companies were operating 680 diesel buses.¹⁰

Not only were the transit authorities under direct attack from General Motors, but also the Federal Highway Act of 1944 eroded its ridership base by making travel by automobile even more enticing.

After the peak in 1946, transit ridership plummeted over the next twelve years. Jones refers to this as the era of precipitous decline. It lasted from 1947 to 1960. Every four years during this period transit ridership fell over

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twenty percent.\textsuperscript{11} Private mass transit operations were in shambles

By the early 1950s, electrical transit was largely abandoned and most private transit operators were bankrupt...Automobile, rubber and oil companies faced Federal investigation and prosecution for market manipulations that contributed to the elimination of rail transit.\textsuperscript{12}

While mass transit operations floundered, the subsidies for highway construction steadily increased.

\textbf{Figure 3.4}

\begin{center}
\includegraphics[width=\textwidth]{subsidies_for_highway_construction.png}
\end{center}


Jones refers to his next era as the period of recovery without stabilization. This is the time when transit


operations began to receive subsidies. This period lasted from 1960 to 1980. Although the decline in ridership slowed, transit operating deficits only increased.

By 1970, US operating deficits were about $2 billion annually, and nearly 90 percent of all operating systems that had existed before World War II had gone bankrupt and were municipalized.\(^\text{13}\)

Figure 3.5 illustrates the increasing portion of cost alleviated by subsidy.

![Figure 3.5](image)


**Key Transformations in American Mass Transit Systems**

Urban Public Transportation has been in America since the 1850s. During the 150 years since its inception, mass

transit metamorphosed from a mule-drawn rail trolley to intricate transportation systems that often include varied types of vehicles such as articulated buses, ferries, commuter or light-rail systems. During this sesquicentennial time period, the regulation pertaining to mass transit changed from regulation to prevent monopolistic abuse to subsidies to insure existence. These subsidies illustrate the desire for a public transit option, not because of its revenue raising capabilities, but because of its other positive impacts created by providing the service. Not only has the essence of public transportation changed, but also the typical rider has changed as well.

Originally, riders were from all walks of life. As personal transportation became available, accepted and supported, individuals with the appropriate means began to choose private transportation. Now, riders are more likely to be disabled, or poorer, younger, or much older than a typical citizen.\textsuperscript{14} Because of these continued declines in per capita ridership and increasing cost, public transportation providers require subsidies to maintain traditional levels of service to their communities

\textsuperscript{14} Ornati, Oscar, A. \textit{Transportation Needs of the Poor}, (1969) p. 42.
Fare as a User Fee

Farebox revenues on mass transit are a type of user fee. Customary user fees are charges on governmental goods or services that traditionally have been free or provided at minimal cost. Fees charged for camping in public parks, general administrative searches or library use, are typical examples of user fees.

With public transportation, fare box revenue originally covered the cost of operation. As illustrated earlier in this chapter, the revenue to cost ratio was referred to as the operating ratio. Now in most transit systems, the revenues cover a percentage of the total operating revenue. The proportion of revenue generated by the fare has decreased over time and in some agencies, the revenue generated by the fare barely covers the full cost of collecting it.

User fees are criticized because they fail to take into account the norm of equity. Fees may exclude people with low incomes from the good or service. "The final condition, 'few unacceptable inequalities,' is the major stumbling

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block for general application of fees...what is the proper (efficient) price to charge the poor?"\textsuperscript{16} Governments often search for a balance between what a public good truly costs to produce and what would be a fair price.

\textbf{Arguments in Favor of Subsidization}

Many diverse reasons exist for investing in public transport. The reasons range from individual costs and rights to societal costs and obligations.

Without subsidized public transportation, many individuals would not be able to move effectively through their city. The inability to be mobile denies an individual the opportunity to many venues. Some argue that there is a fundamental \textit{right to mobility}, which is not limited exclusively to transportation to work or shopping. The inability to afford a car does not make an individual inferior.

To avoid traffic, the cost of gasoline, and depreciation on their automobiles, car owners may choose to take the bus. For them, the fee for public transportation is optional. (On the other hand, the fee for public transportation can be considered mandatory for users who do not own cars.)\textsuperscript{17}


\textsuperscript{17} User Fees: Current Practice. Management Information Service. p.3.
A mass transportation user fee is compulsory to individuals without other options. Without subsidization, this fee would need to be increased and would become prohibitive.

Providing access to the disenfranchised is an impact that most individuals would see as positive. Access does not merely refer to the ability to go from point A to point B. Francisco Martinez defines access "as the economic benefit derived from the interaction between two activities."\(^\text{16}\) Having transportation available to the elderly, poor, and disabled, creates access for these groups to goods, services, or jobs that might not have been readily available. This benefit gives credence to the ADAPT’s (American with Disabilities for Attendant Programs Today) slogan, "To boldly go where everyone has gone before."

A result of the urban changes discussed in Chapter Two is the transformation of the typical transit rider. The proliferation of the personal automobile changed the face of the average rider of public transportation. People unable to drive cars (old, poor, handicapped, young) as well as women became the chief users of public transportation.

...Even by 1965, the mileage traveled as a car driver, or as a local bus passenger, showed a very

substantial age and sex imbalance...83% of total car mileage was driven by men of working age, whereas 73% of passenger miles made by bus were women, the young and the old.¹⁹

During the early years of public transportation, transit riders were representative of most facets of society. As the preceding quote illustrated a disparity between working-age men and the rest of the community utilizing public transportation grew.

As stated earlier in this chapter, public transportation riders tend to be either poorer, younger, much older, or more likely disabled than a typical citizen. The subsidization of public transportation redistributes income from richer to poorer. Since the money is earmarked for transportation, the public can be relatively assured that it is used properly.

The private automobile is deceptively subsidized and has hidden costs to society.

Cheap as they are to drive, cars are enormously costly to society. When the bills are added up--for pollution, road construction, accidents, and warships in the Persian gulf--the total is between $300 billion and $700 billion a year. Were these costs paid at the pump, gas would be $6 to $11 a gallon.²⁰

¹⁹ Pickup, Laurie; Stokes, Gordon; Meadowcroft, Shirley; Goodwin, Phil; Tyson, Bill; Kenny, Francesca. Bus Deregulation in the Metropolitan Areas. (1991) p. 15.
Subsidization of the personal automobile is more covert than subsidization of public transportation. Difficulties abound for any government that would try to tackle the hidden subsidies of personal transportation.

Mass urban transportation can reduce traffic congestion resulting in many positive externalities. "...Every 50 persons diverted to public transit represent a reduction of approximately 30 automobiles in the traffic stream, with a consequent easing of downtown traffic and parking congestion." 21 The reduction in congestion on the roads during peak travel times produces many positive benefits. The driving time saved, created by having fewer vehicles on the road, the reduction of air and noise pollution, as well as fewer accidents made possible by those absent vehicles are examples of positive externalities.

**Arguments Against Subsidization**

Numerous reasons exist for not subsidizing public transport. The numbers of individuals who are dissatisfied with taxes and expenditures are growing. A majority of

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21 Sheldon, Nancy; Brandwein, Robert. *The Economic and Social Impact of Investments in Public Transit.* (1973) p. 3.
states have limitations on taxes and expenditures by local governments. "There is nothing wrong with the United States that a dose of smaller and less intrusive government would not cure." This conservative viewpoint may have some validity. Public systems are less efficient. Also it may be contended that it is not fair for individuals to be taxed for a good that they do not use. Also, subsidizing public transportation chokes off potential private competition. Furthermore, it may be argued that patrons do not really need public transportation.

**Public systems are less efficient and have weak methods of reducing spending.**

...Public enterprises in general offer minimal incentives for profitable operation, while those bearing the ultimate cost of inefficiencies (mainly local taxpayers) generally lack the incentives to monitor operations effectively.

Private companies search for inefficiencies to eliminate them and become more competitive in the market environment. Some examples of governmental failures in the public transit are:

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*Miami’s 21-mile rail system has operation costs three times the amount forecast, with only 15 percent of the ridership forecast.

*Los Angeles’ $900 million trolley system carries barely more than the ridership of the bus lines that parallel the route.

*Portland’s system--built for $215 million--is drawing less than half the passengers forecast.

*In Atlanta, public transit accounted for 20 percent of commuting in 1990, down from 25 percent in 1980, and rail ridership "has stagnated."  

To have projects approved, it is often necessary to have high forecasted numbers of riders. Because of subsidization the general public pays for these inaccurate projections.

**People who benefit should pay.** With subsidization, persons who do not ride urban transportation are inequitably forced to pay for the service.

**Transportation riders really do not need it.** Although many disenfranchised groups have direct input into the transportation agency's planning process, it may be argued that the individuals are not solely reliant on public transportation

Few 'transit dependents' are truly carless in the sense that they are unable to share in the auto-mobility of friends, neighbors, or relatives. While many are ride-reliant, few are solely

---

dependent on public transportation for personal mobility. 26

More people may become transit dependent, as their pool of friends runs out.

Subsidizing public transportation chokes off potential competition. Subsidizing public transportation places private transportation providers at a disadvantage.

On the expenditure side, it is sometimes contended that the current expenditure share is so high that the private sector of the economy has been squeezed in to a position where it has to operate far below its productive potential. This viewpoint finds fault with the use of the government to solve social problems. 27

No doubt, if government subsidization of public transportation ended, private taxi companies would be immediate benefactors.

The scale of government has grown too large. This argument specifically points to the inability of government to yield to market pressures as the reason for inefficiency. This argument suggest that there might be an optimal size of group receiving service for each unit of government 'production'.

---

Government service is likely to be inefficient because the production unit must, by definition, be the same size as the consumer unit without regard to the optimal size. Therefore, if the most efficient size for a school system is one that services 50,000 people, then cities with populations of 1,000, 10,000, 100,000 or 1 million would all be inefficient if the each had their own school system.\footnote{Savas, E. S. Privatizing the Public Sector. Chatham House Publishers, Inc. Chatham, New Jersey. p. 82.}

Likewise, if the most efficient size for a public transportation system is one that services 250,000 people, then any city with a different population would be inefficient if it had its own system.

\textbf{Potential Determinants of the Farebox Ratio}

The result of subsidization is the farebox ratio. This ratio is the percentage of operating expenses that are covered by fare revenue. Any expense that is not covered by fare revenue is typically some form of government subsidy. This research examines the relationship between transit authority size and the farebox ratio. The model to be researched has the farebox ratio as a function of calculated city density, service area, service area population, operating expense, fleet size and average fleet age.
The Service Area Population is hypothesized to have a positive relationship with the farebox ratio. Typically, as the population increases so does the number of riders and the resulting fare revenue. "...For rapid transit is usually argued to be appropriate only for populations densities in excess of 10,000 (persons) per square mile."\textsuperscript{29} To get these degrees of densities, there must be vast numbers of people in the service area.

A negative relationship is expected with the service area. "The pattern of home and job locations and other activities disperse - much more difficult for a public transport systems to serve."\textsuperscript{30} Ordinarily, as the service area is increased, new areas are added with densities not as compact as the original service area. This expansion should increase operating cost without adding the same proportion to the farebox revenue.

The greater a city's density, the less likely that its population may rely on personal transportation. While every metropolitan area has shown growth from 1950 to 1990, almost


\textsuperscript{30} Pickup, Laurie; Stokes, Gordon; Meadowcroft, Shirley; Goodwin, Phil; Tyson, Bill; Kenny, Francesca. \textit{Bus Deregulation in the Metropolitan Areas}. (1991) p. 16.
every city has lost population. Transit system designs have not followed this trend.

Most Transit routes are radials focusing on the CBD. Because the dispersion of suburban trip ends, most circumferential bus routes carry few passengers at a high cost per passenger.

Historically as urban density has declined, revenues for public transit have decreased.

Being a component of the farebox ratio, the variable operating expense is expected to point to some sort of scale (Savas). The results are expected to indicate that a point exists where diminishing return outweighs the economies of scale.

The service fleet has a direct impact on the operating cost. Operating more buses requires more mechanics to handle roadcalls. Conversely, having more buses allows an agency to provide more service and thus collect more fare revenue. Similar to the operating expense variable, the results are expected to indicate in large transit authorities that diminishing returns outweigh the economies of scale.

31 Matoon, Richard. "Can Alternative Forms of Governance Help Metropolitan Areas?"
33 Roadcall or Road Call- Unscheduled maintenance requiring either the emergency repair or service of a piece of equipment in the field or the towing of the unit to the garage or shop. Transportation Expressions. US Department of Transportation, Bureau of Transportation Statistics. Washington DC (1996)
Average fleet age is expected be negatively related to the farebox ratio. Older vehicles tend to need more maintenance than newer ones thus increasing operating cost without adding operating revenue.

The following function describes the model. The direction of the hypothesized relationship found in parentheses.

\[ \text{Farebox Ratio} = f(\text{Service area population}) - (\text{Service area square miles}) + (\text{Calculated city density}) - (\text{Operating Expense}) - (\text{Total Fleet}) - (\text{age of fleet}) \]

This chapter presented an abridged version of the history of urban mass transportation providers as well as some reasons for subsidization of the current operators. Finally, a model is presented for potentially determining the farebox ratio. The following chapter will present the methodology for testing this model.
Chapter Four

Methodology

Introduction

This chapter presents the methodology used to investigate the hypotheses. The farebox model supplied from chapter three is tested using regression. This will not be the first time regression analysis has been done on data from the Transit Profiles provided by the FTA. Brian Cromwell used data from the Transit Profiles in his article "Public Sector Maintenance: the Case of Local Mass-Transit."

Research Design

Published by the Federal Transit Administration (FTA), the 1994 Transit Profiles Agencies in Urbanized Areas Exceeding 200,000 Population furnishes the data used in this analysis. These data provide a list of all transit authorities in the United States. Correlation and multiple regression are used to analyze the data with respect to the model.

Upon inspection of the raw data listed in appendix one, it may be noticed that some transit agencies are not
represented. The following transit agencies were given exemption for 1994: Dallas-Grand Prairie, Dallas-Plano, Shopper Bus Service, Newburgh-Beacon Bus, New Orleans-St. Bernard, NW IN-GNS, and NJ-International Bus.¹

Since this data is only for 1994, it provides a cross section of the public transit industry rather than a longitudinal study. For this type of analysis, there are many benefits to using cross sectional data. The analysis of the cross section data allows comparisons to be made between a variety of transit authorities. Since the data is from municipalities all over the United States, the data avoids problems found with regional bias. The cross sectional study also looks for evidence of the assumed hypotheses.

This research is subject to all the constraints of a cross sectional study. With a cross sectional study the data may be subject to socioeconomical 'spikes,' such as increased funds available to transit authorities by the Intermodal Surface Transportation Act of 1991. It also does not take into account individual transit agencies local

¹ Transit Profiles. P. B-2.
decisions, nor does it encompass regional mandates imposed by state or local governments.

To convert the data to a usable format, certain transit authorities were eliminated from study. Some agencies do not collect fares and thus did not generate a farebox ratio. This was most evident in some sub-contractors and in cities such as Las Vegas, operated by ATC. After eliminating these agencies, 165 cases remained.

**Model**

Multiple regression analysis makes it possible to test a model. (The following equation represents the model as operationalized by the variables.) The sign in front of the independent variables represents the expected direction of the relationship.

\[
\text{Farebox Ratio} = f(SAPOP, \text{SASQMI}, \text{OPEREXPS}, \text{AVGAGE}, \text{CALCDENS}, \text{TTFLEET})
\]

\[
(+) \quad (-) \quad (-) \quad (-) \quad (+) \quad (-)
\]

The results of the multiple regression analysis are used to examine the influence of each independent variable on the farebox ratio.
Dependent Variable (Farebox Ratio)

The ratio of total fares collected to operating expenses is the farebox ratio. Any farebox ratio less than one indicates that some form of subsidy must exist to make up the remainder of the operating expenses. Subtracting the farebox ratio from one hundred percent produces the percentage subsidy of operating expenses that a transit authority receives to operate.

Independent Variables

Most of the independent variables in the model relate to some form of transit agency size. The size could be geographical, fiscal, capital, or population. This analysis intends to use all of these forms of size. Nearest city density and average age of vehicles have been added because of the availability of the data, curiosity, and literature.

The Service Area Population (SAPOP) is the total number of individuals within the transit agency's jurisdiction. The service area (SASQMI) is the total number of square miles within the transit agency's jurisdiction. The operating expense is the total dollars expended by each
agency to function on a yearly basis. Being a component of the farebox ratio, operating expense (OPEREXPS) is predicted to indicate a point of efficient scale of operation. Average city density (CALCDENS) is a calculated variable. It gives the aggregate number of people per square mile in the operating city. Total fleet (TTFLEET) is a capital size variable. It represents the total number of vehicles operated by a transit authority. Average fleet age (AVGAGE) is the average age of the bus fleet.

**Multicollinearity**

One of the main concerns when executing multiple regression analysis is multicollinearity. Multicollinearity exists when two independent variables are highly correlated with each other. If one variable is not excluded, then its actual effect on the dependent variable is miscalculated. To avoid this problem a correlation matrix is created to determine the correlation coefficients.

**Conclusion**

This chapter presented the methodology used to investigate the hypotheses. Almost all variables can be
used 'as is' for the analysis. Regression analysis is employed to determine the effect of the independent variables on the farebox ratio. The findings of the research are be presented in Chapter Five.
Chapter Five

Analysis of Findings

Introduction

This chapter presents the findings of the research. The validity, the significance of the model, and the results of the accuracy of hypotheses representing the farebox ratio will be presented.

Correlation Matrix

The test to avoid the influence of independent variables being overstated is the use of the correlation matrix. If the correlation between two independent variables is high, then multicollinearity probably exist.

In the correlation matrix developed for this project, a high correlation existed between two variables. Operating expense (OPEREXPS) and total fleet (TTFLEET) had a correlation of .9434, a correlation of one is the highest correlation possible. This problem could be foreseen because much of a transit authorities operating expense deal with the size of the fleet (i.e., numbers of drivers and mechanics to be hired). The correlation matrix follows in table 5.1.
Because of the multicollinearity problem, total fleet was excluded from the regression analysis. The relevance of regression analysis is indicated by the adjusted R square. In this form, this model accounted for only 26.5% of the dependent variable.

**Table 5.2**

**Regression Analysis of Farebox Ratio Model**

<table>
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<tr>
<th>Variables</th>
<th>Expected Relationship</th>
<th>Observed Relationship</th>
<th>Beta</th>
<th>Sig T</th>
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<tr>
<td>Service Area Population</td>
<td>Positive</td>
<td>Positive</td>
<td>0.327</td>
<td>0.0098</td>
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<tr>
<td>Service Area Square Miles</td>
<td>Negative</td>
<td>Positive</td>
<td>0.108</td>
<td>0.2223</td>
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<tr>
<td>Calculated Density</td>
<td>Positive</td>
<td>Positive</td>
<td>0.205</td>
<td>0.3702</td>
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<tr>
<td>Operating Expense</td>
<td>Negative</td>
<td>Negative</td>
<td>-0.084</td>
<td>0.0005</td>
</tr>
<tr>
<td>Average Age</td>
<td>Negative</td>
<td>Positive</td>
<td>0.235</td>
<td>0.0089</td>
</tr>
</tbody>
</table>
Unfortunately, since this model accounted for such a low portion of the variance, the absolute effect of the variables was not determined. In this model the most significant variables were average age, calculated density, and service area population. Surprisingly, the average age of the bus fleet was the most significant variable.

The first hypothesis, the percentage subsidy per transit agency \((1-FBR)\), will be less for Regional Transit Authorities (RTAs) with a greater calculated density of the cities in which they operate, was supported. The variable, calculated density, was the second most significant variable. The beta coefficient was positive \(0.205\).

The second hypothesis, the greater a transit agency's operating expenses, the more likely that the percentage subsidy per transit agency is greater was not strongly supported. Although the beta coefficient was slightly negative \((-0.084)\), the value of the coefficient was not significant \((p = 0.3702)\).

The third hypothesis, The larger the service area the greater the percentage subsidy per transit agency was not supported. The sign of the beta coefficient \((+0.108)\) was
opposite of the expected value and the significance of this variable was marginal.

The fourth hypothesis, the greater the service population the less the percentage subsidy per transit agency, was weakly supported. This variable had the largest beta coefficient (.327); the significance was relatively strong ($p = .0098$).

Unexpectedly, the variable with the greatest significance (.0005) was average age. The beta coefficient was positive (.235), which was the opposite of the hypothesized relationship between the variables.

An explanation for this finding might be the regulations regarding ADA compliance, or a transit authority's excursions into global positioning satellite technology. Newer buses must be able to accommodate wheelchair-bound patrons. The complexities of wheelchair lifts increase the cost through training and retention of maintenance staff, thus increasing cost. Also simply having the intricate apparatus increases the likelihood of a service-stopping breakdown, thus creating more roadcalls as well as requiring more buses to complete the service.
Conclusion

The results from this model proved to be weaker than expected. The model only accounted for 26.5% of the variation in the dependent variable. Surprisingly, the variable with the greatest influence was shown to have an opposite relationship than what was hypothesized. In the final chapter, conclusions are drawn and suggestions for future research are presented.
Chapter Six

Conclusion

Introduction

In social sciences, correlations tend to be much more difficult to find due to the myriad of factors that affect an observation. In this chapter, conclusions are drawn and suggestions for future research are presented. The model accounted for 26.4% of the variation in the dependent variable. This is a relatively insubstantial model. Surprisingly, the variable with the most influence was shown to have an opposite relationship than what was hypothesized.

Summary

The first hypothesis, the percentage subsidy per transit agency (1-FBR), would be less for Regional Transit Authorities (RTAs) with a greater calculated density of the cities in which they operate, was supported. Due to the beta coefficient and the significance of this variable, it probably should be kept in the model.

The second hypothesis, the greater a transit agency operating expenses, the more likely that the percentage subsidy per transit agency is greater was not supported. Due
to the beta coefficient and the lack of significance of operating expenses, this variable probably could be dropped from the model.

The third hypothesis, the larger the service area, the greater the percentage subsidy per transit agency, was not supported; and it probably could be dropped from the model or combined with the service area population to create another variable. However, in the latter case, it is likely to have multicollinearity problems with the calculated city density variable.

The fourth hypothesis, the greater the service population the less the percentage subsidy per transit agency, was weakly supported. Since this is one of the three variables with noticeable significance, this variable should be kept.

Unexpectedly, the variable with the greatest significance (.0005) was average age of the bus fleet. The beta coefficient was positive (.235), which was the opposite of the hypothesized relationship between the variables.

A possible reason for the average age of the vehicles, having a slightly positive correlation with the farebox ratio, might be due to the length of existence of some
transit agencies. Although the Urban Mass Transit Administration started granting moneys to local governments in 1964, many transit authorities were not created until the late 1980s or 1990s. There might be a comparative advantage of operating for a longer period of time. Also newer vehicles are more likely to be alternative fuel vehicles, have electronic fareboxes, and/or be wheelchair lift equipped. If any of these feature malfunctions while the vehicle is in service, the vehicle will have to be pulled out of service for repair.

**Strengths and Weaknees of the Project**

The major strength of this research is that it illustrates the feasibility of creating a model for studying transit authority operations and expected performance indicators.

The low significance indicates a problem with either the variables chosen or the way the data were processed. If the method of data processing was flawed, the research might have yielded better results if the data were separated by region. Different regions of the country may have different factors influencing ridership and fare revenue. If this was
the case, then the data should be separated, and individual multiple regression analyses should be run for each area. The extremely large transit authorities could be removed so as not to skew the information base.

It is also possible that the variables were not the best choices. Better variables might exist for prediction; these potential variables are discussed in the following section.

**Suggestions for Future Research**

Transit authorities are ideal agencies for statistical analysis. Data for the authorities is collected by the FTA on an annual basis. Records are methodically kept and presented in published form, with more data soon to be available via the internet.

A longitudinal study would be ideal, with only the time required for data entry being preclusive. This might avoid potential regional factor problems. Using the *farebox* ratio as a gauge of efficiency, research involving the total number of administrative employees or general level of employee education (*Savas*) would be interesting as well as potentially significant.
A number of factors not contained in the FTA report might also be considered. Both internal (operating) and external (environmental) factors could be used. One important factor that may be important to research is the true city density. The calculated city density (CCD) was derived from the data from the transit profiles. By using this data, an average was derived for the entire city. Since transit agencies' jurisdictions regularly gerrymander a municipality's territory, this variable may not have been as significant as possible.

Also, median income of cities should probably be included in some form. The US Census Department provides this data.

...Travel tends to increase with income, these low income households accounted for only 19 percent of trips made in urban areas. On a modal basis, they accounted for 5 percent of commuter rail trips...Although travel increases with income, households will low incomes account for a larger percentage of transit ridership that households with higher incomes.¹

So operating a transit authority in an area with a lower income per capita might gain more ridership. To include this data, a new model is suggested. The proposed model

includes a portion of the model tested in this applied research project as well as a couple other variables.

\[
\text{Farebox Ratio} = f(\text{Service area density}) \cdot (\text{Total Fleet}) + \\
(\text{age of fleet}) - (\text{median household income}) + (\text{Base Fare}) \\
- (\text{Vehicles Operated Maximum Service/Vehicles Operated Base Service})
\]

This research project explored some of the difficulties in creating a function that will predict economic efficiency in public transportation operators. Controversy regarding equity issues and economic efficiency of these operations will probably continue. Quite possibly this controversy will be augmented by future work choices such as telecommuting and varied work hours. The thinning densities of urban centers will continue to provide challenges to transportation planners and public administrators.


Pickup, Laurie; Stokes, Gordon; Meadowcroft, Shirley; Goodwin, Phil; Tyson, Bill; Kenny, Francesca. *Bus*


Tanzer, Andrew. "All aboard for Privatization: Not only do the Commuter Trains run on time in Hong Kong- the darned


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