The Location Efficient Mortgage: A Strategy For Promoting Transit-Supportive Housing
A Case Study of San Juan, P.R.

by

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ABSTRACT

The nation’s heavy reliance on driving as a means of transportation has exacerbated congestion and created environmental and equity problems, deteriorating the overall quality of life. Attempts using innovative technologies, such as Intelligent Transportation System, transportation demand management, and land-use approaches have been taken to alleviate the problems. Besides transportation and land-use policies, housing policy has a role in influencing mode choice, since one’s travel choice is partially influenced by one’s housing choice. In light of this relationship, it is useful to look at the problems from the perspective of housing. The Location Efficient Mortgages (LEM) is a newly developed policy tool to address the mode choice by exploiting the intricate relationship between housing choice, travel behavior and land-use patterns.

Using San Juan as a case study, this thesis is an exploratory analysis of Location Efficient Mortgages. It is aimed at verifying the theories underlying the LEM; developing a set of criteria to evaluate a region’s potential to implement the LEM; analyzing its potential benefits; projecting potential implementation challenges; and recommending strategies to overcome the challenges.

Using the criteria developed, the research demonstrates that San Juan could yield potential benefits in the near future. San Juan may benefit in several different ways from the LEM if the set of hurdles hindering the implementation can be overcome. Such benefits include relief in congestion, enhancement in accessibility, and improvement in air quality. However, a transit agency, such as Tren Urbano, will not be able to overcome all the challenges. Interagency and institutional commitment from housing and planning agencies are necessary for the successful implementation of the LEM.

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1 INTRODUCTION

1.1 FOCUS OF STUDY

Recently, three non-profit organizations have jointly created a new form of mortgage, the Location Efficient Mortgages (LEM), as a tool to promote transit-oriented living. The LEM is a financial incentive to encourage home-ownership and discourage auto-ownership in transit-oriented neighborhoods. By taking into account the amount of money a family can save if it replaces part or all of the auto trips with transit and walking trips while living in a transit-oriented neighborhood, the LEM assumes a greater borrowing capacity of the family in mortgage loan application. This increased borrowing capacity would then allow the family to qualify for a mortgage loan which they otherwise may not be eligible for.

This thesis focuses on exploring the potential use of such an incentive in San Juan, Puerto Rico, where a heavy rail system is being constructed to provide a viable travel alternative to the auto-oriented residents.

1.2 PROBLEM

Just like many other regions on the mainland United States (U.S.), the San Juan Metropolitan Area relies heavily on the use of automobiles in passenger travel. The 90.5 percent mode share of driving clearly indicates the imbalance between the use of cars and public transportation. This is the consequence of many forces which reinforced the effects of each other over the past forty years. Such forces include the continuous investment in roadway expansion, the decline in transit services, and the development of single-family houses in outskirts, among others. These forces resemble those on the mainland. The resulting problems confronting the Commonwealth also parallel those plaguing the Continental U.S.—traffic congestion, degradation in environmental quality, limited accessibility and mobility for certain groups of the population. But, there is one
problem unique to the Commonwealth—the heavy financial burden of driving borne by many Puerto Rican households. Not only do these problems negatively affect the lives of many individuals, they also present as encumbrances to the future health and prosperity of the society.

The need to solve these problems is obvious and urgent. Indeed, many are taking actions from different approaches. For instance, congestion pricing, as a policy tool, is being practiced in certain areas to discourage solo driving. Technological innovations in information technology have allowed the development of Intelligent Transportation System (ITS), which has a role in relieving traffic congestion. The LEM, combining transportation, housing, and land-use components, distinguishes itself as a different mechanism to solve transportation-related problems.

1.3 RESEARCH OBJECTIVES

Based on the theories behind the LEM, this study seeks to develop a framework to conduct a preliminary feasibility analysis of introducing the LEM. Using the framework developed, it then evaluates the metropolitan area of San Juan with respect to introducing the LEM. The study also aims at projecting potential benefits of implementing the LEM in San Juan. Such an implementation in San Juan will not be free of challenges; this study attempts to identify the major challenges. Finally it proposes corresponding strategies to help overcome the hurdles.

1.4 FINDINGS

In order for the LEM to work, a region has to satisfy at least four requirements. First, it must have an adequate and comprehensive transit system. Second, there needs to be sufficient employment opportunities along transit corridors. Third, transit corridors cannot be filled with housing and employment centers alone; activity centers such as retail shopping and recreational facilities need to be present. The final requisite for the introduction of the LEM is a general readiness to accept higher-density development. Currently the San Juan Metropolitan Area satisfies the last three criteria. It is expected that the region will satisfy the first criterion in the near future, when Tren Urbano starts operation and other improvements are continued to be made to the existing transit system.
The LEM, aside from making home-ownership possible, has the potential to bring in more riders to Tren Urbano and other local transit systems. When auto trips are shifted to transit trips, the LEM will help relieve congestion, promote traveler safety, improve environmental quality, and enhance accessibility of the transit-dependent population.

To enjoy these benefits, one would have to overcome five hurdles. First, one would have to deal with the strong culture of driving and the poor image of public transportation. Second, one would have to gain support from the housing finance industry, which could be very challenging if the previous hurdle has not been overcome yet. The limited supply of high-density, for-sale housing units near transit constitutes the third challenge. The fourth issue is the trend of decentralization of population and employment, as well as the general preference for low-density housing. Lastly, making sure that LEM households do replace driving trips with transit trips could be tricky.

1.5 RECOMMENDATIONS

Despite the potential challenges, it is recommended that the LEM be implemented in the SJMA. The following strategies could be considered to tackle the challenges:

- implementing transportation demand management;
- enhancing safety and aesthetic of pedestrian walkways and bike paths;
- marketing transit;
- creating programs favoring transit-supportive home-ownership;
- creating programs favoring businesses locating near transit;
- crafting land-use policies discouraging sprawl and encouraging infill development;
- providing government assistance to developers interested in transit-supportive housing
- provide pre-application counseling to prospective LEM borrowers.

As shown, Tren Urbano is not an agency to undertake all the above actions. Therefore, the implementation of the LEM will be an inter-agency effort; it will need strong commitments from the Puerto Rico Highway and Transportation Authority, the Puerto Rico Department of Housing, the Planning Board, as well as municipalities involved.
1.6 **Thesis Organization**

**Chapter Two** will discuss the motivation of this study. It will first discuss the problems created and exacerbated by the heavy reliance on automobile as transportation means. Then, the causes of the problems and possible approaches to combat the problems will be examined; the LEM will be introduced as a new approach.

**Chapter Three** will present the general context within which this study is conducted—the San Juan Metropolitan Area (SJMA). It will include the reasons for using the SJMA as a case study, and a discussion of the special characteristics of the region with respect to the LEM.

**Chapter Four** will present the Location Efficient Mortgages. It will define the notion of *Location Efficiency* and the theories underlying the Location Efficient Mortgages (LEM). It will then discuss the LEM as a tool for promoting homeownership. The third section will describe the detailed mechanics of the first LEM program in the country. It is then followed by a review of literature, which examines the validity of the underlying assumptions of the LEM. The last section will develop a set of evaluation criteria that can be used to analyze a region's potential for implementing the LEM.

**Chapter Five** will use the criteria developed in Chapter Four to evaluate the SJMA’s potential to implement the LEM. It will include an evaluation of the current and future states of the regional transit system, an examination of the land-use patterns in the region and along the major transit corridor.

**Chapter Six** will estimate the potential savings one could achieve by replacing driving trips with transit trips in the SJMA. It will include an estimation of the cost of driving and that of taking transit. Four scenarios will be generated in the second part of the chapter to estimate how the transportation savings could benefit families of different income groups in mortgage loans.

**Chapter Seven** will project the potential benefits of implementing the LEM in the SJMA. It will also identify potential challenges in the implementation process, as well as a set of potential strategies that can be used to overcome the challenges. It will briefly present a series of experimental design for the measurement of the success of an LEM program.
Chapter Eight will summarize the findings in the preceding analyses and present direction for future research.
2 MOTIVATION

United States passenger travel is dominated by the highway mode. In 1997, the highway mode alone accounts for 86.7 percent of all passenger-miles (UDOT 1997). Certainly, our well-developed roadway network has made a significant contribution in facilitating national economic growth, and many Americans are enjoying the convenience of driving from one place to another. However, some are lamenting the tradeoffs of auto's contribution. The tradeoffs include exacerbating traffic congestion, degrading environmental quality, intensifying social inequity, and deteriorating quality of life.

2.1 TRAFFIC CONGESTION

While autos are supposed to improve individuals' mobility, too many autos on the roads would have the exact opposite effect. Mobility aside, the cost of congestion includes the monetary value of time delayed and that of wasted fuel. In Los Angeles alone, about 2,500 million liters of fuel, valued at $910 million, was wasted due to congestion in 1992. When the delay caused by congested travel was taken into account, the cost of congestion amounted to $8,330 million just in Los Angeles. The highest per capita cost of congestion, at $820 in 1992, was found in Washington, D.C. (Schrank, et al., 1995).

Congestion also jeopardizes a region's relative competitiveness in this era of global economy. The delay in the delivery of goods and services and the loss in labor productivity due to congestion affect business location decisions. As Coughlin (1995) pointed out, some businesses view the role of transportation efficiency so crucial to economic growth that they would spend money to assess transportation alternatives.
2.2 ENVIRONMENTAL QUALITY

2.2.1 Air Quality

Automobile emissions, fuel consumption and disposal, construction of highway and parking lots all cause serious environmental problems. Highway transportation is accountable for 64 percent of the nation’s emissions of carbon monoxide, 44 percent of particulate matter, 35 percent of the nitrogen oxides, 28 percent of lead, and over a quarter of the hydrocarbon compounds produced from all sources (USEPA, 1995). The estimated annual costs of air pollution caused by roadway transportation ranges from as low as $30 billion (Ketcham and Komanoff, 1992) to as high as $220 billion (Miller and Moffet, 1993).

2.2.2 Greenhouse Effect / Global Warming

Emissions from motor vehicles also include carbon dioxide, methane, and nitrous oxide, all of which are greenhouse gases causing global warming. The United States (U.S.) continues to be the world’s largest producer of greenhouse gases.\(^2\) Highway transportation remains the major contributor of these gases. For instance, almost 90 percent of nitrous oxide and 32 percent of carbon dioxide came from highway emissions in 1995. The price tags attached to greenhouse effect and the resulting climate change range from $25 to $27 billions annually (MacKenzie et al, 1992 and Ketcham and Komanoff, 1992).

2.2.3 Other Environmental Costs

Roadways and parking lots, occupying 30 percent of developed land in most U.S. cities, are devouring open space, wetlands, and the larger ecosystem, let alone the unnecessary loss of land needed to facilitate auto-induced sprawl. Other external costs include water pollution from drainage of automobile fluids and road salt, as well as noise from automobile operation and road construction. One study estimated the annual costs

1 Money is in 1990 dollars. These estimations include both the costs borne by users and societal costs.
2 Both absolutely and on a per capita basis
of auto-related water pollution at $10.9 billion¹ (Lee, 1994) while another quantified the costs associated with noise impacts from cars and trucks at $9 billion⁴ (MacKenzie et al, 1992).

2.2.4 Energy Consumption

High automobile reliance is depleting limited energy resources. America remains highly dependent on imported petroleum and finite supplies of fossil fuels, leading to the issue of energy security and balance of trade. With less than five percent of the world’s population, the U.S. consumes 26 percent of the world’s petroleum. Highway transportation accounts for 54 percent of total energy consumption (UDOT, 1997).

The Congressional Research Service concluded that oil dependence would have such potential adverse impacts as higher inflation, unemployment, as well as balance of payments and exchange rate effects (Behrens et al, 1992).⁵ Although automobiles are more fuel-efficient today than before, the gains have been offset by ever-increasing traffic volumes and lengthening of trips (Cervero and Bernick, 1997).

2.3 Social Equity

Most recently, those concerned with social equity have contended that the society’s heavy automobile dependence has shaped the nation’s transportation policy, which has neglected the needs of the transit-dependent population. As stated in the proceedings of the Transportation: Environmental Justice and Social Equity Conference in November 1994:

*Marginalized people and their communities bear the brunt of society’s ills, grapple with the costliest of society’s tradeoffs, and have the least amount of society’s resources to deal with them. Transportation’s role in these dimensions of inequity is ubiquitous.*

Most regions of the United States have been designed for automobile travel, making car ownership a basic necessity. Even though the private costs of driving are low compared with those in other countries, the expense presents a heavy burden for the poor.

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¹ This is in 1991 dollars.
⁴ This is in 1989 dollars.
According to the Bureau of Labor Statistics, the average American household now allocates about 21 percent of its budget to transportation expenses, most of which are auto-related. Poorer households spend an even larger portion of their income on auto-related expenses. Most roadway funds have been invested in projects that benefit middle to upper-income suburban communities. Such spending has not been entirely borne by those benefiting from it; rather, it has come at the expense of transportation services to benefit the poor urban and rural public transit, downtown development, and the maintenance of urban and rural roads (Federal Transit Administration, 1994).

The poor residing in inner cities, as well as those who are disabled, too old or young to operate a car are left out of many of the offerings of the society. This has significant social implications and, thus, merit some discussion.

2.3.1 The Urban Poor

The suburbanization of employment has been a major trend over the past three decades. For the poor living in inner cities, an auto-oriented society, coupled with decentralization of employment, simply implies limited access to employment opportunities. According to the Surface Transportation Policy Project, two-thirds of all new jobs are in the suburbs, while three-quarters of welfare recipients live in central cities or rural areas. Even in metropolitan areas with excellent public transit systems, less than half of the jobs are accessible by transit. Moreover, almost 94 percent of welfare recipients do not own cars. Sociologists have labeled such a phenomenon the spatial mismatch problem.

The spatial mismatch hypothesis argues that inner-city joblessness and inter-generational poverty are rooted in the physical separation of the urban poor from the expanding job opportunities in the suburbs. Some argue that this spatial mismatch contributes to higher unemployment rates for central-city residents, particularly African American (Hughes, 1991). Some contend that the spatial mismatch lowers the wages of workers in central-city jobs, because of the large, low-wage labor pool available there.

---

5 This is because the world's oil reserves are concentrated in relatively few countries.
Lastly, spatial mismatch increases the cost of commuting for those employed, lowering the disposable income of central-city workers (UDOT 1997).

2.3.2 Physically Disabled and Elderly

Many people have physical disabilities, such as walking or other motor functions, hearing or sight impairments, which make it difficult or impossible for them to operate a motor vehicle. For this group of the population, inadequate transportation alternative limits education and job opportunities; it may also present barriers to accessing health care, social and commercial services, as well as social and cultural activities.

Likewise, older Americans are also confronted with similar barriers. As Camph (1993) pointed out, because alternative transportation is often not available, some elderly continue to drive in spite of diminished physical or mental capacities. This can pose a serious safety hazard to the drivers themselves, their passengers, and to other motorists and pedestrians. As the baby-boomers are aging, this problem will affect an increasing portion of the population.

2.4 Quality of Life

Planners and architects have deplored that our auto-oriented lifestyle has spoiled the landscape and destroyed the urban fabric across America. They have been echoed by an increasing number of people. The growing auto ownership and development of the interstate highway system facilitated the suburban expansion during the past fifty years. Such a suburban expansion is believed to have robbed many city centers, creating a vacuum at the heart of many communities and depriving them of civil pride. Places are losing their identities, as Jane Jacob (1961, P.38) pointed out in her landmark book The Death and Life of Great American Cities, that “every place becomes more like every other place, all adding up to Noplace.”

People are getting more segregated because suburban development is so sprawling that friends may live miles away. Neighborhood cohesion is lessening because face-to-face interaction that builds the sense of community is diminishing since we, as drivers, are cocooned in our own cars. Moreover, as congestion is getting more severe, travel time to and from work is getting longer, commuters are spending less and less time
with their families. Children can no longer walk to neighborhood parks; they have to be chauffeured. The overall quality of life is deteriorating. This may be the least articulated concerns among others; yet it is one most deeply felt by many Americans, not just planners and architects.

2.5 Causes of the Problems

What exactly have created these problems? Why does the current population depend so heavily on driving as a means to get around? There are at least five major reasons. First, the country has been decentralizing over the past forty years. Both population and employment have been growing at low-density outside central cities, where cost of land is generally lower than the construction cost of high-density development. Meanwhile, the country has accepted Euclidian zoning as the model in land-use planning. Different land-uses are separated, or excluded, from each other to “protect and promote the health, safety, and general welfare of the public.” Decentralization, coupled with exclusionary zoning, has increased the average distance between home and workplace, and that between home and activity centers. The low-density development pattern has also made it difficult for transit to operate efficiently. Driving then became a more convenient travel option. At the same time, transit service was declining due to a number of reasons. While decentralization and exclusionary zoning can be viewed as “pulling factors,” drawing Americans to driving, decline in transit service can be considered as a “pushing factor,” dissuading people from taking transit. And as the national economy was growing, individuals also flourished from society’s prosperity. As individuals were getting more affluent, automobiles became more attainable.

It is obvious that government had played a role in reinforcing some of these forces. The most significant government actions have been transportation policy, land-use policy, and housing policy. The nation’s transportation policy has focused on expansion of capacity of highways and expressways; transit has been neglected until very recently. These roadway expansions have made much rural land accessible by cars; thus, decentralization. Land-use policy, as discussed, has embraced the principal of separation of uses. Housing policy, which will be discussed in more detail below, has focused on
low-density home-ownership in suburbs. The federal tax policy of mortgage loan interest
deduction represents another government initiative with the side-effect of promoting
suburban living. Many, if not all, of these government policies were crafted for the
society’s good. And, they have served many of their original intentions. For instance,
transportation policy was meant to improve the mobility of passengers and goods, and to
support the growth in economy; and it did achieve the purposes to a large extent. It was
not foreseeable that all these good intentions would create negative impacts on the
society.

As policy-makers have begun to realize the negative side-effects past policies have
created, they have started to pursue new policies to reverse the trend. To encourage more
people to take transit, transportation policy-makers have given more attention to
improving the quality of transit services. To discourage solo-driving, transportation
professionals are practising congestion pricing. They are also trying transportation
demand management, along with parking management, to encourage ride-sharing and the
use of transit. Land-use policies have also shifted away from the traditional Euclidian
zoning to policies encouraging mix of uses at different scales. Some municipalities have
also started to contain sprawl by such policies as the creation of urban growth boundary
and establishment of adequate public facility ordinance.

However, housing-policy makers have not had any reactions yet. It may be
because they are simply not very sensitive to the problems related to heavy reliance on
automobiles, since their primary interest is in providing decent shelters to individuals and
families. It is more likely that the housing profession is not aware of the potential role it
can play in solving some of the problems, since no major studies on the relationship
between housing and travel behavior have been conducted. While the relationship
between land-use and transportation has been studied relatively heavily, that between
housing and transportation has not received much attention.

2.6 THE NEXUS BETWEEN HOUSING CHOICE AND TRAVEL CHOICE

One’s travel behavior is determined, to a large degree, by the travel options they
have and the relative viability of each option. In many cases, the options available and
their viability depend on where one lives and works, as well as where the activities are.
For instance, a person living in Boston could choose between driving, taking buses or subways, and perhaps even cycling or walking. A similar person residing in Groton, a suburb 30 miles west of Boston, would have no option other than driving. In other words, one’s travel behavior is influenced, to a certain extent, by one’s housing choice. The choice is made primarily based on one’s needs, financial ability, and preference.

If one’s housing needs is a rather absolute term, the financial ability could be viewed as a relative concept. It is relative to two sets of variables: (1) the condition of housing market, such as prices of housing, interest rates; and (2) lenders’ underwriting criteria, including loan-to-value ratio, amortization period, etc. Government housing programs can change one’s relative financial ability in purchasing a home, which in turn change one’s choice in the location and type of housing, affecting one’s travel behavior.

In the case of the United States, federal housing programs have encouraged homeownership of single-family homes, which are often in suburbs. Johnson (1996) attributes the suburbanization of America to Federal Housing Administration (FHA) and Veteran Administration (VA) loan guarantee programs, started in the 1930s’ and the 1940s’ respectively. More specifically, the guarantee loan programs for single-family housing liberalized the maximum loan-to-value ratio of eligible mortgages, lengthened the maximum loan period, and increased the maximum dollar ceilings of the mortgages.

These programs have had three major impacts on the nation’s housing market. First, they expanded the relative financial ability and altered the preference of home-buyers, making single-family homes more attractive. Second, they spawned interest of lenders in making single-family home loans, which were made risk-free by the programs. Lastly, these programs also promoted the construction of many single-family homes, since VA or FHA approval became a practical precondition for receiving initial construction loans (Johnson, 1996). The interplay of all these effects has made homeownership possible to many Americans. Many have enjoyed a very spacious, tranquil, and agrarian-style living environment. Further, those who own their homes usually have more stable lives. The equity home-owners put in to their mortgages every month represents accumulation of personal wealth. Unfortunately, these desirable effects of national housing programs also come at a hidden societal cost. More specifically, these
housing programs have promoted suburbanization, which has encouraged reliance on automobiles.

It is, however, not fair to say that the well-intended housing programs, which have benefited millions of Americans, were the sole culprit for the development of suburban sprawl. The concurrent interstate highway program, massive marketing of automobiles by the manufacturers, auto-supportive land-use policies, federal tax deduction on mortgage interest, and some may argue, the individualism of Americans, all have reinforced and propagated the popularity of auto travel and the proliferation of sprawls.

As one moves into low-density single-family homes in suburbia, automobile becomes a more viable option than transit. Transit loses its competitive power because it does not serve low-density areas efficiently, and in many suburbs, transit does not exist at all. Autos, on the other hand, offer a lot of convenience to suburbanites. Once an auto has been purchased and insurance paid, the marginal costs of using it appear to be low, since most auto-owners do not include depreciation in the costs. Transit, because of the out-of-pocket fare, appears less competitive.

For some of the poor working class, the auto-oriented society simply makes it impossible not to own a car. Driving may be the only means of getting to work for some low-wage workers. So, even though these workers earn low or moderate income, they have to spend a significant portion of their income on automobile ownership and operation. This slows down the process of accumulating enough wealth for home-ownership, as money is spent on cars, depreciating assets. For some, automobile ownership may even preclude them from owning a home.

As shown, there is an intricate relationship between one’s travel option and one’s housing choice, which can be influenced by housing programs. Among others, one way to alter the current imbalanced travel behavior between autos and transit is to intervene the housing market. The government housing programs have succeeded in intervening Americans’ housing choices in the past, with a negative side-effect of limiting travel options of many. Can new programs be created to change our housing choices such that more travel options become available and viable while home-ownership is still achievable?
2.7 **The Location Efficient Mortgages**

The (LEM) emerges as such a program. One of its primary intents is to encourage transit-supportive living by making home-ownership in transit-oriented neighborhoods more attractive, just like the way federal loan guarantee programs made auto-supportive single-family home-ownership more attractive in the past.

In theory, the LEM will achieve its purpose through three primary effects. First, it may encourage more housing to be developed near transit at a higher density. Second, it may encourage households who live near transit to use transit. Lastly, it may encourage transit-dependent or transit-supportive families to move into areas proximate transit.
3 PROBLEMS IN THE SAN JUAN METROPOLITAN AREA

Many of the problems discussed in the last chapter are confronting the Commonwealth of Puerto Rico, particularly the San Juan Metropolitan Area (SJMA), the largest urbanized area on the island. In fact, some problems are more poignant in the SJMA than in many other U.S. cities. Therefore, the potential benefits of balancing auto and transit travel there may even be more significant.

3.1 CONTEXT

The Commonwealth of Puerto Rico is an island in the Greater Antilles located between the U.S. Virgin Islands and the Dominican Republic. The island is about 8,406 square kilometers (3,245 square miles) in land area and has a population of 3.7 million inhabitants, based on the 1990 U.S. Census data. Pharmaceuticals, textiles, and tourism constitute the island’s major industries.

The San Juan Metropolitan Area (SJMA) is located on the north coast of the island and is composed of thirteen municipalities. The total population was about 1.3 million in 1990. Of the total land area of 1,036 square kilometers, one-third (350 square kilometers) was urbanized; the remaining 686 square kilometers were undeveloped in 1990. Forty percent of the vacant land is undevelopable because of its nature of being floodplains, wetlands, mangrove forests, or constrained by steep slopes.

3.2 AUTO-DEPENDENCY IN PUERTO RICO

The population density in San Juan is among the top fifteen in the United States. However, in spite of this relatively high population density, transportation in the metropolitan area is dominated by private automobile. Over the last 30 years, car
ownership in Bayamón, Carolina, Cataño, Guaynabo, and San Juan has increased dramatically from 0.141 cars per person in 1964 to 0.405 in 1990, representing an increase of almost three times (USDOT). The auto-oriented land-use patterns and street networks, inadequate bus service, and successful automobile marketing have contributed to make the region highly auto-dependent. The increasingly heavy reliance on automobile of the SJMA is best depicted by the changes in mode share between 1964 and 1990, as shown in Table 3.1.

Table 3-1 Percentage of Trips by Mode (SJMA)

<table>
<thead>
<tr>
<th>Mode</th>
<th>1964</th>
<th>1976</th>
<th>1990</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private Cars</td>
<td>62.7</td>
<td>81.8</td>
<td>90.5</td>
</tr>
<tr>
<td>Públicos</td>
<td>9.2</td>
<td>7.7</td>
<td>5.1</td>
</tr>
<tr>
<td>MBA buses</td>
<td>19.6</td>
<td>8.0</td>
<td>2.4</td>
</tr>
<tr>
<td>Other</td>
<td>8.5</td>
<td>2.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Study area (square kilometers)</td>
<td>363.0</td>
<td>489.0</td>
<td>1,036</td>
</tr>
</tbody>
</table>


According to the 1990 U.S. Census, 88.7 percent of workers in SJMA traveled to work by car, truck, or van. This percentage is slightly higher than the corresponding figure for mainland U.S., 86.5 percent. While these figures depict the journey-to-work travel behavior, they represent less than 30 percent of all trips. However, even taking into account all non-work related trips, automobiles' dominant share remains unchanged. In SJMA, 90.5 percent of all trips made in 1990 were by automobiles (USDOT). Again, this figure is slightly higher than the corresponding figure for U.S., which is 87.1 percent (UDOT, 1990). The density of vehicles per kilometer of paved road in the SJMA, at 56 vehicles per kilometer of paved road, is three times higher than that on the U.S. mainland and is the highest of all metropolitan areas in the world.

1 Since the 1990 census was performed, the Municipality of Naranjito was added as the 13th Municipality in the SJMA.
3.3 PROBLEMS

3.3.1 Increasingly Severe Congestion in Puerto Rico

The consequence of such a high density of vehicles per kilometer of paved road are gridlock traffic conditions, along with extended peak period congestion and delay throughout the region, particularly in central San Juan, including Santurce and Hato Rey (USDOT). Based on a conservative measure\(^2\), more than 27 percent of all freeways/expressways land-miles were defined as congested (volumes to capacity ratio greater than 1.0) whereas about one-third of principal arterial lane-miles were congested in 1990, as shown in Table 3.2. At the same time, roughly 20 percent of minor arterials and collectors were congested.

<table>
<thead>
<tr>
<th>Functional Class</th>
<th>Congested Lane-Miles</th>
<th>Total Lane-Miles</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeways / Expressways</td>
<td>70</td>
<td>256</td>
<td>27.3</td>
</tr>
<tr>
<td>Principal Arterials</td>
<td>203</td>
<td>608</td>
<td>33.4</td>
</tr>
<tr>
<td>Minor Arterials</td>
<td>209</td>
<td>1,033</td>
<td>20.2</td>
</tr>
<tr>
<td>Collectors</td>
<td>46</td>
<td>246</td>
<td>18.7</td>
</tr>
<tr>
<td>TOTAL</td>
<td>528</td>
<td>2,143</td>
<td>24.6%</td>
</tr>
</tbody>
</table>

Source: San Juan Regional Plan 1990.

The costs of congestion encompasses more than just negative environmental impacts and increased energy consumption, the time wasted on roadways could otherwise be spent on tasks enhancing one’s economic well-being. Congestion also causes delay in the movement of goods and delivery of services, which in turn hinders the economic growth and future prosperity of the SJMA.

The acute levels of traffic congestion, limited street and transit service, and for some residents, lack of access to an automobile, have deteriorated the quality of life in the area. Those with low and moderate incomes suffer the most.

Income levels in metropolitan San Juan are very low in comparison to other U.S. cities. According to the 1990 U.S. Census, median household income was $12,334 for Bayamón, $15,041 for Guaynabo, and $10,539 for San Juan, the three largest

\(^2\) This is a conservative measure of congestion because it is based on the lowest level of service F, or “forced flow,” in which operating speed can drop to zero and traffic queues result.
communities in the SJMA. When other municipalities in the SJMA were included, the median was $11,460, just about 39 percent of the median on mainland U.S.\textsuperscript{3}

Despite the lower wages, prices of most commodities, except for housing, are comparable to those on the continental U.S. Percentages of families below poverty line in 1989 were 55, 45, 37, and 40 for Puerto Rico, San Juan, Guaynabo, and Bayamón respectively, compared with 11.6 on mainland U.S. Just by looking at the income level in Puerto Rico, one would think that car ownership would be a luxury. To the contrary, car ownership is almost a necessity for many Puerto Ricans. As a result, many of car-owners are spending disproportionate amount of income on transportation. Other residents simply cannot afford to have a car, as discussed below.

3.3.2 Limited Accessibility and Mobility

In spite of the high proportion of travel made by automobiles (as shown above in Table 3.1), a significant portion of the population in the SJMA do not have access to a vehicle. This seemingly contradictory statement suggests that those who do not have access to a vehicle face significant constraint in mobility and accessibility. Approximately 30 percent of households did not have vehicle available in Puerto Rico in 1989, compared with 11.5 percent on the mainland. Consequently, transportation equity problems in the Commonwealth may be even more pronounced than those in the continental U.S.

The result of a home interview survey conducted in 1990 in the SJMA shows that households who did not own a vehicle accounted for 64.5 percent of all SJMA public transit trips. The 1990 Census data indicate that about 29 percent of households in the SJMA did not have vehicles available. The juxtaposition of these two set of data suggests that about 94 percent\textsuperscript{4} of the trips were made by about 71 percent of the

\textsuperscript{3} The median household income in U.S. was $29,642 in 1989.

\textsuperscript{4} Automobiles had a 90.5% share in all trips made; auto-owning households were responsible for all of these trips. In addition, auto-owning households were also responsible for transit trips not made by vehicle-lacking households. Given that auto-lacking households made 64.5% of all the transit trips, it follows that auto-owning households made 35.5% of all transit trips. The total trips made by auto-owning households = 90.5% + 9.5% (35.5%) = 93.9%. (For simplicity purpose, it is assumed that transit includes walking, cycling, and trips by motorcycles)
population. The 29 percent of the population who did not have access to a vehicle made only six percent of all trips.

For those who do not own automobiles, public transportation becomes very important in their daily lives. The lack of access to effective public transportation means limited access to jobs, education, and services. However, one has to live close enough to transit in order to take full advantage of it. Unfortunately, living close to transit is not always financially possible for many earning modest income, as the land value is usually higher around transit stations.

3.3.3 High Transportation Costs Borne by Auto-Owners

Even those Puerto Ricans with access to a vehicle are not necessarily benefiting from the auto-oriented society. A recent study found that an average family in Puerto Rico spends about 40 percent of its disposable income in the acquisition, operation, and maintenance of its family car (USDOT); this, however, does not include other modes of transportation, such as air-travel. The share of transportation in household budget is more than double that of their American counterparts. According to the U.S. Department of Labor, transportation’s share of a typical American household’s expenditures was 19 percent in 1994; constituting the second largest share of household expenditure. Transportation’s share of household expenditures ranged from 14.1 percent for the $5,000 to $10,000 income category to 22.1 percent for the $40,000 to $50,000 income category in continental U.S.\(^5\)

Lower income automobile owners must spend a disproportionate share of family income on automobile ownership and operation, rather than on housing and other goods and services. Many of the costs involved with auto ownership are hidden; therefore, owners may not be aware of how much they could save by maintaining just one vehicle or by relying on transit alone.

All these problems call for the provision of a transportation alternative. Creation of new transit services is not enough if the overall land-use pattern does not support the

\(^5\) It should be noted that air travel was taken into account in the calculation of transportation expenditure for the mainland.
usage of such services. A more comprehensive approach would combine land-use strategies, housing strategies, as well as transportation demand management strategies.

**TREN URBANO**

As a response to the severe congestion and the growing transportation demand, the Commonwealth is now constructing a twelve-mile heavy rail system in the San Juan Metropolitan Area (SJMA). This $1.5 billion, double-track, grade separated heavy rail system is called Tren Urbano. With the coming of this new urban rail system comes the opportunities for new real estate development. More importantly, from a city planning perspective, the new train also represents an excellent opportunity to change the travel behavior of many residents, improve accessibility of those who are transit-dependent, as well as re-configure the land use pattern to a more sustainable urban form. In particular, the development of the rail system would allow the SJMA to focus future residential development with a mix of complementary uses along the rail alignment and around the train stations. The Location Efficient Mortgages (LEM) may be an ideal policy instrument to help achieve such a goal.
Clearly our auto-oriented society and living style have created different sets of societal problems, many of which are affecting everyone. Many are now advocating for a transit-oriented living style. A new mortgage product, the Location Efficient Mortgages (LEM), is a potential instrument to provide incentives to people to live in a higher density development near transit stations. The LEM builds strongly upon the relationship between land-use and transportation; in addition, a third dimension is added to LEM—housing finance. Because of this third dimension, the LEM is probably more powerful in influencing the type and location of housing families choose to live in.

The Location Efficient Mortgages are innovative mortgage products that are currently being developed by a research partnership, made up of three non-profit organizations: the Center for Neighborhood Technology (CNT) in Chicago, the Natural Resources Defense Council (NRDC) in San Francisco, and the Surface Transportation Policy Project (STPP) in Washington, D.C. The research partnership envisions that the LEM will be offered in Chicago, Los Angeles, and San Francisco to low- and moderate-income borrowers who are interested in urban areas served by public transportation systems. The LEM is not presently on the market, but it is expected that a market test will be undertaken in Chicago in May, 1998.

The original intent of the research was to propose enhancement to the existing Energy Efficient Mortgage programs. Under the Energy Efficient Mortgages, the ability to qualify for a mortgage includes a consideration of utility bill savings as well as the direct costs of a mortgage. Utility savings are subtracted from the usual computation of Principal, Interest, Taxes and Insurance (PITI) to determine mortgage qualification. If the characteristics of a neighborhood allow the reliable calculation of transportation costs savings as well, these too could be subtracted from PITI when calculating mortgage qualification.
4.1 LOCATION EFFICIENCY DEFINED

Location efficiency, as defined by Hoeveler (1997, P. 2), is “a land planning and economic development concept that can be envisioned and quantified through the economics of substitution.” First, accessibility is substituted for mobility when one makes choices concerning where we live, work, and shop. Second, local sources for goods and services are substituted for travel to distant sources, thereby reducing environmental impacts and energy consumption. Third, as perceived by Hoeveler and his colleagues, personal and community investments are made in appreciating resources such as homes and businesses. Finally, less is spent on depreciating personal property such as motor vehicles required to maintain mobility; and a sense of local/regional place is created as a substitute for disconnected and far-flung destinations linked by mobility.

In the context of housing, location efficiency can be seen as a multi-purpose concept which integrates: the spatial match between populations and their activities; the relative efficiency of different modes of transportation; the environmental and energy impacts of dependence on those transportation modes, and the capital costs that households, communities, states, and the federal government shoulder when transportation choices are made.

The major premise underlying the LEM is that a household can spend less on transportation by giving up a car, relying on public transit for their travel needs. Similarly, the LEM acknowledges that households save money when they live in densely-populated, pedestrian-friendly, amenity-accessible communities, where they can shop, work, recreate, socialize, learn, and utilize resources of their local community locally, without the need to travel. A portion of this saving would be integrated into the calculation of borrowing capacity as part of a regular mortgage application process. This assumed increased borrowing capacity would allow families to borrow more with a given amount of income, thereby, making home-ownership for some moderate to low-income families possible. Moreover, for those families who are eligible to apply for a mortgage even without the use of the LEM, the instrument would allow them to obtain a larger loan with the same down payment.

The money saved by switching one’s reliance on the automobile to public transit is relatively easy to quantify. According to a study conducted by the Federal Highway
Administration (FHWA) in 1991, the total costs of owning and operating a compact 1991 model automobile accrued to over $7,000 in the first year, and about $4,000 in the fourth year. An intermediate 1991 model would cost more—almost $7,800 for the first year and well over $3,200 even for the seventh year. The costs include the capital cost of purchasing an automobile, financing cost, repairs and maintenance costs, costs of gasoline and oil, insurance, parking and tolls, as well as taxes and fees. A more recent analysis by the American Automobile Association reveals that ownership costs per year (based on a 6-year/ 60,000-mile retention cycle) for a 1997 Chevrolet 4-door sedan is about $3,560 per year and an operating cost at 9.5c per mile, which amount to the total costs of $4,520 and $6,952 for driving 10,000 and 20,000 miles a year respectively.

Owning one less vehicle would allow a household to save these auto-owning and operating costs. LEM recognizes that portion of these savings be shifted to income available for housing expenses, thereby, qualifying home-buyers for a larger mortgage with higher monthly payment and lower down payment.

To quantify the savings related to population density and neighborhood characteristics is a bigger challenge. Holtzclaw (1994) was the first to attempt to tackle this challenge. The approach he took was to establish a simple arithmetic relationship between certain neighborhood characteristics and the resulting reduction in a household’s annual VMT by examining twenty-eight communities in California. He then translated the annual VMT reduction into monetary value using the result of FHWA’s study in 1991. He defined four neighborhood descriptors that a priori influence personal transportation costs. There are:

- residential density: the number of dwelling units per residential land area;
- transit accessibility (TAI): an index of transit accessibility defined and measured for the neighborhoods under study;
- neighborhood shopping: an index developed to define the ability to perform neighborhood shopping errands with a short walking trip from home; and,
- pedestrian accessibility: factors that encourage or discourage walking are combined into an index that is quantified for the neighborhoods under study.

Of the four variables, only the first two of the four variables are shown to have strong statistical correlation with automobile ownership and usage in Holtzclaw’s study. The results he obtained were:
Autos/Household = 2.704 * (density) ^-25 \quad \quad R^2 = 0.85; \text{ and }

VMT/Household = 34,270 * (density)^{-25} * TAI^{-0.076} \quad \quad R^2 = 0.83

These equations allow one to estimate the number of automobiles and VMT per household in a neighborhood where the residential density and transit accessibility are provided. Costs related with auto uses can then be estimated using FHWA’s study.

4.2 **THE LEM AS A STRATEGY TO PROMOTE HOME-OWNERSHIP**

In addition to its potential to encouraging people to live close to transit and replace auto trips with walking and transit trips, LEM could be a powerful tool to promote home-ownership, especially among the less-well-to-do. In general, there are three primary reasons explaining why families and individuals cannot afford to purchase a house: lack of cash or other financial assets for the down payment and closing costs, insufficient income to make the mortgage payments, and other debt payments which reduce the amount of income available for the mortgage payment. Three basic policy responses which are often discussed are (1) lowering interest rates, (2) requiring a lower down payment for home purchases, and (3) providing a down payment subsidy to home buyers.

Empirical studies conducted by the Census Bureau concluded that decrease in the mortgage interest rate of less than three percent compared with the interest rate prevailing in 1993 (7.117%) had no significant effect on the number of renters who would have qualified for a mortgage (Savage, 1993). A 3 percentage point lower rate would increase the number of renters who would have qualified a mortgage by about one percentage point. This is because renters typically face more than one obstacle to buying a home; lowering of interest rates might remove one obstacle--lack of income to qualify for a loan--but they still might not have enough cash for a down payment and closing costs.

The same study also reported that a decrease in the amount of required down payment from 5 percent to 2.5 percent would have resulted in an increase in renters who would qualify for a mortgage by 1 percentage point. This option would lower the amount of cash required for the purchase, but it would also increase the amount of income
necessary because mortgage payments would increase as a result of the higher amount of the mortgage.

Finally, the study indicated that a subsidy of $1,000 would have increased the number of renters who would qualify for a mortgage by 1 percentage point; $2,500, by 3 percentage points; $5,000, by 14 percentage points; $7,500, by 21 percentage points; and $10,000, by 25 percentage points. This final approach relies on government subsidies, thereby making them subject to government fiscal constraints and vulnerable to political whims. The LEM distinguishes itself as a policy tool because it does not involve any financial contribution of government; instead, it relies on market incentives to influence home ownership.

4.3 HOW THE LEM PROGRAM WORKS IN CHICAGO

Two brief examples of a hypothetical buyer and a specific address in Chicago illustrate how the LEM would work. In the first scenario, assume that a buyer is interested in purchasing a specific property, priced at $120,000. The household has a joint income of $2,500 a month ($30,000 per year). The borrower is seeking a 30-year mortgage with an interest rate of 8.0%, and has a 5 percent down payment available. The borrower currently has no long term debt, owns one car, and will use one monthly transit pass (currently costing $88/month in Chicago) to meet their travel needs. The second scenario is exactly the same as the first except that the borrower has no car and uses two monthly transit passes.

The borrower has heard about the LEM through a realtor and a banker who offers it in Chicago and is aware that the LEM can be secured for qualified borrowers interested in purchasing single or multi-unit, owner-occupied housing located in neighborhoods that have the characteristics of location efficiency described above. The borrower would be aware that the LEM would incorporate the following features:

- 30-year fixed rate mortgage for owner-occupied homes;
- Interest rate established at time of close or through rate lock-in option;
- Applicable to single-unit housing, condominiums, or multi-unit homes but not for cooperative housing units;
- Housing debt (or front end) ratio of 33% and a total debt (or back end) ratio of 38%
• Variable Loan-to-Value (LTV) ratio according to number of units in multi-unit, owner-occupied housing;
• Voluntary or mandatory three to four year transit pass enabling "any one, anytime, anywhere, any reason" mobility for the household;
• Pre-application counseling required;
• Location Efficiency Value (LEV) used as an offset to the total of Principal, Interest, Taxes, and Insurance (PITI) in the same manner as the Energy Efficient Mortgage;
• Mortgage insurance required during first three years to reduce overall risk;
• Widely accepted application scoring system used to determine the credit worthiness of the applicant;
• Single endorsement executed by the buyer at the close to affirm willingness to participate in periodic reporting of employment, auto ownership, transit usage and use of post-closure counseling as needed; and
• Household’s transit pass would be "bundled" with other cost items into a single escrow fund, payable at the time of close and subtracted from the amount of the loan or escrowed from monthly mortgage payments and transferred annually to the public transit provider.

When the borrower meets with the lender to discuss the LEM, the lender would access the LEM Advisor software program through the Internet. The screen would ask a sequence of questions, information would be entered, and then a map would be displayed on the screen. It would show the location of the property that the hypothetical buyer would like to purchase and the bus stops, train stations, and principal cultural features near the property. It would also highlight walking distances (half-mile for a train and a quarter-mile for a bus) which are used to determine the number of transit rides available per day to the borrower.

Based on the personal financial information and mortgage values provided by the borrower, the LEM Advisor program will calculates comparisons of three different geographically-based, borrower-specific cases:

1. the Base Case for Metropolitan Chicago, which represents a hypothetical "least efficient location" within the metropolitan area;
2. the Zone Case, which portrays the same factors within the Travel Analysis Zone (TAZ) in which the property is located; and
3. the Applicant’s Case, which reflects the borrower’s own situation.

The LEM Advisor merges all this information, calculates a Location Efficiency Value (LEV), and enters a predetermined portion of the LEV into the mortgage formula calculation.
4.3.1 Borrower’s Mortgage Situation

Using the information described above, the LEM Advisor calculates that on average in the "Base Case" households own 2.2 cars and drive 23,955 miles a year. This activity costs $662 per month or $7,944 per year. According to this analysis, if the borrower were to conform to the transportation habits of average households in the Base Case setting, she/he would not qualify for a LEM because the LEV is zero, she/he would have very high transportation costs, their total debt ratio in this case would be 42.6%, and the maximum amount they would be qualified to borrow would be $91,651.

Within the Zone Case, on average, households would own 1.5 cars and would drive a total of 8,015 miles per year. The average monthly cost of this activity would be $358 or $4,296 per year. In this case, if the borrower conformed to the transportation habits of the average household within the TAZ, she/he would achieve a LEV of $236 per month, their total debt ratio would be 38.9%, and the maximum amount they would be qualified to borrow would be $110,707. This case is an improvement over the Base Case, but it still falls short of the $114,000 needed to purchase the desired home ($120,000 minus a $6,000 down payment).

Two different scenarios are provided below. In "Scenario #1," the borrower owns one car, is projected to drive 5,387 miles per year at an average monthly cost of $241 or $2,892 per year, and will spend $88 per month on one transit pass. Under these conditions, the borrower would achieve a LEV savings of $318 per month, would have a total debt ratio of 37.8%, and by using a LEM would qualify to borrow as much as $114,939, which is enough to purchase the home.

In Scenario #2, the LEM Advisor calculates that if the same borrower owned no car, she/he would have no auto costs, but would spend $176 per month on two transit passes. In this situation, the borrower would achieve a LEV savings of $486 per month, would have a total debt ratio of 35.6%, and could qualify for a maximum mortgage of $123,614, more than enough to purchase the home.
### Table 4-1 Comparison of Base Case, Zone Case, and Borrower’s Case

<table>
<thead>
<tr>
<th>LEM Statistics</th>
<th>Base Case</th>
<th>Zone Case</th>
<th>Scenario #1</th>
<th>Scenario #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of autos</td>
<td>2.2</td>
<td>1.5</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Yearly VMT</td>
<td>23,955</td>
<td>10,113</td>
<td>6,797</td>
<td>0</td>
</tr>
<tr>
<td>Monthly VMT</td>
<td>1,996</td>
<td>843</td>
<td>566</td>
<td>0</td>
</tr>
<tr>
<td>Monthly auto costs</td>
<td>$662</td>
<td>$380</td>
<td>$256</td>
<td>$0</td>
</tr>
<tr>
<td>Transit use</td>
<td>Not available</td>
<td>Occasional</td>
<td>1 Transit pass</td>
<td>2 Transit passes</td>
</tr>
<tr>
<td>Monthly transit costs</td>
<td>$0</td>
<td>$45</td>
<td>$88</td>
<td>$176</td>
</tr>
<tr>
<td>Monthly location efficiency value</td>
<td>$0</td>
<td>$236</td>
<td>$318</td>
<td>$486</td>
</tr>
<tr>
<td>Total debt ratio</td>
<td>$0</td>
<td>$236</td>
<td>$318</td>
<td>$486</td>
</tr>
<tr>
<td>Qualify for mortgage?</td>
<td>Denied</td>
<td>Denied</td>
<td>Qualify for LEM</td>
<td>Qualify for LEM</td>
</tr>
<tr>
<td>Maximum mortgage available to borrower</td>
<td>$91,651</td>
<td>$110,707</td>
<td>$114,939</td>
<td>$123,614</td>
</tr>
</tbody>
</table>

These calculations assume that 38% of the calculated LEV would be added to the monthly household income portion of the Total Debt Ratio. An alternative approach would be to subtract a portion of the LEV from the purchase price of the home. This approach is more consistent with the findings of researchers who have measured the added value that proximity to public transit imparts to certain properties. Whether the LEV is used to "stretch" the borrower's income or whether it is used to offset the enhanced value of the property is a subject of negotiation between Fannie Mae and the LEM Partnership.

#### 4.3.2 Progress of the Chicago LEM Program

Presently several major mortgage lenders in Chicago have expressed their willingness to write Location Efficient Mortgages to qualified borrowers, contingent upon such mortgages being accepted on the secondary mortgage market. These lenders have asked that the Federal National Mortgage Association (Fannie Mae) initiate an Alternative Underwriting Experiment for the LEM as part of its "One Trillion Dollar Commitment" to expanded homeownership. Concurrently, housing-related community development organizations, the Chicago Public Schools, and the Chicago Association of Realtors have also endorsed the LEM and have offered their support and participation when a market test of the LEM begins. The LEM Partnership is also finalizing work on
Geographical Information System (GIS) models for Los Angeles and San Francisco and plans for the Fannie Mae sponsored market tests of the LEM in these major metro areas are moving forward as well.

4.4 **WHO WILL BENEFIT FROM THE LEM?**

At its present form, the LEM is likely to benefit existing and prospective residents around transit stations, transit agencies, banks, and society at large. When the LEM is made available by local mortgage lenders and backed in the secondary mortgage market by Fannie Mae, it will have the potential to achieve several very desirable changes in urban areas. The LEM could increase homeownership opportunities for low- and moderate-income households. It could create interest in purchasing homes in inner-city communities well served by public transportation, stimulating and/or fostering community economic development. The LEM could also encourage higher population density and support growth of local consumer services and cultural amenities. The LEM helps to create an urban form that encourages a shift from driving to taking transit. It, therefore, could reduce energy consumption, while improving air quality.

4.5 **VERIFYING THE ASSUMPTIONS OF THE LEM**

The success of the LEM in creating the benefits discussed hinges upon two assumptions. The first is that a person is likely to use transit more if he/she lives or works near a transit station. The second assumption is that one has a higher propensity to take transit by living or working in a higher density area. Since these two assumptions form the backbone of LEM, it is important that they are indeed valid.

4.5.1 **Transit Ridership and Proximity to Transit**

Interest in understanding the relationship between transit ridership characteristics of residential and commercial developments located near rail transit stations has spawned since the 1980’s. Three studies in particular have examined this relationship. Stringham has focused on Edmonton and Toronto in Canada; JHK Associates looked at Washington, D.C.; Cervero examined the San Francisco Bay Area.
Edmonton and Toronto, Canada

Stringham (1982) conducted one of the earliest major studies on transit ridership and proximity to station. He focused on two Canadian systems, the Toronto subway system and the Edmonton light rail system. The study examined variation in rail modal splits as a function of distance to stations and modes of access for every 2,000 people either living or working near two suburban stations in each city. It was found that within a radial distance of 3,000 feet\(^1\) from a station, rail transit modal splits ranged from 30 to 60 percent of all work and school trips. The author estimated the “impact zone” (the area within which people walk to the station in significant numbers) to extend perhaps as far as 4,000 feet from a station.

Stringham’s work found that the transit modal share for offices located near suburban rail stations to be considerably lower than that of residences near the same station, which may reflect the availability of abundant parking at the suburban businesses surveyed. This result was consistent with a study conducted in Washington, D.C., in 1987 and 1989. The study placed particular emphasis on how modes of access vary with distance from a station. The author found that well over 90 percent of rail users whose origin or destination was within 1,500 feet of a station walk to the station. At a distance of about 3,200 feet, bus transit replaced walking as the predominant mode of access. At 3,700 feet, virtually no residents or workers walked to the station; approximately 15 percent arrived at the station by car and the remainder reached by bus.

Washington, D.C.

In 1987 and 1989, JHK Associates conducted one of the most comprehensive analyses of rail ridership for developments near urban rail stations in the metropolitan area of Washington, D.C. The 1987 study examined eight multi-family projects located in downtown Washington D.C., and suburbs, each with a minimum of 75 dwelling units, and sixteen office developments. All the developments in the study were located within approximately one-third mile of a station.

\(^1\) This is equivalent to approximately 0.57 mile.
The 1987 results for residential projects are summarized in Table 4.2. Rail transit’s share in work trips ranged from 18 to 63 percent. Transit modal shares generally fall off gradually with distance from stations. The authors calculated that the share of trips by rail and bus transit declined by approximately 0.65 percent for every 100-foot increase in distance of a residential site from a Metrorail station portal.

### Table 4-2 Modal Splits for Residential Development Near Metrorail Stations, Washington, D.C.

<table>
<thead>
<tr>
<th>Metrorail Station</th>
<th>Project</th>
<th>Distance to Station</th>
<th>% Rail</th>
<th>% Auto</th>
<th>% Other¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rosslyn</td>
<td>River Place North</td>
<td>1,000 feet</td>
<td>45.3</td>
<td>41.5</td>
<td>13.3</td>
</tr>
<tr>
<td></td>
<td>River Place South</td>
<td>1,500 feet</td>
<td>40.0</td>
<td>60.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Prospect House</td>
<td>2,200 feet</td>
<td>18.2</td>
<td>81.9</td>
<td>0.0</td>
</tr>
<tr>
<td>Crystal City</td>
<td>Crystal Square Apts</td>
<td>500 feet</td>
<td>36.3</td>
<td>48.8</td>
<td>14.9</td>
</tr>
<tr>
<td></td>
<td>Crystal Plaza Apts</td>
<td>1,000 feet</td>
<td>44.0</td>
<td>45.0</td>
<td>11.0</td>
</tr>
<tr>
<td>Van Ness-UDC</td>
<td>The Consulate Connecticut Heights</td>
<td>300 feet</td>
<td>63.0</td>
<td>32.6</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3,800 feet</td>
<td>24.0</td>
<td>56.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Silver Spring</td>
<td>Twin Towers</td>
<td>900 feet</td>
<td>36.4</td>
<td>52.3</td>
<td>11.4</td>
</tr>
<tr>
<td></td>
<td>Georgian Towers</td>
<td>1,400 feet</td>
<td>34.7</td>
<td>43.1</td>
<td>0.8</td>
</tr>
</tbody>
</table>

¹ “Other” consists of bus, walking, and other forms of access.


A similar survey was conducted in 1989 at ten different residential sites near five stations. A higher transit modal share was found in the 1989 survey, ranging from 30 to 74 percent of commute trips. However, transit usage was found to vary considerably, depending on trip destination. The 1989 follow-up survey by JHK basically confirmed their findings in 1987. Location of residence was shown to be an important determinant of whether office employees near Metrorail stations patronized transit.

The same group of researchers also examined the transit ridership pattern of employees of offices near Metrorail stations. The result revealed that ridership was much higher at downtown than at suburban sites. And, similar to the case of residential survey, ridership fell off steadily as distance from offices to stations increased. The researchers found that transit ridership fell by 0.76 percent for each 100-foot increase in distance from a Metrorail portal.
JHK and Associates (1989, P.2) concluded that “the most significant factors affecting the percent of trips by transit are: (1) the location of the site within the urban area and on the Metrorail system; and (2) the proximity of the building to a Metrorail station entrance.” The origin-destination patterns of trips were also found to be crucial—“poor transit accessibility at either end of the trip results in poor transit ridership between those pairs” (P. 1).

San Francisco Bay Area

Cervero (1993b) conducted the most recent large-scale study on the relationship between transit ridership and distance to station. He examined residential, office and shopping developments located near five rail transit systems in California--Sacramento Transit, Bay Area Transit Authority (BART), CalTrain, Santa Clara County Transit, and San Diego Transit. He concluded, after evaluating the travel behavior of residents living near transit stations, that station area residents were five to seven times more likely to travel by rail than residents elsewhere in the same community or region.

Rail’s modal share fell linearly with distance from the station for the surveyed housing projects in Cervero’s study -- on average, by about 1.1 percentage point for every 100-foot increase in walking distance, ceteris paribus (see Figure 4-1).

For offices, the ridership gradient displayed an exponential decay function. Ridership fell sharply with walking distance, following a negative exponential function. (see Figure 4-2). In all but one of the rail systems studied, only offices within 500 feet of a station had as much as 15 percent of their workers commuting by rail; no more than 10 percent of workers took rail to work in offices beyond 500 feet from the nearest station.

In general, though, ridership gradients for California transit-focused developments were flatter and lower than those found in previous studies for Washington, D.C., Toronto, and Edmonton. In Washington, D.C., ridership fell rapidly with distance within a one-half-mile radius of stations (see Figure 4-3). In the case of Toronto and Edmonton, the difference in the share of residents or workers in a building immediate to a station
these studies, the relationship between rail and modal splits and distance was not linear, implying that the effects of distance changed as one approached the station. It was who used rail transit was greater over a one-mile radius than a one-half-mile radius. In both of
suggested that the difference between the California study and the other studies was likely attributable to the greater abundance of park-and-ride facilities at stations in California, differences in urban form, and higher degree of workplace primacy (i.e., larger downtowns) in those other cities.

Figure 4-3 Rail Mode Share by Distance to Office Sites, Comparison of California and Other Systems.

The propensity to take transit is not merely the result of residential locational advantage. Cervero suggested that the strongest predictor of station-area residents commuting choice was the proximity of their destinations to rail station and the parking fee at those destinations. If the residents worked in a major urban center served by rail transit and faces daily parking expenses, the likelihood of commuting by rail would increase significantly -- as high as 90 to 98 percent (Cervero, 1993). On the contrary, if the residents commuted to work in a suburban office park not served by rail but with ample free parking, the chance of commuting by rail would fall nearly to zero. Hence, Cervero argues that if transit-focused housing is to produce meaningful mobility and
environmental benefits, there must also be transit-focused employment centers. Other significant predictors include vehicle ownership levels and the cost of using alternative modes.

The proportion of residents using transit to work was higher than the proportion of workers near transit lines using transit at comparable distances from stations. As in the case of the Bay Area Rapid Transit system, 27 percent of all station area residents commuted by rail but only 17 percent of all station workers commuted by rail. This phenomenon was not unique to the San Francisco Bay Area. In fact, the ratio appears consistent across all the systems studied; approximately twice the proportion of station area residents used the regional rail system compared to the proportion of station area workers. For the San Diego system the proportions were 13 percent and 7 percent respectively; for Sacramento system the proportions were 11 percent and 6 percent.

The research has also identified external factors contributing to workers’ propensity to commute by transit is also influenced by such public and private policies as flexible working schedule, employee transit subsidies, and other forms of transportation allowances.

**Pedestrian Access and Walking Distance**

In relatively dense areas, the relationship between one’s proximity to transit station and their usage of transit is, to a very large extent, determined by one’s willingness to walk to and from transit stations. Walking as a mode of access to and from transit typically eliminates two vehicle trips. The air quality benefits of eliminating these relatively short trips are substantial. This is because the greater the number of cold starts the higher the emissions, even if total vehicle miles traveled (VMT) are constant. For instance, cold start emissions produce 60 percent of total exhaust plus evaporative emissions for a 5-mile trip, while cold start emissions account for 50 percent of emissions in a 10-mile trip.

Untermann (1984) has conducted the most in-depth work to date on the walking behavior of American. He concluded that most people are willing to walk 500 feet, with 40 percent willing to walk 1,000 feet, and only 10 percent willing to walk half a mile. Trip purpose is not specified in these figures; however, Stringham suggests that
acceptable walking radii might be further for more crucial trips, such as work-trips. Furthermore, Untermann and Stringham have shown that acceptable walking distances can be stretched considerably by creating pleasant, interesting urban spaces and corridors. Untermann has also shown that transit passengers are less sensitive to walking distances as service frequency increases. In fact, Fruin (1992) has found that average walking distances are larger in urban centers. In downtown Boston, 60 percent of walk trips are over one-quarter mile, and the average walking distance in Manhattan is one-third mile.

A study conducted by Parsons Brinckerhoff Quade and Douglas, Inc. in 1996 corroborates Stringham's suggestion that people tend to be willing to walk farther for work-trips. The study focused on three rails systems: the Chicago Transit Authority (CTA) rapid rail which operates within the city limits, the Metro commuter rail which operates between the suburbs of Chicago and the downtown Loop, and the BART system. Most rail transit riders in all the three cases walk half mile to three-quarters of a mile to and from stations. Beyond that range of distance, most riders access stations by automobile in the Chicago area and bus in San Francisco. Research in Chicago suggests that the proportion of all trips made by pedestrians from home to the CTA rail system decreases approximately 1.1 percent for each 100 feet of linear distance between the residence and the rail station for a range of up to 1.5 mile. This result is consistent with Cervero's findings of his study focusing on five rail systems in California.

4.5.2 Pedestrian Amenities and Walking Distance

Cervero (1993) has conducted a study on the importance of pedestrian amenities and land-use environment in influencing pedestrian behavior in Houston. Employment density in downtown Houston is four times that in Uptown, a suburban activity center six miles west of downtown; sidewalk footage per 1,000 workers in downtown is 23 percent more than that in Uptown. Downtown Houston has skywalks and an array of pedestrian amenities, including civic plazas, benches, street sculpture, etc. With street-level shops, eateries, and storefronts, the built environment in downtown is also more interesting. On the other hand, walking in Uptown is a less pleasant experience due to the busy intersections, expansive surface parking lots, and other undistinguished urban spaces. Walking/cycling accounts for around 30 percent of all trips made outside of buildings in
downtown Houston, compared to seven percent in Uptown. The researcher attributes this difference to the different levels of pedestrian amenities in the two areas. He has even estimated that every 10 percent increase in pedestrian amenities is related to a 15 percent decline in motorized trip-making.

Parsons Brinckerhoff Quade and Douglas, Inc. suggests that walking distances are influenced not only by the quality of the urban environment, as Untermann suggests, but also by various factors that are within the realm of public policy. These factors include quantity, location, and pricing of parking facilities near transit, characteristics of the transit service, as well as characteristics and locations of land uses near transit corridors and stations.

4.5.3 Transit Ridership and Development Density

While proximity to transit plays a very important role in determining one’s willingness to take transit, development density has also been found to have very profound influence on demand for transit services. Automobiles can operate in very low-density settings; transit, on the other hand, requires that a certain mass of riders and destinations be located along its routes to operate efficiently. Many argue that one of the major determinants of transit ridership is the density of residential development and employment centers. Numerous empirical studies have identified threshold densities to allow planners to estimate the possibility for transit to work in different settings.

Nelson and Nygaard (1995), in an analysis of variations in transit demand in Portland, Oregon, have noted that “of 40 land use and demographic variables studied, the most significant for determining transit demand are the overall housing density per acre and the overall employment density per acre. These two variables alone predict 93 percent of the variance in transit demand among different parts of the region.” In their study transit demand was measured by the number of weekday transit trip productions and attractions per developed or developable acre (excluding street rights of way, open space, parks, and water).

A recent commuting mode choice study using American Housing Survey data examined the relative effects of density and mixed uses, controlling for level of transit service, income, and other factors affecting mode choice. The analysis found that
residential density has more than ten times the impact on transit mode choice that land-use mix has (Parsons Brinckerhoff, 1996).

Pushkarev and Zupan (1977) have documented that residential densities in transit corridors, together with the distance of the stations from downtown and the size of the downtown, explained demand for a variety of transit modes. This relationship was later confirmed by Smith (1984) using data from six U.S. metropolitan areas. In 1988, Pushkarev and Zupan have reached a series of carefully qualified conclusions regarding between residential densities and different types of transit services. For instance, they have suggested that a 5-minute headway rapid rail service would need a density of 12 dwelling units per residential acre to support. Other findings are included in Table 4.3.

Table 4-3 Relationship Between Residential Densities And Transit Services

<table>
<thead>
<tr>
<th>Service Levels</th>
<th>Density Thresholds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus</td>
<td>minimum service, 1/2 mile between</td>
</tr>
<tr>
<td></td>
<td>routes, 20 routes/day</td>
</tr>
<tr>
<td></td>
<td>4 dwelling unit/residential acre</td>
</tr>
<tr>
<td>Bus</td>
<td>intermed service, 1/2 mile between</td>
</tr>
<tr>
<td></td>
<td>routes, 40 routes/day</td>
</tr>
<tr>
<td></td>
<td>7 dwelling unit/residential acre</td>
</tr>
<tr>
<td>Bus</td>
<td>frequent service, 1/2 mile between</td>
</tr>
<tr>
<td></td>
<td>routes, 120 routes/day</td>
</tr>
<tr>
<td></td>
<td>15 dwelling unit/residential acre</td>
</tr>
<tr>
<td>Light rail</td>
<td>5-minute peak headways</td>
</tr>
<tr>
<td></td>
<td>9 dwelling unit/residential acre</td>
</tr>
<tr>
<td>Rapid rail</td>
<td>5-minute peak headways</td>
</tr>
<tr>
<td></td>
<td>12 dwelling unit/residential acre</td>
</tr>
<tr>
<td>Commuter rail</td>
<td>20 trains/day</td>
</tr>
<tr>
<td></td>
<td>1-2 dwelling unit/residential acre</td>
</tr>
</tbody>
</table>

Source: Boris Pushkarev and Jeffrey Zupan, 1982.

Newman and Kenworthy (1989) have come to a conclusion that there is a marked difference in driving at a density below eight persons per acre. They have noted that bus service would become poor when residential density falls below 12 persons per acre. They have recommended densities above 12 to 15 persons per acre for public transit-oriented urban lifestyles.

Some researchers, such as Harvey and Holtzclaw have suggested that a doubling of residential densities correlate with a decrease of 20 percent to 30 percent in VMT per capita. Holtzclaw (1994) has concluded that 1 mile of transit travel in denser urban environments replaces 4 to 8 mile of automobile travel in low-density suburbs for a similar set of activities.
Parsons Brinckhoff Quade & Douglas, Inc. have undertaken a more comprehensive study in 1996. Three analyses were conducted to estimate the association of different elements of density with transit patronage. One analysis has suggested that a doubling of station-area residential densities is associated with increases in light rail boardings of almost 60 percent and commuter rail boardings of 25 percent. The second analysis has revealed that a doubling of residential densities more than doubles transit use, as shown in Table 4.4. This is, in part, because the higher density urban areas have more transit service than the lower density suburban areas. Moreover, people in denser areas also use transit for more trip purposes than those who live in less dense areas; for example, shopping and recreation, in addition to commuting. The third analysis of Parsons Brinckhoff has shown that employment densities at stations throughout the system affect boardings. A doubling of station area employment density increases boardings by 25 to 50 percent.

Table 4-4 Summary Of Elasticity For Transit Trips Per Person And Densities In Chicago

<table>
<thead>
<tr>
<th>Type of Transit</th>
<th>Transit Use Measure</th>
<th>Neighborhood Residential Density</th>
<th>Neighborhood Employment Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus and CTA rail</td>
<td>Transit trips/person</td>
<td>1.11</td>
<td>n.s.</td>
</tr>
<tr>
<td>Bus only</td>
<td>Bus trips/person</td>
<td>1.04</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

Note: Elasticities were measured holding income and land uses constant within the neighborhood (ns = not statistically significant).

Source: Parsons Brinckhoff Quade & Douglas, Inc. 1996

All the above studies have shown, through the use of different approaches and different sets of data, that transit ridership is strongly influenced by two factors. The first one is the physical distance between transit stations and places of residence and employment centers. The second one is the density of development along transit corridors. As mentioned earlier, the success of the LEM in encouraging replacement of auto trips by transit trips relies on the validity of these two relationships. Empirical studies have proven that the LEM is not simply the ideology of planners and architects; it
indeed could impose quite significant impacts on people’s travel behavior, especially when it is coupled with complementary land-use and transportation policies.

4.6 **ESSENTIAL ELEMENTS FOR LEM IMPLEMENTATION**

The LEM cannot be implemented anywhere. Successful implementation of the LEM requires certain conditions to exist in an area. These conditions include:

4. adequate and comprehensive transit services;
5. sufficient employment opportunities along transit corridors;
6. mix of uses along transit corridors; and
7. readiness to accept high residential density.

4.6.1 *Adequate and Comprehensive Transit Services*

The LEM requires its users to reduce their households’ car ownership. It encourages its users to replace part of their automobile trips with transit trips. In order to make it possible, there has to be a transit system providing adequate services and comprehensive geographic coverage. The transit system needs to allow its riders to travel between home and work in an efficient manner. Services need to be reliable too. In addition, transfers between the same mode and intermodal transfer ought to be seamless; transit riders should not have to spend half-an-hour waiting for transfer. It should be noted that transit service and patronage affect each other at the same time. The better the service, the higher the level of patronage; the higher the level of patronage, the better the service. This mutual relationship holds until a certain patronage threshold is met, in which case increase in patronage would only deteriorate transit service.

4.6.2 *Sufficient Employment Opportunities Along Transit Corridors*

In many cases households possess more than one car because household members need to drive to work at the same time of the day. If one member could take public transportation to work, it would be easier for a household to give up one car. It follows that sufficient employment opportunities need to exist along transit corridors if the LEM is to work. The further away the jobs are from transit corridors, the less feasible it is for workers to travel to work by transit. This refers to the earlier research that proximity between employment and transit stations affect workers’ transit usage (Cervero, 1993).
4.6.3  **Mix of Uses Along Transit Corridors**

Other than earning a living, automobiles are used to make trips that meet the different needs of our lives. As a matter of fact, work trips and work-related business trips only account for 27% of all vehicle trips and about 38% of the total VMT (UDOT, 1997). Vehicle trips dealing with family and personal business account for half of all vehicle trips and about 36% of the VMT (UDOT 1997). Such trips include shopping, taking children to day-care center, going to banks for personal assistance, going to doctor’s/dentist’s office, etc. Driving to social and recreational activities account for about one-fifth of all the vehicle trips and about 23% of the VMT (UDOT 1997). Such trips include going to parks, theaters, concerts, libraries, etc. In light of our mobility needs, it is crucial that LEM users could meet their needs by public transportation. To make this possible, transit corridors cannot be filled only with housing and employment centers; businesses, facilities, and activities centers mentioned above need to be located along transit corridors. In other words, different land-uses have to coexist along transit corridors.

4.6.4  **Readiness to Accept High Residential Density**

As empirical research has shown, there is a positive correlation between residential density and transit ridership. The higher the residential density, the higher the propensity of residents taking transit, everything else constant. Moreover, a development of higher residential density is more likely to attract businesses into an area to serve the daily needs of residents. This would make it easier for households to give up their cars, since some errand trips could be run by walking.
5 DOES THE SJMA QUALIFY FOR THE LEM?

The San Juan Metropolitan Area is chosen as a case for exploration of the newly developed Location efficient mortgages (LEM). There are four primary reasons for selecting the SJMA as the case. First, Puerto Ricans in the SJMA depend heavily on driving to satisfy their mobility needs. Second, auto ownership represents a rather heavy financial burden on an average Puerto Rican family. Third, the cost differential between driving and transit in the SJMA is much higher than in other U.S. region, making the LEM more promising. Lastly, transit service in the SJMA is undergoing major reform. With the coming of Tren Urbano and all the transit improvements made in preparation for the new train, transit service is anticipated to be upgraded significantly.

While the SJMA will benefit greatly if the LEM works, one cannot simply assume that the LEM will work well in the region. Using the requisites developed in the last chapter, this chapter represents a preliminary feasibility study on the implementation of the LEM in the SJMA. The four elements essential for implementation of the LEM are:

1. Adequate and comprehensive transit services;
2. sufficient employment opportunities along transit corridors;
3. mix of uses Along transit corridors; and
4. willingness to accept high density residential development

5.1 TRANSIT SERVICES IN THE SJMA

Transit services in the SJMA are provided by a system of publicly-operated or contracted fixed route bus services, a few privately operated bus routes, a system of privately-operated jitneys (called the públicos), a publicly-operated ferry system (known as the Acuaexpreso), and publicly-operated specialized paratransit service. In about three years, a rail system, Tren Urbano, will be added as part of the transit system.
5.1.1 Rail Transit: Tren Urbano, The Up-Coming Urban Rail System

The $1.5-billion investment in Tren Urbano represents a strong public commitment to promote an alternative mode of transportation, creating ample opportunity to improve the region’s transit system. Tren Urbano has already ignited interest in making system improvement and enhancement in service delivery. Because of Tren Urbano’s significant impact on transportation in the San Juan region, a detailed description the phase I alignment is given below.

5.1.2 The Alignment (Phase I)

Tren Urbano is to be constructed in four phases with the first phase starting in Bayamón in the western part of the SJMA. Phase 1 of the alignment (see figure 5.1) runs eastward passing through some residential communities of different density and income-level until it reaches Centro Médico, an area of high concentration of medical facilities, also a major employment center. It then passes through Villa Nevárez, before it turns north into two of the system’s only subway stops in the community of Río Piedras. The alignment continues northward, passing through Hato Rey, the major commercial center in San Juan, and Nuevo Centro Station, which will serve the Acuaexpreso and public bus terminals, and ends at Sagrado Corazón Station in Santurce. Except for the two stops in Río Piedras, the rest of the alignment is either above grade or at grade.

Phase I extends approximately 17.2 kilometers and incorporates 16 stations. The distance between stations varies; it ranges from 608 kilometer to 2,703 kilometer. Traveling through the entire alignment will take about 25 minutes, including travel time and dwell time. Once completed, Tren Urbano will eventually extend between Old San Juan and the international airport, between Caguas and Santurce, and between Bayamón and Carolina.

5.1.3 Operation of Tren Urbano

The first phase of Tren Urbano is scheduled to open for service in November 2001. Tentative operation plans call for Tren Urbano service seven days a
week between 5:00 a.m. and 1:00 a.m. Operating headways on weekdays have been established for four defined operating periods: morning peak, evening peak, base, and off-peak. During both the morning and evening peak periods, operating headways will be four minutes between trains. Base service will operate on eight-minute headways and off-peak service will operate on 12-minute headways. On weekends and holidays only off-peak service is planned, operating on 12-minute headways all day (USDOT).

Map 5-1 Alignment of Tren Urbano Phase I

(Note: The Domenech station, not shown on the map, has recently been added between Villa Navarez and Rio Piedras)

Currently, the fare is expected to be a flat rate at $0.50\(^1\). This structure has not been finalized yet. However, it is reasonable to assume that there will be different kinds of transit passes offered at a discounted value (Salvucci, 1998). Access to transit stations is expected to come primarily from buses and públicos, especially at the five busiest stations, all of which are transit transfer facilities. Non-transfer stations will be served

\(^1\) This is in 1993 dollar.
mostly by pedestrian access, as park-and-ride and kiss-and-ride patronage is not expected to be very significant.

Table 5-1 Station to Station Distance and Travel Time (Tren Urbano Phase I)

<table>
<thead>
<tr>
<th>Stations</th>
<th>Distance (meters)</th>
<th>Travel Time (seconds)</th>
<th>Dwell Time (seconds)</th>
<th>Cumulative Time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bayamón Centro</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Complejo Deportivo</td>
<td>941</td>
<td>90</td>
<td>20</td>
<td>110</td>
</tr>
<tr>
<td>Jardines de Caparra</td>
<td>2703</td>
<td>188</td>
<td>20</td>
<td>318</td>
</tr>
<tr>
<td>Torrimal</td>
<td>669</td>
<td>53</td>
<td>20</td>
<td>392</td>
</tr>
<tr>
<td>Las Lomas</td>
<td>1853</td>
<td>115</td>
<td>20</td>
<td>527</td>
</tr>
<tr>
<td>San Alfonso</td>
<td>817</td>
<td>38</td>
<td>20</td>
<td>585</td>
</tr>
<tr>
<td>De Diego</td>
<td>1082</td>
<td>49</td>
<td>20</td>
<td>654</td>
</tr>
<tr>
<td>Centro Médico</td>
<td>1120</td>
<td>98</td>
<td>20</td>
<td>772</td>
</tr>
<tr>
<td>Villa Nevárez</td>
<td>608</td>
<td>62</td>
<td>20</td>
<td>853</td>
</tr>
<tr>
<td>Río Piedras</td>
<td>2212</td>
<td>137</td>
<td>25</td>
<td>1015</td>
</tr>
<tr>
<td>Centro Judicial</td>
<td>1143</td>
<td>90</td>
<td>25</td>
<td>1130</td>
</tr>
<tr>
<td>Hato Rey Centro</td>
<td>1500</td>
<td>124</td>
<td>25</td>
<td>1279</td>
</tr>
<tr>
<td>Nuevo Centro</td>
<td>617</td>
<td>49</td>
<td>25</td>
<td>1353</td>
</tr>
<tr>
<td>Sagrado Corazón</td>
<td>920</td>
<td>87</td>
<td>25</td>
<td>1466</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(seconds)</td>
<td>16185</td>
<td>1181</td>
<td>285</td>
<td>1466</td>
</tr>
<tr>
<td>(minutes)</td>
<td></td>
<td>19.7</td>
<td>4.8</td>
<td>24.4</td>
</tr>
</tbody>
</table>

Frequency

With the headways stated above, the service frequency of Tren Urbano will be better than that of the Chicago Transit Authority, the Bay Area Rapid Transit (BART) and the Muni light rail systems in the San Francisco Bay Area.²

Table 5-2 Headways of Tren Urbano & Other Rail Systems

<table>
<thead>
<tr>
<th></th>
<th>Tren Urbano</th>
<th>CTA</th>
<th>BART</th>
<th>Muni Light Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning peak</td>
<td>4 minutes</td>
<td>3-12 minutes</td>
<td>15 minutes</td>
<td>8-10 minutes</td>
</tr>
<tr>
<td>Evening peak</td>
<td>4 minutes</td>
<td>3-12 minutes</td>
<td>15 minutes</td>
<td>8-10 minutes</td>
</tr>
<tr>
<td>Base</td>
<td>8 minutes</td>
<td>8-10 minutes</td>
<td>15 minutes</td>
<td>10-15 minutes</td>
</tr>
<tr>
<td>Off-Peak</td>
<td>12 minutes</td>
<td>10-20 minutes</td>
<td>15 minutes</td>
<td>15-20 minutes</td>
</tr>
<tr>
<td>Weekends</td>
<td>12 minutes</td>
<td>N.A.</td>
<td>20 minutes</td>
<td>10-20 minutes</td>
</tr>
</tbody>
</table>

² Chicago and San Francisco are selected as bases for comparison because the LEM experiment will be initially launched in these two places.
Hours of Operation
The hour of operation of Tren Urbano will be comparable to that of the rail systems in Chicago and San Francisco.

Table 5-3 Hours of Operation of Tren Urbano & Other Rail Systems
(Weekday)

<table>
<thead>
<tr>
<th></th>
<th>Tren Urbano</th>
<th>CTA</th>
<th>BART</th>
<th>Muni Light Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earliest Time Service Starts</td>
<td>5 a.m.</td>
<td>4:10 a.m.</td>
<td>4 a.m.</td>
<td>4:30 a.m.</td>
</tr>
<tr>
<td>Latest Time Service Ends</td>
<td>1 a.m.</td>
<td>2:15 a.m.</td>
<td>12 a.m.</td>
<td>12:30 a.m.</td>
</tr>
<tr>
<td>Hours of Service</td>
<td>21 hours</td>
<td>N.A.³</td>
<td>21 hours</td>
<td>21 hours</td>
</tr>
</tbody>
</table>

Source: CTA, BART, Muni.

Fares
As shown below, the fare of Tren Urbano will be the lowest in all the systems compared.

Table 5.3 Fares of Tren Urbano & Other Rail Systems

<table>
<thead>
<tr>
<th></th>
<th>Tren Urbano</th>
<th>CTA</th>
<th>BART</th>
<th>Muni Light Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular 1-way fare</td>
<td>$0.75</td>
<td>$1.5</td>
<td>$1.1 to $4.7*</td>
<td>$1.0</td>
</tr>
<tr>
<td>Standard Monthly Pass</td>
<td>Undecided</td>
<td>$88</td>
<td>N.A.⁴</td>
<td>$35</td>
</tr>
</tbody>
</table>

Note: BART is a regional rail system, therefore, the travel distance between two stations could be much longer than Tren Urbano. Its fare reflects the range of distances.
Source: USDOT, CTA, Muni, BART, Muni.

³ The hours of service of CTA varies from route to route. For instance, route that starts earlier usually ends earlier. So, the hour of service derived from the earliest time service starts and the latest time service ends is meaningless. In addition, 2 lines run at all time.
⁴ BART does not offer a regular monthly pass. It does have special “BART Plus” ticket for use of BART and other transit services in the region.
5.2 **EXISTING TRANSIT SYSTEM IN SAN JUAN**

Before Tren Urbano starts operation, transit system in San Juan will continue to be provided by four operators: the Metropolitan Bus Authority (known by its Spanish acronym as AMA), *Metrobus, públicos*, and *Acuaexpreso*.

### 5.2.1 Bus Services

The bus system lies primarily within the central municipalities of San Juan, Carolina, and Guaynabo, with a few routes extending into Bayamón, Cataño, Trujillo Alto, Toa Baja, and Loiza. The bus route structure tends to be very good in terms of coverage, connectivity and fare.

**Coverage**

Almost all of the densely populated sections of San Juan and Carolina lie within a walking distance of 1-quarter mile from a bus route. In the municipalities around San Juan, *públicos* fill the gaps in bus coverage.

**Connectivity**

The bus system is designed to minimize transfers. Direct bus services to the four major commercial areas (Old San Juan, Santurce, Hato Rey, and Río Piedras) are available from most part of San Juan.

**Fare**

Bus fares, at 25 cents per ride, are very low. As shown in Table 5.2, fares of other transit systems compared are four to nine times higher than AMA buses.

<table>
<thead>
<tr>
<th></th>
<th>AMA Buses</th>
<th>CTA Buses</th>
<th>Muni Buses</th>
<th>AC Transit$^5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular 1-way fare</td>
<td>$0.25</td>
<td>$1.5</td>
<td>$1.0</td>
<td>$1.25</td>
</tr>
<tr>
<td>Monthly Pass</td>
<td>N.A.</td>
<td>$88$</td>
<td>$35$</td>
<td>$45$</td>
</tr>
</tbody>
</table>

$^5$ AC Transit stands for Alameda County Transit. It is located east of San Francisco.

$^6$ The $SS$ pass is for both buses and subway.
The bus route structure used to be poor in terms of frequency, directness of service, speed, and schedule adherence. For instance, only 12 routes had headways of less than 30 minutes in 1995. However, major improvements have been made to the system over the past two years. One of the most significant improvements made to San Juan’s transit system is the establishment of a series of Transit Centers and a restructuring of bus service to make use of the centers and to provide more effective bus service. A total of twelve Transit Centers, located near regional activity centers, have been established. While ten of them are located in commercial centers, four are located at or near Tren Urbano stations. These centers perform important functions as bus route terminal points, as transfer points between routes, and as safe centralized locations for accessing transit service and obtaining travel information.

Trunk Service

Trunk service connecting one or more Transit Centers with high frequency service has also been established along the most direct routes. Operating at 10-minute or less headways during the day and 15-minute in the evening, these routes provide relatively frequent service between major destinations and connect to as many other routes as possible at the Transit Centers. Transfers are much more convenient than before, since service is more frequent and amenities are provided.

Local Service

In addition to the trunk services between Transit Centers, there are local services operating either between Transit Centers on less direct routes or as feeders to a single Transit Center. Currently there are 22 such routes, operating at 20-minute headways during the day. Although these services are less frequent than trunk services, their arrival and departure times could be coordinated at the Transit Centers, making the service more reliable.

“Express” Bus Routes

The Metropolitan Bus Authority currently provides service on four so-called “express” bus routes. These do not actually provide high-speed, closed-door service.
Rather, they are a one-seat direct trip from southern areas of Río Piedras and Bayamón to Hato Rey, Santurce, and Old San Juan. Service is provided for only one or two trips inbound each morning and one or two trips outbound each evening.

Overall, the frequency of the bus service in San Juan is not as high as those in Chicago and San Francisco. But, the current service represents a major reform of the previous system.

**Table 5-5 Comparison of Headways Between AMA Buses and Other Bus System**

<table>
<thead>
<tr>
<th></th>
<th>AMA Buses</th>
<th>CTA Buses</th>
<th>Muni Buses</th>
<th>AC Transit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning peak</td>
<td>10-20 min</td>
<td>5-15 min</td>
<td>4-8 min</td>
<td>8-10 min</td>
</tr>
<tr>
<td>Evening peak</td>
<td>10-20 min</td>
<td>5-15 min</td>
<td>5-7 min</td>
<td>8-10 min</td>
</tr>
<tr>
<td>Base</td>
<td>10-20 min</td>
<td>8-15 min</td>
<td>10-15 min</td>
<td>10-15 min</td>
</tr>
<tr>
<td>Off-Peak</td>
<td>10-20 min</td>
<td>10-20 min</td>
<td>15-20 min</td>
<td>15-20 min</td>
</tr>
<tr>
<td>Weekends</td>
<td>15-60 min</td>
<td>N.A.</td>
<td>10-20 min</td>
<td>10-20 min</td>
</tr>
</tbody>
</table>

Reliability

Reliability of transit service could be expressed as schedule adherence. In the past, transit service in San Juan was not reliable; less than 70 percent of buses adhered to the schedule. However, this situation has been reversed. Currently AMA buses are meeting a 90 to 95 percent schedule adherence (Salvucci, 1998). This is a very good performance in the Latin American context.

5.2.2  **Públicos**

Perhaps the most unique aspects of the public transportation system in SJMA is the privately operated públicos system. “Públicos” are a jitney-type fixed-route transit service which are privately operated. Públicos are generally vans with a capacity of no more than 17 persons and do not follow a fixed schedule.

Serving 65 percent of daily regional transit trips in the SJMA, públicos play a very significant role in public transportation in Puerto Rico. While the público system covers the entire Commonwealth, there are approximately 120 público routes that currently operate within the SJMA. There are approximately 3,000 público vehicles (1,600 in peak service) serving an estimated 143,000 daily passenger trips.
Of all the público routes, 34 operate with headways of 10 minutes or less during the peak period. A typical público route operates six days a week until about 6:00 p.m. with minimal evening or Sunday service. There is no fixed schedule; service frequency depends on demand; as a result, vehicles generally leave the terminal when a pre-determined number of passengers have boarded. Observed service frequencies in the SJMA range from 30 trips per hour to less than one per hour. About 30 percent of the routes in the SJMA have peak period headways of 10 minutes or less. Although fares differ from route to route, a single flat fare is charged on each route. Fares are distance-based; currently the average fare is about $0.75, while the lowest is $0.35.

Despite its frequent and rather comprehensive services, Públicos has been on the declining trend, due primarily to the aging of fleets, the lack provision of travel information, and the weakening of reliability caused by congestion. However, efforts could be put in to reverse the unfavorable trend to bring out the potential públicos have in making a positive impact on San Juan’s public transportation system.

5.2.3 Ferry Service

Acuáexpreso, the ferry system in San Juan, consists of nine vessels, which have been providing service between the three terminals at Old San Juan, Cataño, and Hato Rey since 1991. The system currently operates two routes: between Cataño and Old San Juan, as well as between Hato-Rey and Old San Juan. Ferry service only has a very limited share in transit ridership currently and is not likely to change significant in the future.

5.3 Evaluation of the Overall System

Overall, the services provided by the transit system in San Juan will be adequate and comprehensive enough to allow the LEM be implemented. Tren Urbano will provide high-frequency, direct, and inexpensive services to many destinations. Bus service, though not as good as that in Chicago and San Francisco, is reasonably adequate. Certainly, there is room for further improvement in frequency and directness. Públicos will fill the gaps of buses and Tren Urbano. Because of the relatively small size of the
vehicles, públicos are particularly well-suited to serve the collection function in residential areas.

In the future públicos could serve as feeders, transporting passengers to Tren Urbano and high-capacity bus routes or directly to nearby urban centers. The high frequency of service provided by públicos may allow areas further away from Tren Urbano stations be eligible for LEM applications. One assumption underlying the LEM is that people are willing to walk a certain distance, usually between a quarter to one-half mile, to take transit; the distance usually depends on the type of transit system and the walking environment. With públicos serving residential areas with short headways, some households outside the walking distance from Tren Urbano stations may be willing to take públicos to get to the train station. These households maybe able to own less, or even none, automobiles, and, therefore, be eligible for LEM loans.

5.4 SUFFICIENT EMPLOYMENT OPPORTUNITIES ALONG TRANSIT CORRIDORS

To introduce the LEM, it is essential that ample employment opportunities exist along the targeted transit corridor such that LEM borrowers could get to work with reasonable ease. The Tren Urbano corridor does fulfill this requirement. The Phase I alignment passes through several major employment centers of the SJMA.

The northernmost station, Sagrado Corazón, is located in Santurce, a district within the municipality of San Juan. Santurce, the center of municipal government, is the most densely developed section of San Juan (Sriver, 1996). The Tren Urbano station is situated near some major institutions, such as the Sagrado Corazón University and the YMCA. South of Sagrado Corazón station is the Nuevo Centro station, the first station in the Hato Rey district when one goes down the alignment from Santurce. Hato Rey, also known as the “Milla de Oro” (the Golden Mile), is the financial and business center of Puerto Rico, and is probably one of the largest in the Caribbean. The station is within a minute’s walk to such large office towers as Banco Popular, one of the major banks on the island, and American International Plaza. Headquarters of other major financial institutions, such as Chase Manhattan Bank and Citibank, all lie within close proximity to
the Hato Rey Centro station. Other employers near the station include the Federal Office Building, as well as countless accounting firms, law firms, and insurance companies.

About half-mile south of Hato Rey Centro is the Domenech station, which is right next to the Department of Labor, some other large institutions, and numerous professional associations. The last station in Hato Rey is the Centro Judicial station. As its name implies, Centro Judicial station is located near the Judicial Center. Other major employers in this station area include the I.B.M. Building, the El Monte Commercial Center, and several other large businesses, all of which provide job opportunities to a large number of Puerto Ricans.

The University of Puerto Rico at Río Piedras, providing education or employment to approximately 22,500 students, faculty, and personnel, is another large employer within the Tren Urbano Project Corridor. The alignment turns west from Río Piedras into Villa Nevárez, which is close to a few institutions and a fair amount of light industry. The last major employment generator along the alignment is in the Centro Médico area, which is home to 28 medical facilities and the Metropolitan Bus Authority’s (AMA) central offices and maintenance garage.

The alignment west of Centro Médico is generally dominated by residential uses, although pockets of light industry, retail, and institutions also exist. The last stop of the Tren Urbano Phase I alignment is Bayamón Centro, where the municipal government of Bayamón sits. Major employers in this area include the new City Hall, the Judicial Complex, and the Civil Defense Center, a municipal hospital. There are also commercial uses concentrated along major streets and avenues.

5.5 Mix of Uses Along Transit Corridors

It is shown that employment opportunities are abundant along the Tren Urbano alignment, allowing prospective LEM borrowers to go to work by transit. From the perspective of a LEM borrower, the ability to travel between home and workplace by public transportation is just as important as the ability to go to shops, doctor’s offices, restaurants, theaters, baseball games, and many other destinations without a car. This is supported by the fact that home-based work trip represented less than a quarter of all trips made by a household in the SJMA in 1990 (Barton-Aschman Associates, Inc., 1990). In
light of the importance of non-work trips, it is crucial that the LEM be introduced in an area where shops, restaurants, sports facilities, etc., are found along or close to transit corridors such that they are either on transit riders’ way to/from work or could be accessible by public transportation with relative ease.

The SJMA satisfies this requirement. Although there are no major shopping malls along the Tren Urbano alignment, pockets of retail activities are scattered along the alignment. The traditional retail districts in central Río Piedras and Bayamón are still active and are serving a significant portion of low- to moderate-income population. The “Calle de Diego”, a 3-block pedestrian shopping mall near the Río Piedras station, is well-known and preferred by many to indoor alternative. With the opening of Tren Urbano and some urban design strategies, the pedestrian mall has the potential to play a more prominent role as a place for shopping. Besides Calle de Diego, retails are found on the ground floor of many apartment buildings near the Río Piedras station. There are also establishments offering personal services, churches, schools, and a fresh produce market.

Retail activities are also found on Munoz Rivera Avenue, the major arterial parallel to the north-south segment of the Tren Urbano alignment. The largest shopping district in the Caribbean Basin, Plaza Las Americas, is about half a mile from the Hato Rey Centro Station. A shuttle service could be run to connect the station and the shopping district. Shopping aside, parks and sports facilities also exist either within a reasonable walking distance from Tren Urbano corridor or could be accessed from Tren Urbano stations through a short ride on buses or públicos.

5.6 READINESS TO ACCEPT HIGH RESIDENTIAL DENSITY

The fourth condition necessary to the introduction of the LEM is the willingness to accept higher residential density. The SJMA seems to meet this test. People in the San Juan region seem to be more willing to accept high-density development than those in many American cities, though the area is still filled with countless low density residential units. There are generally more multi-story condominium developments. While some of these developments serve those with lower income, some actually are targeted to serve the needs of middle- or even upper-income population. The population
density in the San Juan region is among the highest in the U.S. The regional average of 3,230 persons per square mile places it within the top 15 most densely-populated regions in the nation in 1990. Within the Municipal of San Juan, densities average 8,560 persons per square mile with some zones exceeding 20,000 persons per square mile. Even though most of the population growth by 2010 is projected to take place on the urban fringes, population densities will remain high in the center of the region and in nearby communities such as Bayamón and Carolina (Barton-Aschman Associates, Inc., 1993). The average population density along the project corridor\(^7\), according to data from the 1990 U.S. Census, is 6,593 persons per square kilometer, or 17,089 persons per square mile. It would be feasible for one to promote more high-density developments.

In light of the traffic congestion problem, the social implications of the auto-oriented lifestyle and their effects on the region’s long term economic stability, there is a need to provide a viable travel alternative to Puerto Ricans. For the same rationales, the need to focus future growth along major transit corridors is also justified. The Location Efficient Mortgages represent one vehicle to help achieve these two goals. Based on the criteria developed in Chapter 4, the future transportation infrastructure and the land-use characteristics of the SJMA will meet the requirements for introducing the LEM.

\(^7\) The project corridor here refers to a buffer of 500 meters on each of the two sides of the 19 kilometers-train track.
While over half of the Puerto Rican population lived below the poverty threshold, seven out of ten households had access to at least one vehicle in 1989. Almost half of the vehicle-owning households had at least two vehicles. Although household income in the Commonwealth is generally lower, the cost of driving is not. In fact, for various reasons, it costs more to own and operate an automobile in the Commonwealth than in the States. On the other hand, transit services are very inexpensive there. It follows that the cost differential between driving and taking transit is greater on the island than that on the mainland. Thus, the potential of the LEM as an incentive to change one's travel behavior should be greater on the island.

The first part of this chapter seeks to estimate the costs of driving in Puerto Rico and that of alternative transportation modes. Comparison of the two costs would allow one to estimate the net savings that will accrue when one spares his or her car. The idea of the LEM is to capture part of this savings, among others, and use it in financing a home. The second section of this chapter explores possible locations at which the LEM program could be introduced in the near future and in the longer term.

6.1 Estimating the Cost of Driving

6.1.1 Methodology

In order to estimate the amount of money a household can save by living in a "location efficient" neighborhood, defined as one that is located near transit, densely-populated, pedestrian-friendly, as well as amenity- and resources-accessible, the LEM Partnership has spent about two years to develop an economic-geographic model. This model incorporates elements such as savings from not owning an automobile and neighborhood characteristics; it would allow the Location Efficient Savings (LES) for a
specific address be estimated using Geographic Information System (GIS). At the time of writing, the details behind the model are proprietary; no information has been released yet. As a result of this, this research cannot estimate what the LES would be for specific parcels along the Tren Urbano alignment. However, existing data from the FHWA do allow a simple arithmetic calculation be performed to estimate the amount of savings a Puerto Rican household can achieve by sparing an automobile. The calculation is, by no means, an attempt to replicate the LES developed by the LEM partnership. Rather, it is intended to roughly estimate the financial benefits that Puerto Ricans may potentially gain by switching their travel behavior from one that is highly auto-dependent to one that is more transit-supportive.

Even if societal costs are excluded, driving costs more than just the outlays for fuel, oil, tires and tolls, as many Americans perceive. A more careful examination shows that some costs occur regardless of the vehicles' usage, while some others are directly related to the amount of travel. The travel-related group is generally referred as operating costs, and the other group as ownership costs.

Ownership costs include depreciation, finance charges, insurance, registration and titling fees, and any taxes applied to these items. Regardless of the mileage a car has been driven, the majority of the cost of each of these items is incurred. Operating costs include scheduled maintenance and unscheduled repairs and maintenance, fuel, oil, tires, parking, tolls, and the taxes applied to these items. The majority of each of these costs are a function of vehicle usage.

The FHWA has conducted a careful study on the components of these costs in 1990. However, the costs cannot be applied in Puerto Rico without adjustments to incorporate the differences between the factors affecting costs of driving in Puerto Rico and mainland U.S.

6.1.2 Ownership Costs Adjustments

Automobiles in Puerto Rico are about 20 to 30 percent more expensive than on the mainland. For instance, the most economic Toyota Camry model on mainland is

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1 The "location efficient savings" of the LEM concept include savings from living a a resource-accessible
priced at about $18,000 but at $22,500 in Puerto Rico, representing a 25 percent markup. The extra cost of shipping the car from mainland to the island explains part of the difference. Nevertheless, most of the difference is due to the heavy excise tax levied by the Commonwealth. The sales price used in the analysis reflects a conservative 20 percent markup in the Commonwealth.

Insurance, on the other hand, is not as costly on the island than on the mainland. Up until the year 1998, insurance was not required by the government. Many auto-owners did not have it. The mandatory public liability insurance costs about $100 currently, while a full coverage insurance policy for a full-sized car costs about $600 to $1,000 per year. The costs of both types of insurance policies are expected to increase. It is assumed that the full coverage insurance on a subcompact car equals two-third of that of a full-sized car.

6.1.3 Operating Costs Adjustment

The cost of operating an automobile tends to be lower in the Commonwealth. Parking, for instance, is about 80 percent of that on mainland. Tolls, ranging from 26 cents to 46 cents per mile, are also lower than most toll roads on the mainland. The maintenance costs, however, are at least the same as that on the mainland. Although the labor costs is lower in Puerto Rico, the auto-related materials and replacement parts are more costly. So, the costs of each repair and check-up are similar to the costs on mainland. However, because most materials become worn out more quickly in the driving environment in Puerto Rico, it is likely that maintenance and replacement of parts are needed on a more frequent basis. To be conservative, this analysis assumes that the annual maintenance cost to be the same as that on the mainland.
6.1.4 Other Assumptions Used

Life Cycle of an Automobile

A vehicle is assumed to have a life-time of twelve years, as is the case in the study conducted by the FHWA. The costs of the automobile is assumed to be evenly distributed in each of the twelve years.

Finance Charge

Most vehicle buyers either pay interest on money they borrow to buy their vehicles; therefore, a finance charge is added as part of the ownership costs. The finance charge declines with time because the interest portion of the monthly payment decreases as the loan amortizes over time. Even for those who pay the vehicles outright using savings or other investments, there is still a cost. Savings used to purchase the vehicle could have earned interest otherwise. The computation of interest lost on savings is more difficult. The cash payment for the purchase of a vehicle, the type of savings plan, the current interest rate, and the period of time for monthly deposits to equal to cash payment will vary greatly among purchasers. Because of such a wide variation, cash payment is not considered in this analysis. Finance charge is based on a typical automobile loan, with 25 percent down payment, 10.5 percent interest rate, compounded monthly, and an amortization period of four years.

Full Fuel Tax

The tax on gasoline levied by the commonwealth government was $0.16 per gallon in Puerto Rico in 1990. This number is used in the analysis.

Registration and Inspection

Same as in any state on the mainland, the vehicle registration fees vary from model to model. For the purpose of this analysis, an average of $60 registration fees per vehicle per year is used. There is also a $10 annual inspection fees imposed on every vehicle.
Vehicle Miles Traveled Per Automobile

The average auto VMT per automobile is estimated at 9,340 annually. This is based on the total annual VMT of 12,858 million in 1990, reported by the FHWA. Assuming that there were a total of 170 transit routes, with an average length of 26 miles, each ran 40 times per day, the total transit VMT per year would be 0.5 percent of the total VMT\(^2\). Truck traffic accounted for about 3.5 percent (Craven, 1998) of daily VMT. This leaves a 96 percent share by automobiles, or an equivalent of 12,344 million annual VMT. Dividing this aggregated automobile VMT by the number of automobiles registered (1,321,627) would yield the annual VMT per automobile. For the sake of simplicity in the analysis, a VMT of 10,000 is used instead.

Adjusted Total Driving Costs in Puerto Rico--subcompact and full-sized

As illustrated in Tables 6-1, driving a 1991 subcompact car for ten thousand miles in a year would cost $3,000 to $3,300 per year for the first three years; it then drops to $2,550 to $2,859 in each of the nine years that follow. The decrease in costs after the first three years is primarily due to the declining finance charge on the auto loan. The interest paid on the loan in year four is significantly lower than that in the first three years. Starting in the fourth year, no further interest needs to be paid because the loan is supposed to have been paid off by the end of the fourth year.

Table 6-1 Cost of Owning and Operating A Subcompact Car
Source: FHWA, et al.

---

\(^2\) This estimation has probably exaggerated the real VMT share of transit in Puerto Rico.
6.2 Estimating the Cost of Alternative Transportation Mode

When the Final Environmental Impact Statement for the Tren Urbano project was prepared, the average fare for público was $0.75 per trip while that for Tren Urbano was tentatively projected to be at a flat rate of $0.50 one way. As of now, the policy on fare structure has not been finalized yet. However, there have been discussions on the offering of different types of transit pass. Among the various types of transit pass under consideration, one type will allow passengers to take a round-trip Tren Urbano ride with connecting público service for $2. There is also a possibility that a monthly Tren Urbano / públicos pass, allowing for unlimited travel, will be offered at a discounted value equals to the value of full fare for eighteen days, or about $36 per pass. The analysis that follows assumes such a kind of pass, issued at the above rate, will satisfy a large part of the transportation needs of an average Puerto Rican.

---

### Ownership and Operating Costs in Puerto Rico

#### Subcompact 1991 Model Automobiles

**Assumptions:**

- **Sales Price in 1990 in U.S.** = $11,481
- **Sales Price in 1990 in PR** = $14,351
- **VMT/year/Household**
  - Year 1: 10,000
  - Year 2: 10,000
  - Year 3: 10,000
  - Year 4: 10,000

#### Table

<table>
<thead>
<tr>
<th>Item</th>
<th>First Year</th>
<th>Second Year</th>
<th>Third Year</th>
<th>Fourth Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Cost</td>
<td>Total Cost</td>
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<td>Total Cost</td>
</tr>
<tr>
<td></td>
<td>(dollar)</td>
<td>(dollar)</td>
<td>(dollar)</td>
<td>(dollar)</td>
</tr>
<tr>
<td></td>
<td>(cents)</td>
<td>(cents)</td>
<td>(cents)</td>
<td>(cents)</td>
</tr>
<tr>
<td>A) Ownership Costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation Rate</td>
<td>8.33%</td>
<td>8.33%</td>
<td>8.33%</td>
<td>8.33%</td>
</tr>
<tr>
<td>Depreciation</td>
<td>$1,196</td>
<td>$1,196</td>
<td>$1,196</td>
<td>$1,196</td>
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<td>Undepreciated Value of the car at year end</td>
<td>$11,981</td>
<td>$11,981</td>
<td>$11,981</td>
<td>$11,981</td>
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<tr>
<td>Finance Charge</td>
<td>1022</td>
<td>5.96</td>
<td>710</td>
<td>4.48</td>
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<td>Registration, Inspection</td>
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<td>400</td>
<td>400</td>
<td>400</td>
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<td>Total Ownership Costs</td>
<td>2890</td>
<td>15.68</td>
<td>2438</td>
<td>7.22</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>B) Operating Costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel</td>
<td>116</td>
<td>1.16</td>
<td>116</td>
<td>1.16</td>
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<td>Federal Fuel Tax</td>
<td>51</td>
<td>0.51</td>
<td>61</td>
<td>0.61</td>
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<tr>
<td>Parking &amp; Tolls</td>
<td>103</td>
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<tr>
<td>Oil</td>
<td>97</td>
<td>0.97</td>
<td>77</td>
<td>0.77</td>
</tr>
<tr>
<td>Tires</td>
<td>94</td>
<td>0.94</td>
<td>74</td>
<td>0.74</td>
</tr>
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<td>Maintenance</td>
<td>211</td>
<td>2.11</td>
<td>529</td>
<td>5.29</td>
</tr>
<tr>
<td>Total Operating Costs</td>
<td>254</td>
<td>2.54</td>
<td>919</td>
<td>9.19</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>946</td>
<td>9.46</td>
</tr>
<tr>
<td>Total Ownership &amp; Operating Costs</td>
<td>3322</td>
<td>33.22</td>
<td>2386</td>
<td>23.86</td>
</tr>
<tr>
<td>Percentage of Median household income</td>
<td>29.0%</td>
<td>NA</td>
<td>29.3%</td>
<td>NA</td>
</tr>
<tr>
<td>Future Total Ownership &amp; Operating Costs</td>
<td>30164</td>
<td>NA</td>
<td>28008</td>
<td>NA</td>
</tr>
</tbody>
</table>

---

3 In 1995 dollars.
4 This pass will also allow passengers to take a round-trip público ride with connecting Tren Urbano service.
5 In 1995 dollars.
6 The MBTA in Boston determines the value of a monthly pass using this method.
Table 6-2 Cost of Alternative Transportation Mode

<table>
<thead>
<tr>
<th>Expenses on Alternative Transportation Mode</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regular trips</strong></td>
<td></td>
</tr>
<tr>
<td>Tren Urbano/Publico Monthly Pass for 1 person</td>
<td>$373</td>
</tr>
<tr>
<td>Extra Expenditure of the second person</td>
<td>$13</td>
</tr>
<tr>
<td>Bus</td>
<td>$65</td>
</tr>
<tr>
<td><strong>Occasional inter-city trips</strong></td>
<td></td>
</tr>
<tr>
<td>Car Rental (@$24 per day)</td>
<td>$288</td>
</tr>
<tr>
<td><strong>Occasional social activities requiring taxi-cabs</strong></td>
<td></td>
</tr>
<tr>
<td>Taxi-cab</td>
<td>$144</td>
</tr>
<tr>
<td><strong>Total Transportation Expenses</strong></td>
<td>$882</td>
</tr>
</tbody>
</table>

*Total Transportation Expenses as a Percentage of Household Income* 7.70%

*Net Savings* $2,440

*Net Savings As A Percentage of Median Household Income* 21.3%

The regular transportation needs that cannot be satisfied by Tren Urbano and públicos are assumed to be met by bus services at an average of 5 rides per week. To be conservative, it is also assumed that taxi-cab rides are needed once a while. The fare of taxi-cab rides are based on the rate of $1 per mile with an initial charge of $1. There may also be occasional inter-city trips which would require rental of cars. This is taken into account in the analysis by assuming that car rental is needed on an average of once every other month, each lasts for two days, at a rate of $24 per day. The total costs of alternative transportation sum up to $882 per year.7

6.3 **Estimated the Savings From Switching Transportation Mode**

All of the above facts and assumptions are used to estimate the net savings on transportation when one spares his/her car and becomes a transit patronage. The estimated savings in each of the twelve years are shown in Tables 9-1 and 9-2. It ranges from a low of $1,786 to a high of $3,882, depending on the model of the car, whether the

---

7 In 1990 dollars.
8 This does not represent the total transportation cost of a family. It is the extra transit cost that a family would incur if it owns one less car. The underlying assumption is that a family needs to take transit for some of its mobility needs even with a car.
loan on the car has been paid off, and maintenance cost, which is affected by the age of the car to a large extend.

6.4 **SPARE A CAR AND OWN A HOME?**

The LEM suggests that part of the Location Efficient Savings could be used in housing to help renter families to realize the American Dream of owning a home. Automobiles only depreciate even in growing economy\(^9\). On the contrary, real estate does not depreciate, given a stable economy; in fact, it appreciates in many cases. Although not everyone realizes this difference, home ownership certainly remains one of the highest goals for many people because of its many benefits. Along with owning one’s own home comes a sense of security and belonging that cannot be found elsewhere. For many, home ownership represents personal and financial success. There is considerable personal satisfaction in living in a home that one owns. A home is also a valued investment which can create many financial advantages and tax benefits. The amount of interest one pays on a home loan and the real estate taxes one pays on his/her home are among the few major federal tax deductions. Owning a home is the primary way most people build wealth.

If part of the savings from switching transportation behavior is applied in a household’s expenditure on housing, it is likely that some of the renters will be qualified for home mortgage loans. Some may be able to qualify for a larger amount of loans even though they still earn the same amount of income. And, perhaps, some maybe able to use the LEM to improve their existing homes.

With respect to the current housing condition and demography in the SJMA and the Tren Urbano corridor, the LEM could be structured in three ways.\(^9\) First, as an introduction of the LEM, a program could be structured to attract home-buyers from outside the study area to move into the vacant units or any forthcoming new units within the Tren Urbano corridor. In the future, after the LEM has established a solid reputation in the mortgage market, an LEM rehabilitation loan program could be created to help qualified home-owners to improve their homes. Lastly, to encourage those who already

\(^9\) The only exception would be collectible cars such as antique and some limited-edition luxurious cars.
have a regular mortgage loan to change their travel behavior, a LEM refinance program can be set up to allow eligible home-owners to “retrofit” their loans using the LEM terms.

6.5 LEM FOR NEW HOME-OWNERS OF TREN URBANO CORRIDOR

The LEM should first be introduced to the SJMA in its original form, that is, as a financing instrument for those purchasing a home in a qualified location within the Tren Urbano corridor. As an experiment of the mortgage product, the success of this program is crucial to the expansion of the application of the LEM in the future.

To illustrate the potential application of the most basic LEM in the SJMA, four scenarios of mortgage loan applications are generated. The following are assumptions common in all the scenarios:

- Loan is amortized over thirty years\(^\text{11}\).
- Interest rate is at 7\(^%\)\(^\text{12}\) and the mortgage is a fixed-rate mortgage\(^\text{13}\).
- Monthly hazard insurance equals 0.027\(^%\) of the property value\(^\text{14}\).
- Annual mortgage insurance is required on loans with LTV\(^\text{15}\) greater than 80\(^%\)\(^\text{16}\).
- Property tax is exempted for property with value less than $100,000\(^\text{17}\).
- Front-end ratio (housing-expense ratio), or the ratio of the monthly housing expense to the borrower’s gross (pre-tax) monthly income, should not exceed 30\(^%\)\(^\text{18}\).
- Back-end ratio (a.k.a. debt-to-income ratio), or the ratio between the borrower’s total debt to the gross monthly income, should not exceed 41\(^%\), as set by the Federal Housing Administration.
- Housing expense include the mortgage payment, interest, taxes and insurance, often abbreviated PITI.
- The borrower does not have any other long-term debt.

\(^{10}\) For housing condition and demography within the Tren Urbano corridor, please refer to Appendix.

\(^{11}\) Most residential mortgage loans are amortized over 20, 25, or 30 years.

\(^{12}\) At the time of writing the national average mortgage rates for a 30-year fixed rate loan is 6.8-7.0\(^%\).

\(^{13}\) Fixed-rate mortgage dominates the housing market in Puerto Rico; ARM (adjustable-rate mortgage) is not popular there.

\(^{14}\) Estimation by Quicken Mortgage.

\(^{15}\) The Loan-to-Value ratio is the ratio of loan amount to the appraised property value.

\(^{16}\) The general rule in the housing finance industry.

\(^{17}\) Property taxes are usually lower in Puerto Rico than in the States. A $115,000 exemption is entitled to home-owners living in their homes. As a result, most homes priced below $100,000 pay no property taxes. (TIRI Real Estate, PR)

\(^{18}\) This ratio ranges from 28\(^%\) to 32\(^%\) on mainland. All the banks in Puerto Rico which have responded to the author’s information request indicated a higher ratio, between 29-33\(^%\).
It cannot be emphasized more that the four scenarios that follow are intended to provide a rough approximation of the potential use of transportation savings in housing in Puerto Rico. The “extra disposable income”, found in Tables 6.3-6.7, are not the same as the Location Efficient Savings (LES) defined by the LEM Partnership. To estimate the LES, a more sophisticated model, which is currently confidential, is required. Moreover, a very careful analysis of a neighborhood’s attributes needs to be conducted to estimate the LES.

6.5.1 Scenario 1

In the first scenario, a family with income equals to the median income of the SJMA ($11,460) and owning a 1991 subcompact car is interested in moving to a home in an LEM-qualified location. The sales price and the appraised value of the home is $60,000. The lender is willing to lend up to a loan-to-value ratio of 85 percent. In other words, the borrower only has to make a down payment equivalent to 15 percent of the sales price. With the assumptions stated above, the monthly mortgage payment would be $339. With insurance and tax, the borrower would have to spend $356 each month, or 32 percent of its household income, on housing, if the loan is approved. Unfortunately, this exceeds the 30 percent maximum, or $287 in this case, set by the lenders. So, the borrower is not qualified for the loan. She/he is only qualified for a loan in the amount of $40,628, which will allow her/him to purchase a home valued at $47,798. To purchase the home he/she desires, the monthly funding gap is $6 (see Table 6.4).

Another family with the same annual income but no car is interested in the same property. This family takes Tren Urbano, públicos, and busses most of the time, and may need to take taxicab, as well as to rent a car for a few days occasionally. Without owning a car, it is estimated that this transit-supportive family would have a higher disposable income than the auto-owning family. This extra amount, estimated in Section 6.3 of this chapter, ranges from $1,786 to $3,882 annually over a twelve-year period. Conservative lenders would use the lowest amount in the mortgage calculation. However, lenders would not assume all of this extra disposable income be spent on housing. Rather, they would assume a predetermined percentage of the extra disposable income be added to the borrower’s capacity to repay the debt. With the extra income, the borrower will be
qualified for the loan if the lenders assume 46% percent or more of the extra disposable income be used to pay the monthly payment, and therefore, can purchase the home they desire.

Table 6-3 Scenario 1
A Household With a Subcompact Car and 15% Down Payment

<table>
<thead>
<tr>
<th>Mortgage Calculation</th>
<th>$60,000</th>
<th>$60,000</th>
<th>$60,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales Price of Targeted Home</td>
<td>$60,000</td>
<td>$60,000</td>
<td>$60,000</td>
</tr>
<tr>
<td>Downpayment (15%)</td>
<td>$9,000</td>
<td>$9,000</td>
<td>$9,000</td>
</tr>
<tr>
<td>Loan Amount (assumes LTV = 85%)</td>
<td>$(51,000)</td>
<td>$(51,000)</td>
<td>$(51,000)</td>
</tr>
<tr>
<td>Interest Rate</td>
<td>7%</td>
<td>7%</td>
<td>7%</td>
</tr>
<tr>
<td>Amortization Time (year)</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Monthly Mortgage Payment</td>
<td>$339</td>
<td>$339</td>
<td>$339</td>
</tr>
<tr>
<td>Hazard Insurance (0.027% of sales price)</td>
<td>$16</td>
<td>$16</td>
<td>$16</td>
</tr>
<tr>
<td>Property Tax</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mortgage Insurance</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total Monthly Housing cost</td>
<td>$356</td>
<td>$356</td>
<td>$356</td>
</tr>
</tbody>
</table>

| Borrowers' Income (annual) | $11,460 | $11,460 | $11,460 |

**Owning a Subcompact Car and Applying for a Conventional Mortgage**

<table>
<thead>
<tr>
<th>Housing Debt Ratio</th>
<th>30%</th>
<th>30%</th>
<th>30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Allowable Monthly Housing Payment</td>
<td>$287</td>
<td>$287</td>
<td>$287</td>
</tr>
<tr>
<td>Max. Monthly Mortgage Payment</td>
<td>$270</td>
<td>$270</td>
<td>$270</td>
</tr>
<tr>
<td>Max. Value of Home the Borrower Can Afford</td>
<td>$(40,628)</td>
<td>$(40,628)</td>
<td>$(40,628)</td>
</tr>
<tr>
<td>Does the borrower qualify for the loan?</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Funding Gap Per Month</td>
<td>$69</td>
<td>$69</td>
<td>$69</td>
</tr>
<tr>
<td>Funding Gap Per Month as a % of Monthly Income</td>
<td>7.2%</td>
<td>7.2%</td>
<td>7.2%</td>
</tr>
</tbody>
</table>

**Do Not Own a Car and Applying for a Location Efficient Mortgage**

<table>
<thead>
<tr>
<th>Extra disposable income per year*</th>
<th>$1,786</th>
<th>$1,786</th>
<th>$1,786</th>
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</thead>
<tbody>
<tr>
<td>Min. percentage of extra disposable income needed to support the proposed mortgage</td>
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<td>46%</td>
<td>46%</td>
</tr>
<tr>
<td>Percentage of the extra income assumed to be spent on housing</td>
<td>50.0%</td>
<td>55.0%</td>
<td>60.0%</td>
</tr>
<tr>
<td>Amount of extra income spent on housing (monthly)</td>
<td>$74</td>
<td>$92</td>
<td>$89</td>
</tr>
<tr>
<td>Max. allowable monthly housing payment</td>
<td>$361</td>
<td>$381</td>
<td>$376</td>
</tr>
<tr>
<td>New Housing Debt Ratio</td>
<td>37.8%</td>
<td>38.6%</td>
<td>39.4%</td>
</tr>
<tr>
<td>Max. monthly mortgage payment supported</td>
<td>$345</td>
<td>$352</td>
<td>$360</td>
</tr>
<tr>
<td>Max. Loan Amount based on this mortgage payment</td>
<td>$(51,814)</td>
<td>$(52,932)</td>
<td>$(54,051)</td>
</tr>
<tr>
<td>Increase in the Loan Amount</td>
<td>$27,957</td>
<td>$30,325</td>
<td>$33,049</td>
</tr>
<tr>
<td>Max. value of a home the borrower can qualify for</td>
<td>$60,957</td>
<td>$62,273</td>
<td>$63,589</td>
</tr>
<tr>
<td>Does the borrower qualify for the loan?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Increase in Purchasing Power</td>
<td>28%</td>
<td>30%</td>
<td>33%</td>
</tr>
</tbody>
</table>

Notes:
1. Property Tax is usually exempted for homes with values greater than $100,000 in Puerto Rico
2. Mortgage Insurance is required only on loans with LTV greater than 80%
3. Max. monthly mortgage payment supported is the difference between the max. allowable monthly housing payment and the sum of insurance and tax.
4. All money values are in 1990 dollars.

*Extra disposable income per year is derived from the annual net savings from change of transportation mode. The value of this saving varies from year to year. To be conservative, the minimum of all 12 years is used in this mortgage calculation.

6.5.2 Scenario 2

One may wonder if a larger amount of down payment would help the auto-owning family to purchase the home it desires. As depicted in scenario 2, even a 20 percent down payment would not do the family much help. The borrower would need to pay a total of $336 monthly, but he/she is assumed by the lender to be able to pay $287. In order for this family to purchase the home it desires, a 33 percent down payment, or
$19,800, is required. This is $7,800 more than a 20 percent down payment. For a family earning $11,460 a year, it would take years to accumulate $7,800. On the other hand, if the no-car family increases the down payment from 15 percent in scenario 1 to 20 percent in this scenario, it would be much easier to be qualified for the loan it needs to purchase the home. As shown in Table 4.3.2, even if the lender assumes only 38 percent of the extra disposable income be applied in housing, the borrower will be qualified for a loan worths $48,010, allowing them to buy a home priced at $60,013. This represents an increase in purchasing power of 18 percent. As the percentage of extra disposable income assumed to be spent on housing goes up, the value of home the borrower can afford goes up (as reflected in rows 30 and 37.)

Table 6-4 Scenario 2

<table>
<thead>
<tr>
<th>A Household With a Subcompact Car and 20% Down Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Sales Price of Targeted Home: 60,000</td>
</tr>
<tr>
<td>5. Loan Amount (assumes LTV = 80%): 12,000</td>
</tr>
<tr>
<td>6. Interest Rate: 7%</td>
</tr>
<tr>
<td>7. Amortization Time (year): 30</td>
</tr>
<tr>
<td>8. Monthly Mortgage Payment: 319</td>
</tr>
<tr>
<td>10. Mortgage Insurance: -</td>
</tr>
<tr>
<td>11. Total Monthly Housing cost: 336</td>
</tr>
<tr>
<td>12. Borrowers' Income (annual): 11,460</td>
</tr>
<tr>
<td>13. Housing Debt Ratio: 30%</td>
</tr>
<tr>
<td>15. Maximum Loan Qualified For: (40,628)</td>
</tr>
<tr>
<td>16. Max. Value of Home the borrower can afford: 50,785</td>
</tr>
<tr>
<td>17. Does the borrower qualify for the loan?: No</td>
</tr>
<tr>
<td>18. Funding Gap Per Month: 49</td>
</tr>
<tr>
<td>19. Funding Gap Per Month as a % of Monthly Income: 5%</td>
</tr>
<tr>
<td>20. Extra disposable income per year*: 49</td>
</tr>
<tr>
<td>21. Min. percentage of extra disposable income needed to support the proposed mortgage: 33.0%</td>
</tr>
<tr>
<td>22. Percentage of the extra income assumed to be spent on housing: 33.0%</td>
</tr>
<tr>
<td>23. Amount of extra income spent on housing (monthly): 49</td>
</tr>
<tr>
<td>24. Max. allowable monthly housing payment: 330</td>
</tr>
<tr>
<td>25. New Housing Debt Ratio: 35.1%</td>
</tr>
<tr>
<td>26. Max. monthly mortgage payment supported: 319</td>
</tr>
<tr>
<td>27. Max. Loan Amount based on this mortgage payment: (40,410)</td>
</tr>
<tr>
<td>28. Increase in the Loan Amount: 18,528</td>
</tr>
<tr>
<td>29. Max. value of a home the borrower can qualify for: 60,013</td>
</tr>
<tr>
<td>30. Does the borrower qualify for the loan?: Yes</td>
</tr>
<tr>
<td>31. Increase in Purchasing Power: 22%</td>
</tr>
</tbody>
</table>

Notes:
1. Property Tax is usually exempted for homes with values greater than $100,000 in Puerto Rico.
2. Mortgage insurance is required only on loans with LTV greater than 80%.
3. Max. monthly mortgage payment supported is the difference between the max. allowable monthly housing payment and the sum of insurance and tax.
4. All money value are in 1990 dollars.
5. Extra disposable income per year is derived from the annual net savings from change of transportation mode.
6. The value of this saving varies from year to year. To be conservative, the minimum of all 12 years is used in this mortgage calculation.
6.5.3 Scenario 3

The previous scenarios show how an average Puerto Rican family, making the area’s median income, can benefit in financing a home when it does not own a subcompact car. The LEM’s ability to help families with home-ownership is not limited to just moderate-income group. Rather, it can help different segments of the population across the income spectrum. In scenario 3, the benefits of the LEM for a family making 120 percent of the area’s median income is being considered.

Table 6-5 Scenario 3

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A Household With a Full-Sized Car and 20% Down Payment</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2</td>
<td>Mortgage Calculation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Sales Price of Targeted Home</td>
<td>$72,000</td>
<td>$72,000</td>
<td>$72,000</td>
<td>$72,000</td>
</tr>
<tr>
<td>4</td>
<td>Downpayment (20%)</td>
<td>$14,400</td>
<td>$14,400</td>
<td>$14,400</td>
<td>$14,400</td>
</tr>
<tr>
<td>5</td>
<td>Loan Amount (assumes LTV = 80%)</td>
<td>$(57,600)</td>
<td>$(57,600)</td>
<td>$(57,600)</td>
<td>$(57,600)</td>
</tr>
<tr>
<td>6</td>
<td>Interest Rate</td>
<td>7%</td>
<td>7%</td>
<td>7%</td>
<td>7%</td>
</tr>
<tr>
<td>7</td>
<td>Amortization Time (year)</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>8</td>
<td>Monthly Mortgage Payment</td>
<td>$383</td>
<td>$383</td>
<td>$383</td>
<td>$383</td>
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<tr>
<td>9</td>
<td>Hazard Insurance (40,027% of sales price)</td>
<td>$19</td>
<td>$19</td>
<td>$19</td>
<td>$19</td>
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<tr>
<td>10</td>
<td>Property Tax</td>
<td>$-</td>
<td>$-</td>
<td>$-</td>
<td>$-</td>
</tr>
<tr>
<td>11</td>
<td>Mortgage Insurance</td>
<td>$-</td>
<td>$-</td>
<td>$-</td>
<td>$-</td>
</tr>
<tr>
<td>12</td>
<td>Total Monthly Housing cost</td>
<td>$403</td>
<td>$403</td>
<td>$403</td>
<td>$403</td>
</tr>
<tr>
<td>13</td>
<td>Borrowers' Income (annual)</td>
<td>$13,752</td>
<td>$13,752</td>
<td>$13,752</td>
<td>$13,752</td>
</tr>
<tr>
<td>14</td>
<td>Owning a Subcompact Car and Applying for a Conventional Mortgage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Housing Debt Ratio</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td>16</td>
<td>Max. Allowable Monthly Housing Payment</td>
<td>$344</td>
<td>$344</td>
<td>$344</td>
<td>$344</td>
</tr>
<tr>
<td>17</td>
<td>Max. Monthly Mortgage Payment</td>
<td>$304</td>
<td>$304</td>
<td>$304</td>
<td>$304</td>
</tr>
<tr>
<td>18</td>
<td>Max. Loan Qualified For</td>
<td>$(48,754)</td>
<td>$(48,754)</td>
<td>$(48,754)</td>
<td>$(48,754)</td>
</tr>
<tr>
<td>19</td>
<td>Max. Value of Home the borrower is qualified for</td>
<td>$60,942</td>
<td>$60,942</td>
<td>$60,942</td>
<td>$60,942</td>
</tr>
<tr>
<td>20</td>
<td>Does the borrower qualify for the loan?</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>21</td>
<td>Funding Gap Per Month</td>
<td>$59</td>
<td>$59</td>
<td>$59</td>
<td>$59</td>
</tr>
<tr>
<td>22</td>
<td>Funding Gap Per Month as a % of Monthly Income</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>23</td>
<td>Do Not Own a Car and Applying for a Location Efficient Mortgage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Extra disposable income per year*</td>
<td>$2,699</td>
<td>$2,699</td>
<td>$2,699</td>
<td>$2,699</td>
</tr>
<tr>
<td>25</td>
<td>Min. percentage of extra disposable income needed to support the proposed mortgage</td>
<td>26%</td>
<td>26%</td>
<td>26%</td>
<td>26%</td>
</tr>
<tr>
<td>26</td>
<td>Percentage of the extra income spent on housing</td>
<td>28.5%</td>
<td>33.0%</td>
<td>36.0%</td>
<td>39.5%</td>
</tr>
<tr>
<td>27</td>
<td>Amount of extra income spent on housing (monthly)</td>
<td>$63</td>
<td>$74</td>
<td>$85</td>
<td>$97</td>
</tr>
<tr>
<td>28</td>
<td>Max. allowable monthly housing payment</td>
<td>$407</td>
<td>$418</td>
<td>$429</td>
<td>$441</td>
</tr>
<tr>
<td>29</td>
<td>New Housing Debt Ratio</td>
<td>35.5%</td>
<td>36.5%</td>
<td>37.0%</td>
<td>37.5%</td>
</tr>
<tr>
<td>30</td>
<td>Max. monthly mortgage payment supported</td>
<td>$387</td>
<td>$399</td>
<td>$410</td>
<td>$421</td>
</tr>
<tr>
<td>31</td>
<td>Max. Loan Amount based on this mortgage payment</td>
<td>$(58,220)</td>
<td>$(59,910)</td>
<td>$(61,600)</td>
<td>$(63,291)</td>
</tr>
<tr>
<td>32</td>
<td>Increase in Loan Amount</td>
<td>19.4%</td>
<td>22.9%</td>
<td>26.3%</td>
<td>29.8%</td>
</tr>
<tr>
<td>33</td>
<td>Max. value of a home the borrower can afford</td>
<td>$72,775</td>
<td>$74,887</td>
<td>$77,000</td>
<td>$79,113</td>
</tr>
<tr>
<td>34</td>
<td>Does the borrower qualify for the loan?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>35</td>
<td>Increase in Purchasing Power</td>
<td>19%</td>
<td>23%</td>
<td>26%</td>
<td>29%</td>
</tr>
</tbody>
</table>

To reflect the trend that families with higher income would buy homes with higher prices, the sales price of the targeted home is 120 percent higher than that in the previous two scenarios. As shown in Table 6.6, the auto-owning borrower would not be...
qualified for the loan it needs to buy its desired home. This is because its assumed
capacity to repay loan is $344 per month, translating to a loan amount of $48,754, which
is $8,846 less than what the borrower needs. Not owning a full-sized car would save a
family about $2,699 every year. Assuming this family uses 28 percent of this amount in
housing, it can pay $407 on housing every month. Thus, it is qualified for buying the
home with the loan it needs. If a larger portion of the transportation saving, say, 33%, is
allocated to housing expenditure, the family will increase its purchasing power by 23%.

6.5.4 Scenario 4

This final scenario is to demonstrate how the LEM program could benefit the
relatively wealthy families in Puerto Rico. Price of the targeted home is raised to
$115,000 while annual income of borrower, at $20,628, represents 180 percent of that of
the median of the SJMA. This family is a relatively well to do one, and, thus, owns a
full-sized car. Having accumulated more savings than the other families in the previous
scenarios, this family is able to pay a down payment equivalent to 30 percent of the
property value. Even with this relatively large amount of down payment, the monthly
housing cost for this family would still be $590, or 34.3 percent of the borrower’s annual
household income, exceeding the limit of a convention loan. The amount of loan this
family is qualified for is $69,389, less than the $80,500 it needs to purchase the desired
home.

A family with the same amount of income and also interested in the same
property, applies for a LEM loan. Being a true transit supporter, this family spends much
less on transportation. Based on the analysis in section 6.3, this transit-supportive family
spends $2,699 less on transportation per year than its auto-owning counterpart. As a
result, the lender would expect a higher repayment ability from this family. In fact, if the
lender expects that 33 percent of the $2,699 annual savings be spent on housing, the
family could borrow $11,157 more than the its auto-owning counterpart¹⁹. With the
expanded borrowing capacity, the transit-supportive family is eligible for the loan it

¹⁹$11,157 is the difference between the maximum loan amount under a conventional mortgage ($69,389)
and that under a LEM ($80,546).
The family can purchase a home of $124,724 if 53% of the transportation saving is spent on housing.

### Table 6-6 Scenario 4

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A Relatively Wealthy Household With a Full-Sized Car and 30% Down Payment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mortgage Calculation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Sales Price of Targeted Home</td>
<td>$115,000</td>
<td>$115,000</td>
<td>$115,000</td>
<td>$115,000</td>
<td>$115,000</td>
</tr>
<tr>
<td>5 Downpayment (30%)</td>
<td>$34,500</td>
<td>$34,500</td>
<td>$34,500</td>
<td>$34,500</td>
<td>$34,500</td>
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<tr>
<td>6 Loan Amount (assumes LTV = 80%)</td>
<td>$80,500</td>
<td>$80,500</td>
<td>$80,500</td>
<td>$80,500</td>
<td>$80,500</td>
</tr>
<tr>
<td>7 Interest Rate</td>
<td>7%</td>
<td>7%</td>
<td>7%</td>
<td>7%</td>
<td>7%</td>
</tr>
<tr>
<td>8 Amortization Time (year)</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>9 Monthly Mortgage Payment</td>
<td>$536</td>
<td>$536</td>
<td>$536</td>
<td>$536</td>
<td>$536</td>
</tr>
<tr>
<td>10 Hazard Insurance ($0.027% of sales price)</td>
<td>$31</td>
<td>$31</td>
<td>$31</td>
<td>$31</td>
<td>$31</td>
</tr>
<tr>
<td>11 Property Tax ($0.24% of property value per year)</td>
<td>$31</td>
<td>$31</td>
<td>$31</td>
<td>$31</td>
<td>$31</td>
</tr>
<tr>
<td>12 Mortgage Insurance</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>13 Total Monthly Housing cost</td>
<td>$590</td>
<td>$590</td>
<td>$590</td>
<td>$590</td>
<td>$590</td>
</tr>
<tr>
<td><strong>14 Borrowers' Income (annual)</strong></td>
<td>$20,628</td>
<td>$20,628</td>
<td>$20,628</td>
<td>$20,628</td>
<td>$20,628</td>
</tr>
<tr>
<td>15 <strong>Owning a Full-Sized Car and Applying for a Conventional Mortgage</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 Housing Debt Ratio</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td>17 Max. Allowable Monthly Housing Payment</td>
<td>$516</td>
<td>$516</td>
<td>$516</td>
<td>$516</td>
<td>$516</td>
</tr>
<tr>
<td>18 Max. Monthly Mortgage Payment</td>
<td>$462</td>
<td>$462</td>
<td>$462</td>
<td>$462</td>
<td>$462</td>
</tr>
<tr>
<td>19 Max. Loan Qualified For</td>
<td>($69,369)</td>
<td>($69,369)</td>
<td>($69,369)</td>
<td>($69,369)</td>
<td>($69,369)</td>
</tr>
<tr>
<td>20 Max. Value of Home the borrower can afford</td>
<td>$99,128</td>
<td>$99,128</td>
<td>$99,128</td>
<td>$99,128</td>
<td>$99,128</td>
</tr>
<tr>
<td>21 Does the borrower qualify for the loan?</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>22 Funding Gap Per Month</td>
<td>$74</td>
<td>$74</td>
<td>$74</td>
<td>$74</td>
<td>$74</td>
</tr>
<tr>
<td>23 Funding Gap Per Month as a % of Monthly Income</td>
<td>4%</td>
<td>4%</td>
<td>4%</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>24 Does the borrower qualify for the loan?</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>25 Extra disposable income per year*</td>
<td>$2,699</td>
<td>$2,699</td>
<td>$2,699</td>
<td>$2,699</td>
<td>$2,699</td>
</tr>
<tr>
<td>26 Min. % of extra disposable income needed to support the proposed mortgage</td>
<td>33%</td>
<td>33%</td>
<td>33%</td>
<td>33%</td>
<td>33%</td>
</tr>
<tr>
<td>27 Percentage of the extra income spent on housing</td>
<td>33%</td>
<td>33%</td>
<td>33%</td>
<td>33%</td>
<td>33%</td>
</tr>
<tr>
<td>28 Amount of extra income spent on housing (monthly)</td>
<td>$74</td>
<td>$74</td>
<td>$74</td>
<td>$74</td>
<td>$74</td>
</tr>
<tr>
<td>29 Max. allowable monthly housing payment</td>
<td>$690</td>
<td>$690</td>
<td>$690</td>
<td>$690</td>
<td>$690</td>
</tr>
<tr>
<td>30 New Housing Debt Ratio</td>
<td>34.2%</td>
<td>34.2%</td>
<td>34.2%</td>
<td>34.2%</td>
<td>34.2%</td>
</tr>
<tr>
<td>31 Max. monthly mortgage payment supported</td>
<td>$536</td>
<td>$536</td>
<td>$536</td>
<td>$536</td>
<td>$536</td>
</tr>
<tr>
<td>32 Max. Loan Amount based on the mortgage payment</td>
<td>($80,546)</td>
<td>($80,546)</td>
<td>($80,546)</td>
<td>($80,546)</td>
<td>($80,546)</td>
</tr>
<tr>
<td>33 Increase in Loan Amount</td>
<td>16.1%</td>
<td>16.1%</td>
<td>16.1%</td>
<td>16.1%</td>
<td>16.1%</td>
</tr>
<tr>
<td>34 Max. value of a home the borrower can afford</td>
<td>$115,065</td>
<td>$115,065</td>
<td>$115,065</td>
<td>$115,065</td>
<td>$115,065</td>
</tr>
<tr>
<td>35 Does the borrower qualify for the loan?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>36 Increase in Purchasing Power</td>
<td>16%</td>
<td>16%</td>
<td>16%</td>
<td>16%</td>
<td>16%</td>
</tr>
</tbody>
</table>

### 6.5.5 The LEM for Existing Home-Owners In the Tren Urbano Corridor

The preceding section of this chapter is focused on the potential use of a LEM program to help finance new home-buyers interested in moving to a location-efficient community within the Tren Urbano corridor. The program, if implemented successfully, will help families from different income groups to obtain financing necessary to purchase a home they desire. Nonetheless, this is not the only application of the LEM concept.

With respect to the declining housing conditions in some areas along the corridor, such as
Rio Piedras, San Alfonso, and Bayamón Centro, the LEM concept could be used in rehabilitation loans to help qualified home-owners in financing home improvement.

To encourage those families who currently reside in location-efficient neighborhoods to take transit, a refinance program incorporating the LEM concepts could be established. Under such a program, home-owners with mortgages would be able to restructure their loans if they meet a set of pre-determined criteria. The restructured loans would allow borrowers to pay a higher monthly mortgage payment if they desire, allowing them to incur less interest payment by paying off the loans sooner. The criteria used to evaluate the eligibility of borrowers for this refinance program should be similar to those used in a regular LEM loan and should reflect the fundamental principles underlying the LEM. This program should give incentive to those mortgage-holders in location-efficient neighborhoods to switch their travel behavior from an auto-oriented one to one that is transit-supportive.

6.6 THE LEM TARGETS OF OPPORTUNITY

The LEM programs for housing rehabilitation and refinancing, albeit their potential to encourage travel behavior change, should be implemented later. The priority should be to establish a LEM program for regular mortgage financing in the SJMA. It is crucial that the LEM, as a mortgage product and an incentive for people to take transit, performs well in the experimental stage. Without the endorsement from the housing finance industry, the LEM product will not sustain itself in the long run, let alone the future expansion of the LEM to create rehabilitation and refinancing programs. In other words, the experimental stage of the LEM program in the SJMA must aim at establishing a solid reputation in the housing finance industry.

As its name implies, the success of the Location Efficient Mortgages highly depends on the location the mortgage is offered. Selecting the right places to introduce the LEM is, therefore, one of the most crucial steps. The selection process in the experimental stage should pay attention to four characteristics of a neighborhood:

1. Sufficient new or vacant for-sale housing units of high-density
2. Strong mix-use characteristics and Pedestrian Friendliness
3. Good intermodal connection
4. Moderate income level
It should not be surprising that these location selection criteria resemble those used to evaluate if the SJMA meets the requisites for the implementation of LEM. While the region as a whole has the transit infrastructure and certain land-use characteristics to support the LEM, not every neighborhood within the region enjoys the same level of transit accessibility, and certainly, not every neighborhood displays the LEM-supporting land-use characteristics.

6.6.1 **Sufficient new or vacant for-sale housing units of high-density**

Based on the 1990 Census data, the stations Rio Bayamón, Las Lomas, and Nuevo Centro are the ones with the largest number of vacant housing units with sound condition within a half-mile radius study area. Nonetheless, the usefulness of this information may be limited for three reasons. Firstly, Census does not differentiate between vacant units in high-density development and vacant units in low-density development. Secondly, Census does not differentiate between for-sale units and rental units. Lastly, the 1990 information may be out-dated when the LEM program experiment is ready to be launched in San Juan. If locations of the LEM experiment have to be selected now, perhaps it is wiser to focus on future development, particularly that in close proximity to Tren Urbano stations.

Joint development between Tren Urbano and private developers on property owned by Tren Urbano will be ideal sites for experimenting with the LEM. This is because residents of joint development are more likely to change their travel behavior because of their proximity to transit stations. An experiment launched at joint development locations will verify whether one’s savings resulting from living in a location-efficient community would support extra borrowing capacity.

Although work on preparing future joint development has already started, no concrete development plan has been finalized at the time of writing. The joint development program is at a very preliminary stage, so it is still uncertain where new for-sale housing units will be offered. As of now, the largest residential development along the Tren Urbano corridor is expected to take place on a 400-acre parcel south of the Rio Bayamón station. The land, owned by the Puerto Rico Department of Housing, will be
Map 6-1 Vacant Housing Units in Sound Condition in the Tren Urbano Corridor

LEGEND
- Tren Urbano Phase I Stations
  1 Tren Urbano Phase I Alignment
Vacant But Sound Housing
  0 - 25
  26 - 50
  51 - 100
  100 - 250

Source: U.S. Census Bureau 1990.

---

Source: U.S. Census Bureau 1990.
developed into 2,500 housing units with supporting retail spaces. However, this is not a joint
development between Tren Urbano and a developer; it is unclear when the development
will start and when it will be completed. This parcel currently enjoys close proximity to
the nearby Tren Urbano station. If designed with the principles of transit-oriented
development, this development could become a location-efficient community, thus, home
to a large number of LEM borrowers.

Rio Bayamón aside, Las Lomas is another station where joint development is
being pursued. The current plan proposes construction of up to almost 400 residential
units, 88,000 to 316,000 square foot of retail space, and 637,000 to 933,000 square foot
of office space. Another focus of joint development is the Sagrado Corazón station in
Santurce. The scale of development at Sagrado Corazón station will be smaller. Housing
units are envisioned to be between 188 to 339 units; retail space will occupy 147,000 to
173,000 square foot; office space will constitute about 500,000 square foot. Other
stations with large number of residential units as part of the preliminary joint
development program include Centro Judicial and Nuevo Centro. Although the densities
vary, all the joint development plans call for relatively high-density development (Raine,
1998).

If parts or all of these development plans are realized, a significant number of
housing units will be available within minutes’ walk from Tren Urbano stations. The
LEM could be applied in areas where for-sale units are abundant.

Although joint development, by definition, will be the closest to Tren Urbano
stations, and hence, making it the easiest for residents to use the LEM, the selection
criteria should consider more than joint development in the future, if the experiment is
proven to be successful. As review of literature shows that people are generally willing
to walk a-quarter to a-half mile to take rail transit, new private or public residential
development within a half mile from Tren Urbano stations should be counted. In fact, the
boundary may be extended to three-quarter miles in areas with extensive público
services. Without an inventory of housing units, it would be difficult to conclude which
stations meet this criterion the best. The importance of selecting the right location

1 With the exception of the Las Lomas and the Sagrado Corazón stations, the proposed square footage of
each joint development provided here are very preliminary.
warrants a market study to estimate which station areas have the highest potential to absorb new for-sale housing units, since this is how investment decisions are made by private developers.

6.6.2 Strong mix-use characteristics / Pedestrian Friendliness

As discussed in Chapter 4, most people are willing to walk a-quarter mile to transit stations. So, when examining land-use characteristics, this distance should be applied. Thus, in this section, the “area around the station” refers to area within a-quarter-mile radius from the station. Seven of the 16 Tren Urbano stations display, to a different extend, characteristics of mix of land-uses in the area around them. Nonetheless, this does not imply all seven stations have the attributes to support LEM implementation.

The stations with the strongest mix-use character include Río Piedras, Bayamón Centro, Sagrado Corazón. The area around four other stations, Centro Judicial, Nuevo Centro, Las Lmoas and Villa Nevárez, also consists of a multitude of uses, though the intensity and mixes are different.

Río Piedras, Bayamón Centro, and Sagrado Corazón distinguish themselves from other stations by their old town-centers character that still lingers. A pedestrian and transit-oriented urban fabric already exists in these areas, although it has been disrupted severely by adjacent highways. The areas around these three stations are filled with small blocks, narrow streets, small local businesses, and multi-story vertically mixed-use buildings. Among many others, retail uses in these areas include pharmacies, supermarkets, and personal services, serving the daily needs of their neighboring communities. Adding to these uses are numerous cafes and fast-food shops. Among the three stations, Sagrado Corazón is the only one with a relatively large parcel of land for future development. While opportunities for large-scale residential development is limited near Río Piedras and Bayamón Centro stations in the near future, small parcels for infill development certainly exist. This is particularly true for Río Piedras, where vacant lots and under-utilized plots, filled with parking lots and dilapidated buildings,
abound. These three station areas would be ideal for LEM implementation if the right type of development occur.

Centro Judicial and Nuevo Centro stations share similar character. They are both surrounded by high-rise offices, parking lots, as well as high-density condominium and apartment complexes. Retail uses are quite limited at present; however, future joint development may change the current situation by bringing in a significant number of retail businesses. The existing high-density residential uses in the areas would allow the LEM program be experimented if more retails are introduced to meet the daily needs of residents. The number of parking lots would need to be replaced by other uses to make the areas more pleasant for pedestrian activities.

The area around Las Lomas station features yet another type of land-use character. While residential use of different densities dominates the area, commercial, light industrial, and minor-scale institutional uses intermingled between each other. As of now, the mix of uses is unlikely to support the LEM implementation. The street network is rather irregular, and the blocks tend to be larger. This area would need to be redesigned if the LEM is to be implemented.

Villa Nevárez is the seventh station with heterogeneous land-use types in its quarter-mile radius. It is mainly surrounded by commercial, industrial and institutional land uses, with a few dedicated to residential use. Population density in the area is rather low, since most of the housing units are single-family homes. The commercial activity developed in the area is oriented to automobile use. The services provided in the area are mostly dedicated to sales, maintenance, and repair of vehicles. Preliminary joint development plan focuses on office and retail development; housing development remains an uncertainty. Although rich in different type of land-uses, Villa Nevárez does not appear to be a good candidate for the LEM implementation.

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2 Vertically mixed-use buildings usually have retails and or businesses offering personal services on the ground floor and residential uses on the upper floors.

3 The preliminary joint development program calls for over 120,000 square feet of retail in the Centro Judicial station area, and 398,000 to 615,000 square feet in the Nuevo Centro station area.
6.6.3 **Good Transit Connection**

In order to make it possible for the LEM borrowers to fully capture the services of transit, it is recommended that the LEM be introduced in an area with good transit connection. This section first examines the current transit connection at each Tren Urbano station.

Bayamón Centro Station serves as a major intermodal transfer station. It is one of the twelve Transit Centers which have recently been established in the region. The town center of Bayamón is currently served by 4 público routes, buses and other private bus lines. The Municipality of Bayamón has proposed to implement shuttle service within the town center area that would also be integrated into the Tren Urbano station area.

Complejo Deportivo Station is served by six bus routes, private bus routes, and seven público routes.

Jardines de Caparra Station is expected to serve Tren Urbano riders from the surrounding neighborhoods. At present, this area is not served by any transit service. There are plans to provide bus and público services to this station.

Torrímar Station is not served by transit service currently. The Municipality of Guaynabo has proposed a shuttle between the town center and the San Patricio area that could provide access to this station.

Las Lomas Station is not served by any direct transit service currently. There are, however, some bus routes and público routes operating nearby. Similar to Torrímar Station, the Municipality of Guaynabo has announced plans for a shuttle bus service in the area.

San Alfonso Station can be reached through three bus routes and three público routes.

De Diego Station is currently served by four bus routes and three público routes. It is proposed to integrate Tren Urbano, bus, and público services at De Diego Station.

Centro Médico Station is one of the SJMA's major trip generators. Four bus routes and nine público routes serve this area. In addition to Tren Urbano, the PRHTA is improving transit service in this area by expanding transit facilities and improving access.

Villa Nevárez Station is currently served by one bus route and four público routes. The station will primarily serve the Villa Nevárez and the State Penitentiary.
Río Piedras and UPR Stations are well-served by buses an públicos. Transit services operating this area include seventeen bus routes and seven público routes. This area is very close to the Capetillo Transit Center.

Centro Judicial is another major trip generators in the Tren Urbano corridor. It is served by 11 bus routes and one público route at present.

Hato Rey Centro Station is where another Transit Center is located. The area is currently served by eight bus routes and one público route.

Nuevo Centro Station is anticipated to serve the Golden Mile banking district and the large residential areas nearby. Current bus service include 14 routes.

Sagrado Corazón Station is the third station designated as Transit Center in the Tren Urbano corridor. It will function as an important intermodal facility. Transit service currently serving the Santurce area include 14 bus routes and four público routes.

Hato Rey Centro, Bayamón Centro, and Sagrado Corazón are the stations which will enjoy the best intermodal connection when Tren Urbano is in operation. This is mainly due to the Transit Centers at each of these three stations, which have been put in place over the past two years. As for públicos service, Río Piedras and Bayamón Centro enjoy the highest level of. This is because they are connected to each of the thirteen municipalities in the SJMA. While all municipalities in the SJMA have one or more local público routes, Bayamón and Río Piedras have the largest number of local routes.

6.6.4  Non High-Income Area

The LEM should be introduced to families making medium income or even relatively lower-income in the initial stage, although the higher-income group should not be excluded in the future. The rationale is to avoid the potential abuse of the LEM as a home-financing mechanism by people who could afford to buy transit passes without using them. With the exception of Torrimar, none of the sixteen Tren Urbano stations is purely high-income; both low-income and moderate-income groups are found in the remaining fifteen stations. As shown in Map 6-2, almost all of the stations have households making income both above and below the area median ($15,300).

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4 Not each municipality is connected to another by público.
Map 6-2 Median Household Income in the Tren Urbano Corridor

**LEGEND**

- Tren Urbano Phase I Station
- Boundary of Study Area
- Tren Urbano Phase I Alignment
- Median Household Income
  - Below $7650
  - $7651-15301
  - $15301-20000
  - $20001-40000
  - $40001-75001

**Source:** U.S. Census Bureau 1990.
6.6.5 Selected Target of Opportunities

Integrating all the four criteria, five stations stand out to have the potential for future implementation of the LEM. They are:

1. Sagrado Corazón
2. Nuevo Centro
3. Bayamón Centro
4. Río Piedras
5. Centro Judicial

Nuevo Centro and Centro Judicial are selected in spite of the fact that they do not have the best transit access. Nuevo Centro is only one stop away from Sagrado Corazón; a train ride between the two stations will take less than two minutes. It is reasonable to believe that people living near Nuevo Centro will reasonably good transit accessibility benefits offered at Sagrado Corazón. Centro Judicial, being one station away from the large público terminal in Río Piedras and three stations away from the Transit Center at Centro Médico, is likely to capture many of the transit accessibility benefits too.
7 REALIZING THE BENEFITS OF THE LEM IN THE SJMA

The Location Efficient Mortgages have potential to offer a multitude of benefits when implemented successfully in the San Juan region. Individuals, organizations, as well as the entire region will benefit differently.

7.1 BENEFITS OF IMPLEMENTATION OF LEM IN THE SJMA

7.1.1 Benefits to Prospective Home-Buyers in Transit-Oriented Neighborhoods

Some families who are not be qualified for a conventional mortgage will be able to enjoy home-ownership because of their increased borrowing capacity assumed by the LEM. Those families who are qualified for a conventional mortgage loan will be able to get a larger loan amount. This would allow them to either purchase a better home, or pay a smaller amount of down payment when they purchase the same home. The down payment saved can be used for other purposes or be invested.

7.1.2 Benefits to Current Home-Owners in Transit-Oriented Neighborhoods

In addition to prospective home-buyers purchasing a home in a transit-oriented neighborhoods near the Tren Urbano corridor, current residents of those neighborhoods will benefit when the rehabilitation LEM and the refinancing LEM are introduced. Like many Americans, Puerto Ricans are simply not aware of the hidden costs associated with auto ownership and operation. It is taken for granted that a car is a necessity. One aspect of the LEM is to reveal the true cost of driving, offering an alternative use of the transportation money, and allowing individuals to make a informed decision which best fits their needs.
7.1.3 Benefits to Neglected Communities

Physical improvement of housing stock contributes to neighborhood stability. In some cases, it even stimulates community economic development. The fact that the LEM makes it easier to own a home in transit-oriented neighborhoods creates demand for housing in such areas. The demand then translates into developers’ interest in infill development in those neighborhoods. The new residents may attract new businesses too.

Some of the older inner-city neighborhoods in the SJMA actually possess the skeleton of a transit-oriented neighborhood, since many were built with pedestrians and transit in mind. With appropriate private investment, many of these neighborhoods can be transformed into true transit-oriented neighborhoods. The LEM may serve as an impetus to such kind of private investment. Río Piedras is a good example of such a neighborhood.

Being developed in the early part of this century, Río Piedras features many small blocks and narrow streets, which are lined with three- to four-story buildings with retail or services on the ground floor and residential uses on the upper floors. These are the assets of Río Piedras. Yet Río Piedras has numerous problems. One of them is the large number of vacant and under-utilized plots, some of which are parking lots and others filled with dilapidated buildings. These plots contribute to an unkempt, dangerous, destitute image of Río Piedras. The LEM may spur development interest on those plots, hence, helping to revitalize the area.

7.1.4 Benefits to Tren Urbano

The LEM will likely to benefit Tren Urbano by attracting more non-captive riders. It is likely to attract those who inherently prefer transit to driving to live close to Tren Urbano stations; thus, promoting the use of Tren Urbano of this group. Further, it will also give incentives to those living close to Tren Urbano stations to take transit. Since a LEM loan will be approved with the condition that the borrower purchases at lease one transit pass for a pre-determined number of years, Tren Urbano will likely to generate higher revenue from sales of transit passes. Further, sales of transit passes
represents a more predictable income stream. Thus, it helps Tren Urbano to plan for multi-year service or facility improvement projects.

In addition to increased farebox revenue, Tren Urbano will likely to benefit indirectly from the LEM implementation. The LEM stimulates interest in residing close to transit stations, hence, fostering demand for residential units in joint development. Tren Urbano may enjoy higher revenue from joint development projects. It should be noted, though, that the LEM stimulates interest in for-sale units, not rental units. So, for Tren Urbano to capture the benefits, condominiums or other for-sale housing units are necessary.

7.1.5 Benefits to Buses and Públicos

Buses and públicos are likely to gain ridership after the LEM is in place. The first phase of Tren Urbano, though serving some of the busiest areas in the SJMA, does not reach many destinations buses and públicos serve. The LEM not only encourages the use of Tren Urbano, but all the other components of the transit system. During the first few years of the mortgage loan, when transit passes are mandatory, borrowers will begin to explore and learn to use Tren Urbano, buses, and públicos. The initial period can be viewed as a transition period for the borrowers, as they will realize that transit system are better and more efficient than they thought, and that cars are not as crucial as they have always perceived. If the program is successfully implemented and transit agencies keep the current momentum of improving their services, it will not be long before LEM borrowers come to appreciate the benefits transit provides. In addition, the increasing patronage of transit will help to improve transit service, which will in turn attract more riders. This is because transit is a rather unique industry; ridership increases would make it easier to improve the level and comprehensiveness of service until it reaches a certain threshold.
Benefits to the San Juan Region

Environmental And Energy Benefits

Besides the individual borrowers, transit agencies and banks, many others in the San Juan region will benefit from the LEM in the long run.

As mentioned above, the LEM will encourage infill development and high-density development. Both types of development represent a more efficient land-use pattern, which translates into numerous environmental benefits. The more efficient land-use pattern leads to a more cost-effective provision of infrastructure, saving municipalities and individuals costs associated with unnecessary infrastructure expansion.

The LEM encourages transit-oriented development, which is believed to reduce the number of vehicle trips per housing unit. According to the LUTRAQ analysis performed by 1000 Friends of Oregon, the number of vehicle trips per unit in transit-oriented neighborhoods is 13 percent less than average. About half of the reduction is attributable to transit-supportive design and public transportation, and half to other financial inducements to choose transit.

The environmental benefits resulting from reduced automobile travel and increased transit use induced by the LEM could be significant. According to the FTA, the travel pattern of the 80 million Americans living in transit-intensive metropolitan areas result in less pollution, emitting 200 million fewer pounds of hydrocarbons and 272 million fewer pounds of nitrogen oxides annually. Although similar estimates have not been prepared for Puerto Rico, it is unquestionable that the island will enjoy cleaner air if more people spare their cars.

Transit travel also represents a more energy-saving travel mode. According to the FTA, transit reduces auto fuel consumption by approximately 1.5 billion gallons annually (FTA 1996).

Even for a person who is indifferent about the environment and energy consumption, the LEM’s potential in discouraging driving at least means saving of time. Recent research conducted for the FTA (1996) indicated that transit significantly improves the overall point-to-point speed of travel for both transit riders and highway users in severely congested urban travel corridors in several cities: Boston, New York,
Atlanta, Pittsburg, Philadelphia, Chicago, San Francisco, and Washington, D.C. As motorists in those cities switched from automobile commuting to transit, congestion on highways lessened and highway travel time improved. The FTA suggests that the national congestion reduction benefits of transit alone are worth at least $15 billion each year. By the same token, through shifting some of the auto trips to higher-occupancy Tren Urbano trains, buses, and públicos, the LEM will eliminate many unnecessary autos on roadways in the SJMA. This would help relieve the severe traffic congestion confronting the region, saving the time of both transit riders and motorists.

**Transportation Equity Benefits**

Introducing the LEM in the SJMA will help the 29 percent of the region's transit-dependent population in two ways. Firstly, the LEM will promote an urban form that is transit- and walking-conducive, making resources and services more accessible for those who cannot afford owning a car or who cannot operate a vehicle. Secondly, as more people benefit from transit, the political barrier to allocating public funding to transit industry recedes. This is particularly true with LEM, since the LEM can be programmed in such a way that even people in the higher end of the socio-economic ladder will have more incentive to take transit. Funding used to improve transit service will benefit everyone, but the transit-dependent group will probably find the improvement more valuable than the non-transit-dependent group.

Both the transit-supportive urban form and the improved transit service brought about by the LEM in the longer run will broaden economic opportunities for the poor who suffer mobility constraint by the lack of automobile. For the disabled and the elderly, this long-term benefit of the LEM would mean better, and probably cheaper, access to health care, social and commercial services, as well as social and cultural activities.

**Quality of Life**

Many of the afore-mentioned benefits created by the implementation of the LEM in the SJMA directly and indirectly improve the quality of life of everyone in the region. For instance, everyone in the region will enjoy breathing in cleaner air. They will all
appreciate the time saved by congestion reduction. The LEM’s potential to stimulate reinvestment in some older city centers will help bring back the lost sense of place and the once thriving civic pride. The home-ownership LEM promotes is conducive to building neighborhood cohesion, which most people treasure.

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7.2 **LEM IMPLEMENTATION CHALLENGES**

The realization of these benefits depends on the success of the LEM implementation, which, however, will not be free of challenges. While the analysis in Chapter 5 shows that SJMA will meet the basic conditions for the implementation of the LEM, there are still hurdles which need to be overcome and issues addressed when trying to replicate this Chicago-originated program in the SJMA.

7.2.1 *Culture of Driving / Image of Transit*

The major hurdle one would experience is the popularity of driving and the relative inferior position of transit. As pointed out in Chapter 3, transportation in the SJMA is dominated by private automobile, which accounted for over 90% of all trips.
made in 1990. While auto ownership has been on the rising trend throughout the last three decades, transit ridership plummeted from 230,000 average weekday passengers in 1964 to 80,000 in 1990. Transit services have been perceived as unreliable, indirect, infrequent, and sometimes, even uncomfortable. Some have concerns about the issue of security in taking transit. Driving has already become the norm in SJMA. In the Chicago region, where LEM is first initiated, transit system is a more popular travel option. The bus system there has a 10.5% modal share in journey-to-work trips, together with other components of the system, transit accounts for almost 20% of modal share (Chicago Area Transportation Study, 1993).

7.2.2 Gaining Support From Housing Finance Industry

Another significant hurdle one will have to overcome to get the LEM into the mortgage market place in the SJMA is to gain recognition and support from the housing finance industry, both at the local and federal level. At the local level, it is important that mortgage bankers, underwriters, mortgage brokers, and mortgage insurer believe in the theory behind the LEM -- that households, by elimination of trips and replacement of auto trips by non-auto trips while residing in “location efficient” communities, will have a higher capacity to repay loans. In other words, the housing finance industry will not endorse the LEM unless the players in the industry believe that Puerto Ricans will indeed change their travel behavior. This is related to the public’s perception of transit system discussed in the previous section. Because Tren Urbano is new to Puerto Ricans, use of the system is uncertain. The players in the housing finance industry may question the validity of the theoretical framework of LEM as it applies in the SJMA.

Without the support from the local housing finance players, it would be very difficult to gain commitment at the federal level. At the same time, getting the endorsement at the federal level would help getting recognition at the federal level. As in the case of Chicago, several major mortgage lenders had expressed their willingness to write LEMs to qualified borrowers, contingent upon such mortgages being accepted on the secondary mortgage market.

1 This modal share is for Cook County, where Chiacgo is in.
It should be made clear that the mortgage lenders in Chicago sought to sell the LEMs in the secondary mortgage market not because of their lack of confidence in the performance of LEMs. In fact, it is a common practice that mortgage lenders sell their loans to investors, instead of keeping those loans in their portfolios.

7.2.3 Trend of Decentralization & Preference For Low-Density Development

The third hurdle in implementing the LEM program in the SJMA is the trend of decentralization and the general preference for low-density residential housing over higher-density units. The island has been experiencing suburbanization of population and employment, though to a much lesser extend than many other U.S. cities. This trend was dated back several decades ago, when the FHA initiated a program of guaranteed loans for single family suburban houses, making it financially feasible and attractive to create the suburban sprawl that is typical in many other U.S. cities. Meanwhile, public housing and affordable housing have been developed in suburban fringes where the cost of land is lower. Employment tends to follow the same trend. Already some office development has occurred along the radial expressways, even though the familiar U.S. trend towards large-scale suburbanization of office space has not taken root in the San Juan metropolitan area. Although happening slowly, the trend of decentralization is certainly one force that the LEM has to work against.

7.2.4 Limited Supply of Medium- to High-Density Residential Development

Because of the general preference for low-density housing, the supply of high-density residential development is limited. It will remain so if no policies are enacted to encourage developers to provide some alternatives. The present medium- to high-density housing units are scattered throughout the region. While some of them will enjoy great transit accessibility once Tren Urbano starts operating, some will not. The inadequate supply of medium- to high-density residential units in transit accessible locations will present a barrier to the implementation of the LEM program.
7.2.5 Monitoring of Auto Ownership

If the goal of the LEM is to reduce reliance on automobiles, monitoring of automobile ownership of households becomes an important part of the program. In the Chicago case, the current plan is to require LEM borrowers to participate in periodic reporting of auto ownership and transit usage, as well as employment. There is, however, no plan to sanction those who acquire more automobiles over the course of the repayment period. Borrowers will be provided with counseling service before any LEM application. It is hoped that the borrowers, through the counseling, would come to understand and appreciate the importance of minimizing automobile ownership in their abilities to pay the monthly mortgage payment on time.

Monitoring of automobile ownership is a complicated issue. It is to the interest of transit authority and society, and even both the lenders and the borrowers to ensure borrowers’ conformance to the auto ownership limitation. Yet, the mechanism should not be so stringent that one may be scared away from even considering the LEM. The balancing of these two competing forces suggest that the positive incentive of requiring one or more transit pass per family is a possible way to encourage one to take transit.

7.3 Actions To Facilitate The LEM Implementation

As shown, there are five major hurdles which one would have to overcome in order to implement the LEM program in the San Juan region. They are:

1. strong culture of driving and poor image of transit;
2. gaining support from the housing finance industry;
3. the trend of decentralization and the general preference in low-density development;
4. limited supply of high-density residential housing in transit-accessible locations; and
5. monitoring of automobile ownership.

Fortunately, there are myriad of actions and policies which one may take or formulate to help overcome some of these challenges. These actions and policies can facilitate the implementation of the LEM program. Many of them reinforce the effects of each other, and LEM as well. They will help realizing the potential benefits of the LEM concept.
Actions or Policies to Overcome the First Hurdle

7.3.1 Transportation Demand Management

Transportation demand management (TDM) plays a crucial role in encouraging the shift of travel behavior from driving to taking public transportation, a goal as well as a premise of the LEM provisions. TDM consists of an array of mechanisms to reduce driving trips. It ranges from congestion pricing and tolling to raising gasoline tax, from parking management to work-trip related incentives, and from negotiated demand management agreements to trip reduction ordinances. The underlying theme connecting these mechanisms is the use of economic disincentives to discourage driving and economic incentives to encourage alternative travel mode. Non-economic mechanisms, which are even more direct, may include establishment of auto-restricted zones and instituting alternative drive day.

7.3.2 Employment-Related TDM Strategies

A wide variety of work-related initiatives could be taken to encourage taking public transportation or alternative modes. One of the major reasons employees drive to work is that they need to drop off and pick up their children to and from day-care centers. So, day-care centers located within walking distance of major employment hubs would likely to reduce driving work trips. The municipal government of San Juan, Guynabo, and Bayamón could work with large employers to establish day-care centers near workplaces. Alternatively, Tren Urbano could actively pursue the establishment of day-care centers near the stations. Day-care centers at stations near employment centers would allow parents to visit their children during lunch hour. The convenience offered would be particularly appealing to working mothers.

7.3.3 Parking Management

The prevalent parking policies have profound impacts on travel behavior both directly and indirectly. When parking supply greatly exceeds demand, the price of parking becomes close to zero, thereby directly encouraging driving. At the same time, high minimum parking requirements contribute to the development of a low-density...
urban form and an auto-oriented transportation system, both of which further amplify the
degree of auto-dependency. This is a vicious cycle, which feeds back to itself. Action to
break such a cycle is necessary for sustainable development.

Research shows that parking pricing strategies are among the most effective
deterrents to driving, particularly solo driving. Parking pricing could be undertaken in
various forms. Charging workers for parking space is one effective way to reduce
driving work trips, since parking charges would be one of the largest and most visible
costs of commuting and other local travel if most travelers paid them. Free parking is
currently an employer-provided tax-free benefit, whereas monthly transit allowances in
the amount over $65 paid by employers are subject to income taxes. Employers could
initiate a parking cash-out program, under which an employer provides a travel cash
allowance in lieu of free onsite or offsite parking. Because they are tax-free, every dollar
of transit subsidy can be worth as much as $1.5 in extra salary. The Metropolitan
Transportation Commission (MTC) in the San Francisco Bay Area has started this kind
of program in 1991; it was found that over one-third of the employees surveyed increased
their use of transit by an average 3.24 trips per week.

This type of tax policy, albeit its effect in shifting commuting behavior to transit,
still creates an advantage for use of auto over transit in places where the value of the free
parking exceeds the travel allowance. The solution is, thus, to allow larger amount of tax
write-offs for employee transit in such places. Unfortunately, due to the complexity in
the tax codes of the U.S. Internal Revenue Services (IRS), this solution is difficult to
implement in the continental U.S. However, it would be much easier to implement this
idea in Puerto Rico, where the IRS tax codes do not apply.

The option to cash out employer-paid parking will reduce commuter parking
demand, which then warrants a corresponding reduction in minimum parking
requirements. Thus, a longer-term measure to encourage transit use is to reduce
minimum parking requirement of new developments, with focus on those in suburban
areas. Some further argue that, as a consequence of the parking policies of the past four
decades, there is an oversupply of existing parking space even without the cash-out
option. Therefore, parking policies deserve close examination.
Negotiated Demand Management Agreements

The implementation of the LEM could also be coupled with negotiated traffic mitigation agreements, which have become a common practice in numerous mainland cities, including Dallas, Los Angeles, Orlando, San Francisco and Seattle. By virtue of such agreements, local governments mandate private sector involvement in traffic mitigation as a condition of individual development approval. The agreements set a traffic reduction goal, but differ in the degree of prescription concerning implementation methods. An example of a non-prescriptive approach is the trip reduction agreements negotiated by the Montgomery County (MD) Planning Board. The agreements specify the number of vehicle trips to be ultimately eliminated from a given development but leave wide latitude to the developers in deciding how those reductions are to be achieved. Jurisdictions in the SJMA could emulate the efforts of these communities to come up with different agreements within the limit of local political acceptability. This would give impetus for developers to limit auto-ownership of their customers (that is, the residents of the housing development), using such strategy as limiting parking space per housing unit or imposing high value on parking space. Hence, it indirectly encourages “one-car” or “no-car” households, a goal embedded in the LEM.

Trip Reduction Ordinances

Trip reduction ordinances represent an even more stringent and progressive approach than negotiated demand management agreements. A community’s regulatory authority is used to limit trip generation from new developments. Ordinances appeal to local officials on several grounds. Firstly, they can potentially achieve more significant trip reductions because they usually cover an entire local political subdivision rather than just an individual project. Secondly, they spread the burden more equitably between existing and future development. And, lastly, they may be less vulnerable to legal challenges than conditions imposed on development approvals. Same as the negotiated demand management ordinance, trip reduction ordinances would create strong incentive
for developers to constrain auto-ownership of their clients; thus, making the LEM more appealing to home-buyers.

7.3.6 **Enhancement of Pedestrian Walkway and Bike Path**

As discussed in the theory behind the LEM, one could replace some auto trips by walking and cycling when one lives in a mixed-use, higher-density neighborhood. This desirable result could be strengthened if the environment in which walking and cycling take place is a pleasant one. Therefore, in areas where the LEM is to be implemented, efforts should be put to enhance the safety and aesthetics of pedestrian walkways and bike lanes. Pedestrian safety could be improved by traffic calming techniques and enforcement of bicyclist and pedestrian traffic rights. Furthermore, extensive auto-free pedestrian zones could be established where appropriate. Provision of bicycle parking facilities is also necessary.

7.3.7 **Marketing Transit**

As pointed out in the previous section of this chapter, one of the challenges in implementing the LEM in the SJMA is the prevalent culture of driving in Puerto Rico. Rail transit is new to Puerto Ricans, who are accustomed to driving. At the same time, there is much room for the improvement of image of public transportation. Marketing transit becomes very important in creating a positive image of transit services.

Marketing transit could be undertaken in numerous forms. Tren Urbano and other transit operators in the SJMA could hold transit carnivals and issue transit sweepstakes with free transit passes as prizes. They could also join with environmental groups to hold fairs promoting the environmental advantages of transit. To reach a larger segment of the population, transit operators could send informational brochures via mail to virtually all households in the SJMA region. Transit advertisements could be regularly placed in the SJMA’s newspapers, magazines, on billboards, on transit vehicles, in transit stations and at bus stops, as well as on radio and television.

Similarly, Tren Urbano and other transit operators could produce special monthly or quarterly newsletter, which are to be distributed free of charge to riders, with
highlights of new services, improvements, and environmental advantages. There is also a need to produce brochure showing how to use the transit system to reach major activities centers and other desirable destinations for weekend entertainment. It is equally important that youngsters have a positive outlook on public transportation. Transit operators could hold informational presentations in schools to teach children about transit and to encourage them to use it. If financially feasible, gifts or souvenirs with transit logo could be given out to children using transit.

Transportation demand management and improvement in pedestrian and cyclists’ environment are intended to help overcome the first hurdle of LEM implementation by making driving less convenient while making transit a more viable and attractive option. Once the first hurdle is handled successfully, the second challenge of getting support in the mortgage market would be easier to deal with.

Policies To Overcome The Third and Fourth Challenges

7.3.8 Changes in Housing Programs

In light of Puerto Ricans’ general preference in low-density housing options, housing programs, one of the acclaimed culprits for suburban sprawl, can be changed to stop and reverse the negative environmental consequences it help created. Currently, under the federal tax code, the interest payment of one’s home mortgage loan is tax-deductible for a particular income group. Some state housing finance agencies have programs that allow a larger portion of one’s mortgage payment be tax-deductible. The same idea could be applied in the SJMA to allow those living in a home, of a certain minimum density, located within a pre-determined distance from a transit station. One way to augment the tax-deductible portion of the mortgage payment would be to multiply the interest portion by a certain multiplier. Alternatively, a portion of the principal payment could be made tax-deductible too. This would boost the desire for home-ownership near transit stations.
7.3.9 Government Assistance

While augmented tax-incentive represents a demand-side approach to encourage high-density living, similar tax incentives could be used to intervene the supply side of the housing market. The supply of for-sale medium- to high-density units is essential for LEM implementation. Home-builders interested in building higher-density housing around transit stations should receive extra assistance from local government. The assistance may be a subsidy, zoning relaxation, or help in assembly of land for development. In Puerto Rico, even an expedited permitting process would be a very attractive incentive, since getting a permit usually takes a long time. This extra assistance is warranted by the societal benefits of more transit-supportive development.

It is also important that there be ample employment opportunities along transit corridors for successful implementation of the LEM. In areas along the corridors where employers’ interest to establish businesses is low, municipalities could create “transit-supportive zones”, where new businesses would enjoy some kind of tax abatement when they create a pre-determined number of jobs.

7.3.10 Land Use Policies

Land use policies should complement many of the strategies in overcoming different barriers to the implementation of the LEM program. For instance, while the above TDM is expected to reduce reliance on automobiles, it would work best if it is conjoined with the larger land use, zoning and subdivision changes. Many of the TDM measures discussed above are aimed at reducing journey-to-work auto trips, which account for only one-quarter of all trips. To reduce the remaining three-quarters of trips, a shift in major comprehensive and long-range urban planning policies is required. The new land-use policies and zoning ordinances should encourage transit-oriented development.
**Actions to Overcome the Fifth Challenge**

**7.3.11 Auto-Ownership Monitoring**

One way to control auto-ownership is to have the transit pass fare escrowed from monthly mortgage payments and transferred annually to Tren Urbano. This mechanism of managing funds would give LEM borrowers greater incentive to take transit, as purchase of transit pass for a certain number of years is a requirement and is “merged” with the monthly mortgage payment. Also, it is unlikely that low- to moderate-income households, with limited budget, can afford to have “double spending” on transportation - both transit pass and automobile ownership.

This method of limiting a LEM household’s automobile ownership may not always work though. For those who are more wealthy, the cost of transit pass may be negligible, and so the “double spending” on transportation may not be as big an issue for them. Yet, they could still use LEM to get a loan larger than what they otherwise could, due to the way their borrowing capacity is estimated. Perhaps, coordination could be established between the lenders and the local Department of Motor Vehicles (DMV) to monitor auto ownership. It may be more cost-effective for one to make non-conformance difficult than to sanction non-conformance. For instance, parking should be limited where the LEM is to be introduced. Strategies similar to this could be devised, depends on the needs.

**7.4 Evaluation of the LEM Program**

The LEM can potentially achieve various goals, which are quite different in nature. Depending on one’s specific goal of introducing the mortgage, the methodology used to evaluate the program’s effectiveness can be quite different.

**7.4.1 Measuring the LEM’s Effectiveness to Directly Change Travel Behavior**

As in the case of the San Juan region, one obvious goal of introducing the LEM is to change travel behavior. At least three indicators can be used to measure the effects of the LEM with regard to this goal: automobile ownership per household, VMT per household, and transit usage per household.
Table 7-2 Challenges of LEM Implementation in the SJMA and the Corresponding Strategies

<table>
<thead>
<tr>
<th>CHALLENGES</th>
<th>CORRESPONDING STRATEGIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong culture of driving</td>
<td>Transportation demand management e.g., employer-related incentives, parking management, negotiated demand management agreements, trip reduction ordinances, etc. Enhancement of pedestrian walkways and bike paths</td>
</tr>
<tr>
<td>Poor image of transit</td>
<td>Marketing of transit Constant improvement of transit services</td>
</tr>
<tr>
<td>Gaining support from mortgage market</td>
<td>Strategies a, b, c, d, f, h</td>
</tr>
<tr>
<td>Decentralization trend</td>
<td>Housing programs favoring transit-supportive homeownership Program for business locating near transit Land-use policies discouraging sprawl</td>
</tr>
<tr>
<td>Preference for low-density development</td>
<td></td>
</tr>
<tr>
<td>Limited supply of high-density for-sale housing near transit</td>
<td>Government assistance encouraging such kind of development near transit Land-use policies encouraging infill development</td>
</tr>
<tr>
<td>Monitoring auto-ownership</td>
<td>Pre-application counseling Coordination with local DMV Parking Restrictions</td>
</tr>
</tbody>
</table>

A study to compare the auto-ownership rate of LEM borrowers before and after they get LEM loans can be conducted. The study should include both LEM borrowers and non-LEM borrowers who live in the same neighborhood. Comparing with non-LEM borrowers in the same neighborhood would control for the effects of neighborhood characteristics that affect travel behavior. Since it is impossible to keep constant some factors affecting travel behavior, such as change in price of gasoline, change in price of automobiles, comparing LEM borrowers with non-LEM borrowers prove to be even more important. In addition, it is necessary to control for other confounding variables, which have impacts on auto-ownership. Such confounding variables include household income, household structure, and other demographic variables known for affecting travel pattern. The place of work also affects one’s travel mode; those who work at places well
served by transit have higher propensity to take transit. This variable, however, will be relatively difficult to control for. The same set of studies can be conducted to determine LEM’s effect on VMT per household and transit usage per household.

The results of these studies should reveal whether or not LEM alone can switch an auto-oriented household to a less auto-oriented one, or even a transit-oriented one. Even if the results indicate that LEM per se only has minimum impact, it does not necessarily mean that the LEM program is a failure. This is because the LEM may give incentive to people to live in neighborhoods that are conducive to transit use. In that case, it is not the LEM per se which changes the travel behavior, but the characteristics of those neighborhoods.

7.4.2 Measuring The LEM’s Ability To Promote Home-Ownership Near Transit

Most Puerto Ricans live with the same ideology as Americans in choosing a home. Many opt for single-family homes in single-use suburban subdivision, where automobile is almost a must. If the LEM program can change this ideology of some Puerto Ricans, it will indirectly change the travel behavior. So, one measure of the success of the LEM program should be on the program’s ability to attract home-buyers to high-density, mixed-use development near transit stations within the urban core.

To do that, a survey can be conducted to estimate the percentage of LEM households moved to their residences because LEM allows them to get a larger loan amount to finance their homes.

7.4.3 Measuring The LEM’s Ability To Promote Home-Ownership

Travel behavior aside, LEM is created to help the low- to moderate-family to enjoy the benefits of home-ownership. With respect to this, one can undertake a study to estimate the number of households whose home-ownership are made possible by the LEM program. Mortgage lenders should be the primary source of information needed to complete this study.
7.4.4 Measuring The LEM’s Ability To Reduce Transportation Costs Of Households

An underlying assumption of the LEM is that money saved from switching travel pattern would allow families to own a home by allocating more money to housing without shrinking expenditures on other items, such as food, health care, etc. In other words, households should not have to spend more on housing and transportation (consolidated) after they get LEM loans.

In light of this, one could conduct a study to estimate if this proposition holds in reality. Inflation needs to be taken into account in this study. This should be a rather straight forward study, since the amount a household spends on housing and transportation is quite easy to estimate. This is particularly true when the household pays a regular mortgage payment and purchase monthly transit pass.

If it turns out that LEM borrowers have to reduce expenditure on other household items to balance the household budget, a more careful estimation of the Location Efficient Savings is warranted.

7.4.5 Measuring the performance of LEM as a mortgage product

Support from mortgage lenders, insurance underwriters, and other players in the housing finance arena is critical in a LEM program. From their perspectives, the success of such a program is reflected by the performance of the mortgage product. It is, therefore, important to measure the default rate, foreclosure rate, and work-out rate of LEM borrowers. However, the region’s economic health has much influence on borrowers’ ability to repay debt on time. Therefore, it is not adequate just to look at the default, foreclosure, and work-out rates of LEM loans by themselves. A fair analysis would include a comparison of the performance of conventional and other mortgage products in the mortgage market during the same time period.
7.4.6  Measuring the LEM’s Impact on Transit Agencies

The simplest way to measure the degree of impacts a LEM program has on Tren Urbano, AMA bus and the público system is to look at sales of transit passes directly related to the LEM.
8 CONCLUSION

8.1 RESEARCH SUMMARY

American’s fervor in driving their own cars and single-family homes, and the land-use, transportation, and housing policies supported by, as well as encouraging such behavior have created environmental and social problems, both are deteriorating the quality of life. In light of these problems, environmentalists, social justice advocates, as well as urban planners and architects all call for a more transit-oriented society, one which effectively links residence, employment, and commercial services to and via public transportation.

Living in a transit-oriented society has three implications. Firstly, it entails relying on public transportation rather than on automobiles to satisfy one’s travel needs. Secondly, it implies living in denser housing development. And lastly, it usually means living in communities that are more heterogeneous in land uses. All of these seem to violate the ideology ingrained in the predominant American culture. There is much resistance to these changes, posing challenges to those trying to materialize the idea of transit-oriented society. While the society seeks to provide more viable transportation alternatives, incentives are needed to promote behavioral changes.

The Location Efficient Mortgages (LEM) emerge as such a type of incentive. By taking into account the amount of money a family can save if it replaces part or all of its auto trips by transit and walking trips while living in a transit-oriented neighborhood, the LEM assumes a greater borrowing capacity of the family in mortgage loan application. This increased borrowing capacity would then allow the family to qualify for a mortgage loan which they otherwise may not be eligible for.

While the concept of LEM sounds promising as an incentive to encourage transit-oriented lifestyle, it cannot be implemented anywhere. In order for the LEM to work, a place must meet four requisites. First, a transit system providing adequate and reasonably comprehensive transit services must be in place. This is not enough; there
needs to be sufficient employment opportunities along transit corridors such that prospective LEM borrowers can take advantage of the transit system to travel to work. The third requisite is a mix of land uses along transit corridors, allowing prospective LEM borrowers to take transit for non-work trips. Finally, the LEM needs to be introduced in a place where there is general readiness to accept high residential density.

The Commonwealth of Puerto Rico is now constructing a light rail system in the San Juan Metropolitan Area (SJMA). This major transit investment brings along opportunities for re-configuring the land-use pattern; it also represents an excellent opportunity to change the automobile-oriented travel behavior of Puerto Ricans. Introducing the LEM in San Juan now would allow these opportunities be captured.

The problems associated with auto-oriented lifestyle on the mainland U.S. also plague the Commonwealth. Some of the problems are even more pronounced on the island, affecting a larger percentage of the population. What differentiates Puerto Rico from the States the most is the cost of driving -- it costs a Puerto Rican family twice as much as what it costs an American family to use a car as the primary travel mode, yet transit services are much cheaper on the island than on the mainland. With respect to this issue, the LEM seems to have more to offer in Puerto Rico than in the States.

An analysis of the SJMA's existing and future transit infrastructure and land-use characteristics shows that the region meets the four requisites for introducing the LEM. Using data from the Federal Highway Administration and the American Automobile Association with adjustments to costs reflecting the situation in Puerto Rico, it is estimated that the net savings resulting from switching transportation mode ranges from a low of $1,786 to a high of $3,882 per family per year. If 38 percent of this savings is applied in housing, a family can borrow approximately $8,000 to $12,300 more than under normal situation. This amount is quite significant in buying a home in Puerto Rico, where two-thirds of the properties are under $100,000.

With respect to the current housing condition and household characteristics within the Tren Urbano corridor and the SJMA, three types of LEM program could possibly

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1 This is not in raw amount, but in relative term. While transportation cost constitutes 19% of an average American family’s income, it represents 40% of an average Puerto Rican family’s income.

2 Many assumptions are used to arrive at these numbers. For details, please refer to Chapter 4 of this thesis.
work: a regular LEM loan program for home-buyers, a LEM rehabilitation loan program for property owners of deteriorating structures, and a LEM refinance program for home-owners to “retrofit” their conventional loans. The regular LEM loan program should be the first to be introduced.

Four criteria are recommended as the basis for selecting a few Tren Urbano stations as the testing ground for the regular LEM loan program.

1. Sufficient new or vacant for-sale housing units of high-density within a half-mile radius from the station in the future
2. Strong mix-use characteristics
3. Good transit connection
4. Non high-income area

The LEM programs have potential to offer an array of benefits when implemented successfully in the San Juan region. Prospective home-buyers and some current home-owners in transit-oriented neighborhoods are likely to enjoy the augmented borrowing capacity in mortgage or rehabilitation loans. Some older inner-city neighborhoods along the Tren Urbano corridor may benefit from potential reinvestment interest spurred by the LEM. Tren Urbano, as well as buses and públicos, are likely to receive increased farebox revenue; Tren Urbano may even enjoy higher revenue from joint development projects.

Individuals and organizations aside, the LEM programs will help relieve traffic congestion, saving time and energy. The programs will also bring to the region the environmental benefits associated with reduction in vehicle-mile-traveled (VMT). Equally important, the longer-term effects of the LEM on urban form and transit services will enhance accessibility of those unable to own or operate vehicles. The overall quality of life in the San Juan region will be improved as all these benefits are realized.

The realization of all these benefits depends on the success of the LEM program implementation, which will not be free of challenges. There are five major hurdles, which need to be overcome. Perhaps the most significant one is the strong culture of driving and the poor image of transit in the SJMA, which makes it difficult to ask Puerto Ricans to take transit instead of driving. This leads to the second hurdle--gaining recognition and support from the housing finance industry. The housing finance industry will not endorse the LEM loans unless it believes that Puerto Ricans will indeed change their travel behavior. Another challenge is the general housing reference of home-owners
in single-family detached units over units in higher density. Even though Puerto Ricans are more willing to live in higher density, the predominant culture still favors low density. This relates to another issue -- there may not be enough high-density residential development in transit-oriented neighborhoods, as the demand for it is not great presently. The last issue involves the monitoring of automobile ownership of the LEM borrowers once the program has been established.

Fortunately, there are myriad of actions and policies which one may take or implement to help overcome some of these hurdles. To overcome the first hurdle of popularity of driving and the relative inferior position of transit, an array of transportation demand management strategies could be introduced, in conjunction with enhancement of pedestrian walkways and bike paths to make walking trips to/from transit safer and more pleasant. At the same time, aggressive transit marketing can be launched. If successful, these programs will lure motorists out of their cars. The second issue of having the housing finance industry to believe in the promises of LEM will be easier to deal with.

With regard to the decentralization trend, Puerto Ricans’ general favor in low-density development, and the limited supply of high-density for-sale housing near transit, the LEM could be coupled a variety of government initiatives and policies. These may include a demand-side approach, such as creating housing programs favoring transit-supportive home-ownership; it may also consists of a supply-side approach, such as provision of government assistance to developers interested in transit-supportive housing. These two are targeted to counteract the forces of decentralization of population and the preference for low-density housing. To stop decentralization of employment, programs favoring location of businesses near transit could be initiated. Further, land-use policies, the framework within which future development occurs, need to be crafted to contain sprawl and encourage infill-development.

Obviously, Tren Urbano, as a transit agency, will not be able to take all of these actions to facilitate the implementation of the LEM. The Puerto Rico Department of Housing, the Puerto Rico Planning Board, as well as municipalities will need to make strong commitment. Thus, the implementation should be a joint collaboration between the Puerto Rico Highway and Transportation Authority and the agencies identified.
8.2 NEXT STEP AND DIRECTION FOR FUTURE RESEARCH

If it is decided that Puerto Rico should pursue the LEM, there are many steps to take before the LEM can become a reality in the SJMA. The first step will involve the development of a model to estimate the Location Efficient Savings (LES) of neighborhoods. As discussed, the difference between the cost of driving and transit cost, though very important, is one of the determinants of the LES. Household income represents another determinant, since it influences the automobile ownership and VMT of households. It is equally important to quantify the impacts of other neighborhood attributes affecting one’s travel behavior. The most important attributes are likely to include:

1. residential density;
2. transit accessibility;
3. pedestrian accessibility; and
4. neighborhood-shopping accessibility

These four variables can be viewed as independent variables; they are likely to affect auto ownership and vehicle miles traveled of households, the dependent variables.

After a model is being developed and calibrated, one could revise the preliminary criteria for selecting the targets of opportunity for the LEM implementation. Based on the revised criteria, one can select a few neighborhoods near some Tren Urbano stations as foci of more detailed analysis. It may also be necessary to undertake a market study to determine where high-density residential development will occur in the near future. A series of comprehensive neighborhood analyses will be needed in order to collect data on the various neighborhood attributes, which will then serve as the input to the model to determine the LES of a specific neighborhood.

While these quantitative studies are performed, it may be necessary to start building a coalition for the LEM in San Juan. Institutional partners should be sought, both locally and at the federal level. Potential partners from the public sector include the Puerto Rico Housing Department, the Federal National Mortgage Association (FNMA), and the Federal Housing Administration (FHA). Environmental agencies may also have an interest in promoting the LEM, since the LEM is likely to create environmental benefits. It is not possible to introduce the LEM without the support from the banking
industry, so the LEM coalition should seek to include mortgage bankers. There are some community-based organizations (CBOs) which specialize in developing affordable housing; they should be members of the coalition too. The final steps will involve the development of underwriting criteria for the LEM and the design of the LEM program in details.
9 APPEndix

9.1 Household and Housing characteristics in the SJMA

9.1.1 Household Income and Standard of Living

The households in the SJMA are generally wealthier than others on the island. At $11,460, the median household income in the region was 1.3 times that of the island. For home-owners the median household income was about $14,400, almost double that of renters, whose median was about $7,300. Compared with the corresponding figures for the mainland U.S., Puerto Ricans were earning much less than Americans, whose median household income in 1989 was $29,642. This is primarily due to two reasons. Firstly, the average wages in Puerto Rico is much lower than that on mainland. For instance, workers in manufacturing industries were earning about 60% of their American counterparts in 1995. (U.S. Dept. of Labor and Puerto Rico Department of Labor and Human Resources) The other reason is that more people were unemployed in Puerto Rico. The civilian unemployment rate was 20.4% for the island and 17% for the SJMA. The prices of commodities in Puerto Rico, however, are not much lower than those on mainland.\footnote{This is based on personal observations and experience of myself, Jefferey Sriver, Cathal Ridge, and many other individuals who have either visited Puerto Rico or have lived in both San Juan and Boston.} As one may expect, poverty is more severe in the Commonwealth than in the U.S, as is reflected by data from the 1990 U.S. Census. Even the relatively well-to-do SJMA has 48% of its families living in poverty.

9.1.2 Mortgage Status and Housing Cost

In spite of the poverty status in Puerto Rico, many Puerto Ricans own their homes. This is shown by the seventy-percent home-ownership rate in the SJMA. About half (49%) of the home-owners had mortgage loans and half did not. A second home
mortgage was not popular in Puerto Rico; less than 4% households had it in 1989. Among those who had home mortgage loans, close to half spent less than 20% of their household income on housing and about one-third spent 30% or more. The median was 21.7%.

9.1.3 Renters’ Housing Costs

Renters in the SJMA had to spend more on housing than home-owners. Only 28% of renters spent less than 20% of income on gross rent; 40% spent at least 35% income on gross rent. Utilities were not included in gross rent in most cases. The lower the income of the households, the larger the proportion on income spent on gross rent. This pattern is shown by the declining value of the median gross rent as a percentage of household income as income goes up. 70% of those earning less than $5,000 in 1989 paid rent which no less than 35% of their income; less than 4% of those making $20,000 or more were spending that much of their income on rent.

Table 9-1 Renters’ Housing Cost in the SJMA

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Median Gross Rent As A Percentage of Household Income</th>
<th>Households Spending at Least 35% of Household Income on Gross Rent</th>
<th>Renter Households Within This Income Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than $5,000</td>
<td>35%</td>
<td>70%</td>
<td>37.9%</td>
</tr>
<tr>
<td>$5,000 to $9,999</td>
<td>32.3%</td>
<td>44.5%</td>
<td>24.2%</td>
</tr>
<tr>
<td>$10,000 to $19,999</td>
<td>25.5%</td>
<td>24.1%</td>
<td>22.4%</td>
</tr>
<tr>
<td>$20,000 or more</td>
<td>17.2%</td>
<td>3.8%</td>
<td>15.4%</td>
</tr>
<tr>
<td>All Income Groups</td>
<td>29.4%</td>
<td>40%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Condition of Housing Units

As reported by the U.S. Census, there were a total of about 422,000 housing units in the SJMA in 1989. Over 90% were considered as sound; 7.5%, or about 32,000 units were either deteriorating, dilapidated, or had inadequate original construction. The judgment was made based on criteria dealing mainly with weather tightness, extent of
disrepair, hazards to physical safety of the occupants, and inadequate or make-shift construction. Condition was evaluated by observation. Therefore, defects which would be revealed only by a more thorough inspection by person with fairly thorough knowledge in construction were not included in the standards by which housing units were rated. Each unit was judged on the basis of its own physical characteristics, regardless of the neighborhood, the attractiveness or dreariness of the unit, the degree of crowding, the housekeeping standards of the occupants, or other considerations unrelated to the physical condition.

**Figure 9-1 Occupancy of Puerto Rico Housing Units**

<table>
<thead>
<tr>
<th>Occupancy of Puerto Rico Housing Units: 19990</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vacant Units</td>
</tr>
<tr>
<td>Renter occupied</td>
</tr>
<tr>
<td>Owner occupied</td>
</tr>
</tbody>
</table>

**Figure 9-2 Home-owners’ Housing Cost in Puerto Rico**

<table>
<thead>
<tr>
<th>Selected Monthly Housing Costs As A Percentage of Household Income in 1989 in Puerto Rico</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10%</td>
</tr>
<tr>
<td>10 to 14%</td>
</tr>
<tr>
<td>15 to 19%</td>
</tr>
<tr>
<td>20 to 24%</td>
</tr>
<tr>
<td>25 to 29%</td>
</tr>
<tr>
<td>30 to 34%</td>
</tr>
<tr>
<td>35% or more</td>
</tr>
<tr>
<td>Not computed</td>
</tr>
</tbody>
</table>
Figure 9-3 Renter’s Housing Cost in Puerto Rico

Gross Rent As A Percentage of Household Income in Puerto Rico (1989)

Note: Units which Gross Rent is not computed are excluded.

Figure 9-4 Age of Housing Stock in Puerto Rico

Year Housing Units Built in Puerto Rico

1940 and earlier 9%
1950 to 1959 13%
1960 to 1969 23%
1970 to 1979 29%
1980 to 1984 13%
1985 to 1990 13%
9.2 ANALYSIS OF HOUSEHOLD CHARACTERISTICS OF TREN URBANO ALIGNMENT

9.2.1 Study Area and Level of Analysis Defined

Unless stated otherwise, the study area in this analysis, termed "Tren Urbano corridor," is defined as the area within one-half mile radius from any Tren Urbano stations of the Phase I alignment. The analyses that follow were performed at the block group level defined by the U.S. Census Bureau. There were a total of 316 census block groups in the study area in 1989. However, not all of them were entirely within the boundary of the study area; there were some which were partially outside the study area. All the data were collected in 1989 for the 1990 Decennial Census. Because the data used were aggregated at the census block group level, one should be careful in interpreting some of the statistical indicators. The most confusing indicator is, perhaps, the median. The median value of an attribute in the following analyses refers to the median value of that attribute in one specific block group; it is not the median value of that attribute for our study area. Finding the median value of an attribute in our study area would require the raw data sets collected for every block group in the study area, which are not available to the public. As a consequence, the average of the median value of an attribute is used to give a general depiction of the picture.

9.2.2 Financial Characteristics of Households

Household Income

The median household income in the Tren Urbano corridor varied significantly. It ranged from as low as approximately $500 to as high as $75,000. The average of all the medians was about $15,300 in 1990. As shown in the following figure, about 13% of the households made less than $2,500 in 1989; 11% earned $2,500 to $4,999; roughly one-fifth made $5,000 to $9,999. Less than a quarter earned between $10,000 and $20,000, and about one-third made $20,000 or more.

1 This indicator does not adjust for the size of households, which may affect the income of the households.
Figure 9-5 Median Household Income in the Tren Urbano Corridor

Housing Value

The value of owner-occupied housing units in the Tren Urbano corridor also spanned a wide range, from the minimum at $10,000 to the maximum at about $350,000. The average of the median value was about $90,000. Roughly one-third of the units had a value of less than $60,000; one-third between $60,000 and $100,000, and the remaining one-third were valued at $100,000 or above.

Figure 9-6 Value of Housing in the Tren Urbano Corridor
Mortgage Status and Housing Cost

About 40% of all owner-occupied housing units in the study area were mortgaged. Over 60% of the home-owners with a mortgage spent less than 20% of their household income on housing. On mainland U.S., however, only 46% of home-owners spent less than 20% of their household income on housing. There may be two possible reasons explaining the disparity. Firstly, housing cost in Puerto Rico, expressed as percentage of one’s household income might indeed be lower when compared to mainland. Another reason might be that banks in Puerto Rico assumed a smaller portion of a borrower’s household income be spent on housing, therefore, setting a cap on the monthly mortgage payment. Given that an average Puerto Rican family spent about 40% of its income on transportation, it is plausible that banks would assume a smaller repayment power of borrowers.

Renter’s housing cost

Of all the occupied housing units in the study area, a little less than half (46%) were occupied by renters. The study area had an average value of median gross rent at approximately $300 per month, which did not cover utilities 90% of the time. Approximately 40% of the renters spent less than 20% of their household income on gross rent; a quarter of them spent 20 to 29%; and about one-third spent 30% or more. The lower the income of the household, the larger the proportion of income household spent on gross rent. This pattern is quite clear: over 70% of household making less than $2,500 in 1989 spent 35% or more on gross rent; about 28% of those making $5,000 to $9999 had to spent this much; and less than 4% of those earning $20,000 or more did that.

Vehicle Availability of Households

Four out of five home-owners had at least one vehicle available in their households. Half of these vehicle-owning households had at least two vehicles. Renters had fewer vehicles in general. Only 53% of them had one vehicle or more.
Means of Transportation To Work

Just as in most American cities, driving is the predominant mode of transportation to work in SJMA. It is also true for those residing in the Tren Urbano corridor, as could be inferred by the high auto ownership level. About two out of three workers drove alone to work; 15% shared the vehicle with others; those who took public transportation, including bus, público and ferryboat, summed up to less than 12%. There is tremendous potential for one to change the travel behavior of those residing in the Tren Urbano corridor.

Condition of Housing Units

Of over 113,000 housing units in the study area, about 6%, or over 7,000 units were either deteriorating, dilapidated, or inadequately constructed. Among the units considered as sound, over 10,000 were vacant.
Map 9-1 Households With Vehicles In the Tren Urbano Corridor

**LEGEND**

- Tren Urbano Phase I Alignment
- Vehicle-Owned Households
  - 0 - 25%
  - 26 - 50%
  - 51 - 75%
  - 76 - 100%

*Source: U.S. Census Bureau 1990.*

2 0 2 Miles

---

123
Map 9-2 Households Owning At Least Two Vehicles in the Tren Urbano Corridor

LEGEND
- Tren Urbano Phase I Stations
- Tren Urbano Phase I Alignment

Percentage of Households Owning At Least 2 Vehicles
- 0 - 25%
- 26 - 50%
- 51 - 75%
- 76 - 100%

Source: U.S. Census Bureau 1990.
Map 9-3 Percentage of Workers Driving Alone to Work in the Tren Urbano Corridor

LEGEND
- Tren Urbano Phase I Stations
Tren Urbano Phase I Alignment
Percentage of Workers Drove Alone
0 - 24
25 - 45
46 - 62
63 - 77
78 - 100

Source: U.S. Census Bureau 1990.
Map 9-4 Percentage of Workers Taking Transit to Work

LEGEND

- Tren Urbano Phase I Stations
- Tren Urbano Phase I Alignment

Percentage of Workers Taking Transit

- 0 - 9%
- 10 - 22%
- 23 - 40%
- 41 - 77%

Source: U.S. Census Bureau 1990.
Map 9-5 Median Housing Value Within the Tren Urbano Corridor

**LEGEND**
- Tren Urbano Phase I Station
- Boundary of Study Area
- Tren Urbano Phase I Alignment
- Median Household Income
  - 499 - 10000
  - 10001 - 15000
  - 15001 - 30000
  - 30001 - 75001

*Source: U.S. Census Bureau 1990.*
Map 9-6 Percentage of Households Spending at Least 30% Household Income on Housing

**LEGEND**
- Tren Urbano Phase I Stations
- Tren Urbano Phase I Alignment
- Unaffordable Housing Units
  - 0 - 11%
  - 12 - 28%
  - 29 - 67%
  - 68 - 100%

*Source: U.S. Census Bureau 1990.*

2 0 2 Miles

128
Map 9-7 Housing Units in Poor Condition in the Tren Urbano Corridor

LEGEND

- Tren Urbano Phase I Stations
- Tren Urbano Phase I Alignment

Percentage of Housing Units That Were Deteriorating, Delapidated, or Had Inadequate Original Construction

- 0 - 9%
- 10 - 26%
- 27 - 53%
- 54 - 88%

Source: U.S. Census Bureau 1990.

Scale: 2 Miles
### Table 9-2: Savings From Replacing Driving Trips (Subcompact Car) to Transit Trips

**Ownership and Operating Costs in Puerto Rico**

**Subcompact 1991 Model Automobiles**

**Assumptions:**
- **Sales Price in 1990 in US:** $11,481
- **Sales Price in 1990 in PR:** $14,351
- VMT/year/Household: 10,000

<table>
<thead>
<tr>
<th>ITEM</th>
<th>First Year</th>
<th>Second Year</th>
<th>Third Year</th>
<th>Fourth Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Cost</td>
<td>Cost Per Mile</td>
<td>Total Cost</td>
<td>Cost Per Mile</td>
</tr>
<tr>
<td>A) Ownership Costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td>8.33%</td>
<td>NA</td>
<td>8.33%</td>
<td>NA</td>
</tr>
<tr>
<td>Depreciation</td>
<td>$1,196</td>
<td>$11.96</td>
<td>$1,196</td>
<td>$11.96</td>
</tr>
<tr>
<td>Undepreciated Value of the car at year end</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Finance Charge</td>
<td>6.3%</td>
<td>NA</td>
<td>6.3%</td>
<td>NA</td>
</tr>
<tr>
<td>Insurance</td>
<td>400</td>
<td>2.33</td>
<td>400</td>
<td>2.33</td>
</tr>
<tr>
<td>Registration, Inspection</td>
<td>70</td>
<td>0.41</td>
<td>70</td>
<td>0.41</td>
</tr>
<tr>
<td>Total Ownership Costs</td>
<td>$2,688</td>
<td>15.65</td>
<td>$2,688</td>
<td>12.82</td>
</tr>
</tbody>
</table>

| B) Operating Costs | | | | | | | | |
| Fuel | 116 | 1.16 | 116 | 1.16 | 116 | 1.16 | 116 | 1.16 |
| Federal Fuel Tax | 61 | 0.61 | 61 | 0.61 | 61 | 0.61 | 61 | 0.61 |
| Parking & Tolls | 100 | 1.00 | 100 | 1.00 | 100 | 1.00 | 100 | 1.00 |
| Oil | 70 | 0.70 | 70 | 0.70 | 70 | 0.70 | 70 | 0.70 |
| Tires | 106 | 1.06 | 106 | 1.06 | 106 | 1.06 | 106 | 1.06 |
| Maintenance | 211 | 2.11 | 211 | 2.11 | 211 | 2.11 | 211 | 2.11 |
| Total Operating Costs | $634 | 6.34 | $634 | 6.34 | $634 | 6.34 | $634 | 6.34 |

| Total Ownership & Operating Costs (A+B) | $3,322 | 33.22 | $3,322 | 33.56 | $3,322 | 31.03 | $3,322 | 28.20 |

| Future Total Ownership & Operating Costs | $3,216 | NA | $2,880 | NA | $2,571 | NA | $2,280 | NA |

| Expenses on Alternative Transportation Mode | | | | | | | | |
| Regular trips | | | | | | | | |
| Tren Urbano/Publico Monthly Pass | 373 | NA | 373 | NA | 373 | NA | 373 | NA |
| Extra Expenditure of the second person | 13 | NA | 13 | NA | 13 | NA | 13 | NA |
| Bus | 65 | NA | 65 | NA | 65 | NA | 65 | NA |
| Occasional inter-city trips | NA | NA | NA | NA | NA | NA | NA | NA |
| Car Rental ($25 per day) | 288 | NA | 288 | NA | 288 | NA | 288 | NA |
| Occasional social activities requiring taxi-cabs | 144 | NA | 144 | NA | 144 | NA | 144 | NA |
| Total Transportation Expenses | $642 | NA | $642 | NA | $642 | NA | $642 | NA |
| Total Transportation Expenses as a Percentage of Median household income | 19.4% | NA | 19.3% | NA | 19.3% | NA | 19.3% | NA |

| Other Assumptions | | | | | | | | |
| Finance charge based on: downpayment = 73%; interest rate = 10.5%; monthly payment: 4 year repayment period | | | | | | | | |
| Parking and Tolls equal 80% of that on mainland | | | | | | | | |
| Maintenance costs increase at a rate between 5-10% between year 2 and year 12; and at a rate of 250% between year 1 and 2 (based on a FHWA study) | | | | | | | | |
| Costs of each item are from FHWA and AAA, with adjustment made for use in Puerto Rico | | | | | | | | |
| Avg MPG | 26.2 | | | | | | | |

**Transit Cost Assumptions:**
- This is a 2-person household. With a car, one member of the household would drop off the second person at a transit stop before he/she drives alone to work. Assumes that this second person would have to spend $1.50 a day, 20 days per month on journey to and from work even if the household owns a car. Without the car, he/she needs a Tren Urbano/Publico pass (she can no longer be dropped off by a car).

| Net Savings | $244 | 2.44 | $244 | 2.44 | $244 | 2.44 | $244 | 2.44 |

| Net Savings As A Percentage of Median Household Income | 21.3% | NA | 21.6% | NA | 19.4% | NA | 16.9% | NA |
Table 9-2 (Part II)

Ownership and Operating Costs in Puerto Rico
Subcompact 1991 Model Automobiles

| Assumptions: |
| Sales Price in 1990 in US = | $14,351 |
| Sales Price in 1990 in PR = | $14,351 |

VMT/year/Household

<table>
<thead>
<tr>
<th></th>
<th>Fifth Year</th>
<th>Sixth Year</th>
<th>Seventh Year</th>
<th>Eighth Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(dollar)</td>
<td>(cents)</td>
<td>(dollar)</td>
<td>(cents)</td>
</tr>
<tr>
<td><strong>Depreciation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degreciation Rate</td>
<td>8.33%</td>
<td>NA</td>
<td>8.33%</td>
<td>NA</td>
</tr>
<tr>
<td>Depreciation</td>
<td>$1,196</td>
<td>$11.96</td>
<td>$1,196</td>
<td>$11.96</td>
</tr>
<tr>
<td>Undepreciated Value of the car at year end</td>
<td>9,568</td>
<td>NA</td>
<td>8,372</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Finance Charge</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finance Charge</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Insurance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insurance</td>
<td>400</td>
<td>4.00</td>
<td>400</td>
<td>4.00</td>
</tr>
<tr>
<td><strong>Total Ownership Costs</strong></td>
<td>1666</td>
<td>1666</td>
<td>1666</td>
<td>1666</td>
</tr>
<tr>
<td><strong>Operating Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel</td>
<td>116</td>
<td>1.16</td>
<td>116</td>
<td>1.16</td>
</tr>
<tr>
<td>Federal Fuel Tax</td>
<td>61</td>
<td>0.61</td>
<td>61</td>
<td>0.61</td>
</tr>
<tr>
<td>Parking &amp; Tolls</td>
<td>100</td>
<td>1.00</td>
<td>100</td>
<td>1.00</td>
</tr>
<tr>
<td>Oil</td>
<td>37</td>
<td>0.37</td>
<td>37</td>
<td>0.37</td>
</tr>
<tr>
<td>Tires</td>
<td>74</td>
<td>0.74</td>
<td>74</td>
<td>0.74</td>
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<tr>
<td>Maintenance</td>
<td>612</td>
<td>6.12</td>
<td>612</td>
<td>6.12</td>
</tr>
<tr>
<td><strong>Total Operating Costs</strong></td>
<td>1003</td>
<td>10.03</td>
<td>1003</td>
<td>10.03</td>
</tr>
<tr>
<td><strong>Total Ownership &amp; Operating Costs (A+B)</strong></td>
<td>2669</td>
<td>26.69</td>
<td>2669</td>
<td>26.69</td>
</tr>
<tr>
<td><strong>Total Ownership &amp; Operating Costs As a Percentage of Median Household Income</strong></td>
<td>23.3%</td>
<td>NA</td>
<td>23.6%</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Future Total Ownership &amp; Operating Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total owninga and Operating Costs (sum of future ownership and operating costs)</td>
<td>20217</td>
<td>NA</td>
<td>17518</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Net Savings As A Percentage of Median Household Income</strong></td>
<td>15.6%</td>
<td>NA</td>
<td>15.6%</td>
<td>NA</td>
</tr>
</tbody>
</table>

Other Assumptions:
Finance charge based on: downpayment = 75%; interest rate = 10.5%; monthly payment; 4 year repayment period
Parking and Tolls equal 80% of that on mainland
Life-time of a vehicle = 12 years
Maintenance costs increases at a rate between 5-10% between year 2 and year 12; and at a rate of 250% between year 1 and 2 (based on a FHWA study)
Costs of each item are from FHWA and AAA, with adjustment made for use in Puerto Rico
Avg MPG = 26.2

Transit Cost Assumptions:
This is a 2-person household. With a car, one member of the household would drop off the second person at a transit stop before h(they) drive alone to work. Assumes that this second person would have to spend $1.50 a day, 20 days per month on journey to and from work even if the household owns a car. Without the car, h(they) needs a Tren Urbano/Publico pass (she can no longer be dropped off by a car).
The extra expenditure this second person would have to spend = $373-(1.5*20*12) = $13.
Ownership and Operating Costs in Puerto Rico
Subcompact 1991 Model Automobiles

Assumptions:

Sales Price in 1990 in US = $14,351
Sales Price in 1990 in PR = $14,351

<table>
<thead>
<tr>
<th>Ownership Costs</th>
<th>Ninth Year</th>
<th>Tenth Year</th>
<th>Eleventh Year</th>
<th>Twelfth Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depreciation Rate</td>
<td>8.33%</td>
<td>NA</td>
<td>8.33%</td>
<td>NA</td>
</tr>
<tr>
<td>Depreciation</td>
<td>$1,196</td>
<td>$1,196</td>
<td>$1,196</td>
<td>$1,196</td>
</tr>
<tr>
<td>Undepreciated Value of the car at year end</td>
<td>$4,784</td>
<td>$3,588</td>
<td>NA</td>
<td>$2,392</td>
</tr>
<tr>
<td>Finance Charge</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Insurance</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Registration, Inspection</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Total Ownership Costs</td>
<td>1,666</td>
<td>1,666</td>
<td>1,666</td>
<td>1,666</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operating Costs</th>
<th>Ninth Year</th>
<th>Tenth Year</th>
<th>Eleventh Year</th>
<th>Twelfth Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel</td>
<td>$116</td>
<td>$116</td>
<td>$116</td>
<td>$116</td>
</tr>
<tr>
<td>Federal Fuel Tax</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Parking &amp; Tolls</td>
<td>61</td>
<td>61</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>Oil</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tires</td>
<td>74</td>
<td>74</td>
<td>74</td>
<td>74</td>
</tr>
<tr>
<td>Maintenance</td>
<td>900</td>
<td>900</td>
<td>900</td>
<td>900</td>
</tr>
<tr>
<td>Total Operating Costs</td>
<td>1,200</td>
<td>1,200</td>
<td>1,200</td>
<td>1,200</td>
</tr>
<tr>
<td>Total Ownership &amp; Operating Costs (A+B)</td>
<td>2,866</td>
<td>2,866</td>
<td>2,866</td>
<td>2,866</td>
</tr>
</tbody>
</table>

| Percentage of Median Household Income | 25.0% | NA | 25.7% | NA | 26.5% | NA | 27.3% | NA |

<table>
<thead>
<tr>
<th>Transportation Expenses</th>
<th>Ninth Year</th>
<th>Tenth Year</th>
<th>Eleventh Year</th>
<th>Twelfth Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trans Urbano/Publico Monthly Pass for 1 person</td>
<td>373</td>
<td>373</td>
<td>373</td>
<td>373</td>
</tr>
<tr>
<td>Extra Expenditure of the second person</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Bus</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Occasional inter-city trips</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Car Rental ($1.00 per day)</td>
<td>288</td>
<td>288</td>
<td>288</td>
<td>288</td>
</tr>
<tr>
<td>Occasional social activities requiring tax-race</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Total Transportation Expenses</td>
<td>932</td>
<td>932</td>
<td>932</td>
<td>932</td>
</tr>
<tr>
<td>Total Transportation Expenses as a Percentage of Household Income</td>
<td>7.70%</td>
<td>7.70%</td>
<td>7.70%</td>
<td>7.70%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Net Savings</th>
<th>Ninth Year</th>
<th>Tenth Year</th>
<th>Eleventh Year</th>
<th>Twelfth Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>2,004</td>
<td>2,153</td>
<td>2,191</td>
<td></td>
</tr>
<tr>
<td>Net Savings As A Percentage of Median Household Income</td>
<td>17.5%</td>
<td>NA</td>
<td>18.5%</td>
<td>NA</td>
</tr>
</tbody>
</table>

Other Assumptions:
- Finance charge based on: downpayment = 75%; interest rate = 10.5%; monthly payment; 4 year repayment period
- Parking and Tolls equal 80% of that on mainland
- Life-time of a vehicle = 12 years
- Maintenance costs increase at a rate between 5-10% between year 2 and year 12; and at a rate of 250% between year 1 and 2 (based on a FHWA study)
- Costs of each item are from FHWA and AAA, with adjustment made for use in Puerto Rico
- Avg MPG = 26.2

Transit Cost Assumptions:
This is a 2-person household. With a car, one member of the household would drop off the second person at a transit stop before he/she drives alone to work. Assumes that this second person would have to spend $1.50 a day, 20 days per month on journeys to and from work even if the household owns a car. Without the car, he/she needs a Trans Urbano/Publico pass (she can no longer be dropped off by a car). The extra expenditure the second person would have to spend = $373 ($1.50*20*12) = $337.
### Table 9-3 Savings From Replacing Driving (Full-Sized Car) Trips With Transit Trips

#### Savings from Switching Transportation Mode From Driving to Taking Transit

**Full-sized 1991 Model Automobiles**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>First Year</th>
<th>Second Year</th>
<th>Third Year</th>
<th>Fourth Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Cost (dollar)</td>
<td>Cost Per Mile (cents)</td>
<td>Total Cost (dollar)</td>
<td>Cost Per Mile (cents)</td>
</tr>
<tr>
<td>A) Ownership Costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td>1,684</td>
<td>8.33%</td>
<td>1,994</td>
<td>11.94</td>
</tr>
<tr>
<td>Insurance</td>
<td>600</td>
<td>6.00%</td>
<td>900</td>
<td>6.00</td>
</tr>
<tr>
<td>Registration, Inspection</td>
<td>90</td>
<td>0.90%</td>
<td>90</td>
<td>0.90</td>
</tr>
</tbody>
</table>

**Total Ownership Costs**

- First Year: $4,127
- Second Year: $3,737
- Third Year: $3,306
- Fourth Year: $2,823

**B) Operating Costs:**

- Fuel: $116
- Federal Fuel Tax: 61
- Oil: 41
- Tires: 106
- Maintenance: 211

**Total Operating Costs**

- First Year: $638
- Second Year: $955
- Third Year: $981
- Fourth Year: $1,009

**Total Ownership & Operating Costs**

- First Year: $4,764
- Second Year: $4,692
- Third Year: $4,285
- Fourth Year: $3,832

**Future Total Ownership & Operating Costs**

- First Year: $42,993
- Second Year: $38,301
- Third Year: $34,016
- Fourth Year: $30,184

**Total Transportation Expenses**

- First Year: $882
- Second Year: $882
- Third Year: $882
- Fourth Year: $882

**Net Savings**

- First Year: $3,882
- Second Year: $3,809
- Third Year: $3,403
- Fourth Year: $2,949

**Net Savings As A Percentage of Median Household Income**

- First Year: 33.9%
- Second Year: 33.2%
- Third Year: 29.7%
- Fourth Year: 25.7%

---

**Note:**

All monetary values are expressed in 1990 constant dollar.

**Other Auto-Related Assumptions:**

- Constant depreciation of car
- Avg MPG = 18.0
- Finance charge based on: downpayment = 75%, interest rate = 10.5%, monthly payment; 4 year repayment period
- Parking and Tolls equal 60% of that on mainland
- Life-time of a vehicle = 12 years
- Maintenance costs increase at a rate between 5-10% between year 2 and year 12; and at a rate of 250% between year 1 and 2 (based on a FHWA study)
- Costs of each item are from FHWA and AAA, with adjustments made to reflect standard of living in Puerto Rico.

**Transit Cost Assumptions:**

This is a 2-person household. With a car, one member of the household would drop off the second person at a transit stop before he/she drives alone to work. Assumes that this second person would have to spend $1.50 a day, 20 days per month in transit to and from work even if the household owns a car. Without the car, he/she needs a Tren Urbano/Publico pass he/she can no longer be dropped off by a car). The extra expenditure the second person would have to spend = $373-(81.5*20)= $13.
Table 9-2 (Part II)

Full-sized 1991 Model Automobiles

### Basic Assumptions:

Sales Price in 1990 in US = $22,230
Sales Price in 1990 in PR = $22,230

### VMT/year/Household

<table>
<thead>
<tr>
<th>Item</th>
<th>Fifth Year</th>
<th>Sixth Year</th>
<th>Seventh Year</th>
<th>Eight Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depreciation</td>
<td>$1852.50</td>
<td>$1852.50</td>
<td>$1852.50</td>
<td>$1852.50</td>
</tr>
<tr>
<td>Finance Charge</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Insurance</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
<td>$600</td>
</tr>
<tr>
<td>Registration, Inspection</td>
<td>$90</td>
<td>$90</td>
<td>$90</td>
<td>$90</td>
</tr>
<tr>
<td><strong>Total Ownership Cost</strong></td>
<td>$2,543</td>
<td>$2,543</td>
<td>$2,543</td>
<td>$2,543</td>
</tr>
</tbody>
</table>

### Operating Costs:

<table>
<thead>
<tr>
<th>Item</th>
<th>Fifth Year</th>
<th>Sixth Year</th>
<th>Seventh Year</th>
<th>Eight Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel</td>
<td>$116</td>
<td>$116</td>
<td>$116</td>
<td>$116</td>
</tr>
<tr>
<td>Federal Fuel Tax</td>
<td>$61</td>
<td>$61</td>
<td>$61</td>
<td>$61</td>
</tr>
<tr>
<td>Parking &amp; Tolls</td>
<td>$103</td>
<td>$103</td>
<td>$103</td>
<td>$103</td>
</tr>
<tr>
<td>Oil</td>
<td>$41</td>
<td>$41</td>
<td>$41</td>
<td>$41</td>
</tr>
<tr>
<td>Tires</td>
<td>$106</td>
<td>$106</td>
<td>$106</td>
<td>$106</td>
</tr>
<tr>
<td>Maintenance</td>
<td>$612</td>
<td>$612</td>
<td>$612</td>
<td>$612</td>
</tr>
<tr>
<td><strong>Total Operating Cost</strong></td>
<td>$1038</td>
<td>$1038</td>
<td>$1038</td>
<td>$1038</td>
</tr>
</tbody>
</table>

### Total Ownership & Operating Costs:

<table>
<thead>
<tr>
<th>Year</th>
<th>Fifth Year</th>
<th>Sixth Year</th>
<th>Seventh Year</th>
<th>Eight Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Ownership &amp; Operating Costs</td>
<td>$28,571</td>
<td>$28,571</td>
<td>$28,571</td>
<td>$28,571</td>
</tr>
<tr>
<td>As a Percentage of Median Household Income</td>
<td>31.2%</td>
<td>NA</td>
<td>31.5%</td>
<td>NA</td>
</tr>
<tr>
<td>Future Total Ownership &amp; Operating Costs</td>
<td>$26,603</td>
<td>NA</td>
<td>$22,992</td>
<td>NA</td>
</tr>
<tr>
<td>As a Percentage of Median Household Income</td>
<td>32.3%</td>
<td>NA</td>
<td>32.3%</td>
<td>NA</td>
</tr>
</tbody>
</table>

Note:
All monetary values are expressed in 1990 constant dollar.

Other Auto-Related Assumptions:
- Constant depreciation of car
  Avg MFG = 18.0
- Finance charge based on: downpayment = 75%; interest rate = 10.5%; monthly payment; 4 year repayment period
- Parking and Tolls equal 80% of that on mainland
- Life-time of a vehicle = 12 years
- Maintenance costs increase at a rate between 5-10% between year 2 and year 12; and at a rate of 250% between year 1 and 2 (based on a FHWA study)
- Costs of each item are from FHWA and AAA, with adjustments made to reflect standard of living in Puerto Rico.

### Transit Cost Assumptions:
- This is a 2-person household. With a car, one member of the household would drop off the second person at a transit stop before he/she drives alone to work. Assumes that this second person would have to spend $1.50 a day, 20 days per month to journey to and from work even if the household owns a car. Without the car, he/she would have to spend $373 (i.e., $373/20) = $18.70.
- This extra expenditure the second person would have to spend = $373 (i.e., $373/20) = $18.70.

### Transportation Expenses:

<table>
<thead>
<tr>
<th>Year</th>
<th>Fifth Year</th>
<th>Sixth Year</th>
<th>Seventh Year</th>
<th>Eight Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transit Cost</td>
<td>$26,603</td>
<td>$22,992</td>
<td>$19,336</td>
<td>$15,631</td>
</tr>
<tr>
<td>As a Percentage of Median Household Income</td>
<td>31.2%</td>
<td>NA</td>
<td>31.5%</td>
<td>NA</td>
</tr>
<tr>
<td>Future Total Transportation Expenses</td>
<td>$26,603</td>
<td>NA</td>
<td>$22,992</td>
<td>NA</td>
</tr>
<tr>
<td>As a Percentage of Median Household Income</td>
<td>32.3%</td>
<td>NA</td>
<td>32.3%</td>
<td>NA</td>
</tr>
</tbody>
</table>

### Net Savings:

<table>
<thead>
<tr>
<th>Year</th>
<th>Fifth Year</th>
<th>Sixth Year</th>
<th>Seventh Year</th>
<th>Eight Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Savings</td>
<td>$2,699</td>
<td>$2,729</td>
<td>$2,774</td>
<td>$2,822</td>
</tr>
<tr>
<td>As a Percentage of Median Household Income</td>
<td>23.5%</td>
<td>NA</td>
<td>23.8%</td>
<td>NA</td>
</tr>
</tbody>
</table>

Note:
All monetary values are expressed in 1990 constant dollar.
Table 9-2 (Part III)

**Savings from Switching Transportation Mode From Driving to Taking Transit**

<table>
<thead>
<tr>
<th>Full-sized 1991 Model Automobiles</th>
</tr>
</thead>
</table>

**Basic Assumptions:**
- Sales Price in 1990 in US = $22,230
- Sales Price in 1990 in PR = $22,230
- VMT/yr/Household = 10,000

<table>
<thead>
<tr>
<th>Ninth Year</th>
<th>Tenth Year</th>
<th>Eleventh Year</th>
<th>Twelfth Year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ITEM</strong></td>
<td><strong>Total Cost</strong></td>
<td><strong>Cost Per Mile</strong></td>
<td><strong>Total Cost</strong></td>
</tr>
<tr>
<td><strong>A. Ownership Costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation Rate</td>
<td>8.33%</td>
<td>NA</td>
<td>8.33%</td>
</tr>
<tr>
<td>Depreciation</td>
<td>$1852.50</td>
<td>$18.53</td>
<td>$1852.50</td>
</tr>
<tr>
<td>Finance Charge</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>Insurance</td>
<td>600</td>
<td>6.00</td>
<td>600</td>
</tr>
<tr>
<td>Registration, Inspection</td>
<td>90</td>
<td>0.90</td>
<td>90</td>
</tr>
<tr>
<td><strong>Total Ownership Costs</strong></td>
<td>$2,543</td>
<td>25</td>
<td>$2,543</td>
</tr>
<tr>
<td><strong>B. Operating Costs:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel</td>
<td>116</td>
<td>1.16</td>
<td>116</td>
</tr>
<tr>
<td>Federal Fuel Tax</td>
<td>61</td>
<td>0.61</td>
<td>61</td>
</tr>
<tr>
<td>Parking &amp; Tolls</td>
<td>103</td>
<td>1.03</td>
<td>103</td>
</tr>
<tr>
<td>Oil</td>
<td>41</td>
<td>0.41</td>
<td>41</td>
</tr>
<tr>
<td>Tires</td>
<td>106</td>
<td>1.06</td>
<td>106</td>
</tr>
<tr>
<td>Maintenance</td>
<td>809</td>
<td>8.09</td>
<td>809</td>
</tr>
<tr>
<td><strong>Total Operating Costs</strong></td>
<td>$1,236</td>
<td>12.36</td>
<td>$1,317</td>
</tr>
<tr>
<td><strong>Total Ownership &amp; Operating Costs</strong></td>
<td>$3,778</td>
<td>37.78</td>
<td>$3,869</td>
</tr>
</tbody>
</table>

**Future Total Ownership & Operating Costs**:
- As a Percentage of Median household Income: 33.0% NA 33.7% NA 34.5% NA 35.3% NA

**Total Ownership & Operating Costs as a Percentage of Median household Income**: 7.70% NA 7.70% NA 7.70% NA

**Net Savings**:
- As a Percentage of Median Household Income: 25.3% NA 26.0% NA 26.8% NA 27.6% NA

**Note**
- All monetary values are expressed in 1990 constant dollar.

**Other Auto-Related Assumptions**
- Constant depreciation of car
- Avg MPG = 18.0
- Finance charge based on: downpayment = 75%; interest rate = 10.5%; monthly payment; 4 year repayment period
- Parking and Tolls equal 80% of that on mainland
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- and at a rate of 250% between year 1 and 2 (based on a FHWA study)
- Costs of each item are from FHWA and AAA, with adjustments made to reflect standard of living in Puerto Rico.

**Transit Cost Assumptions**
- This is a 2 person household. With a car, one member of the household would drop off the second person at a transit stop before he/she drives alone to work. Assummes that this second person would have to spend $1.50 a day, 20 days per month on journey to and from work even if the household owns a car. Without the car, he/she needs a Tren Urbano/Publico pass he/she can no longer be dropped off by a car. The extra expenditure this second person would have to spend = $373-($1.5*20*12) = $13.

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BIBLIOGRAPHY


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Multisystems, Inc. 1996. Short-Range Transit Center Plan. (Prepared for the Puerto Rico Highway and Transportation Authority)


Salvucci, Frederick. 1998. Personal Interview.


