**The Potential Economic Development Opportunities of Tren Urbano**

by

Daniel J. Freire Coloma

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Submitted to the Department of Urban Studies and Planning
and the Department of Civil and Environmental Engineering
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Master of Science in Transportation

and

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Signature of Author_____
Department of Urban Studies and Planning
May 21, 1998

Certified by_
Joseph M. Sussman
JR East Professor
Professor of Civil and Environmental Engineering
Thesis Supervisor

Certified by___
Alvaro E. Pereira
Department of Urban Studies and Planning, Visiting Lecturer
Thesis Supervisor

Accep
Joseph M. Sussman
Chairman, Departmental Committee on Graduate Studies
Department of Civil and Environmental Engineering

Accepted b
Lawrence S. Bacow
Chair, MCP Committee
Department of Urban Studies and Planning

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ABSTRACT

This thesis intends to show that urban rail can foster local and regional economic development and identifies those factors that can be changed to maximize its economic development benefits.

This research identifies the potential economic benefits from the construction and operation of an urban rail system. These benefits are related to urban rail's ridership levels and the densification it promotes. Urban rail forms part of a broader urban and economic system and its ridership levels and the densification that it encourages depend on the urban characteristics of the metropolis, the design of the system and its operations, and on local policies such as zoning. Based on the literature and on the study of three recent U.S. urban rail systems: Metrorail in Miami-Dade County, BART in the San Francisco Bay area, and Metro in the District of Columbia metropolitan area, the most important urban factors that affect urban rail's ridership and densification impacts are identified.

The lessons from the literature and from these three systems are applied to Tren Urbano (TU), a heavy rail system that is scheduled to begin its operations in San Juan Metropolitan Area (SJMA), Puerto Rico in 2001. After considering SJMA's characteristics, recommendations are made to change zoning policies, reduce auto-dependency, modify SJMA's economic structure, and several other factors. The implementation of these recommendations will help maximize the economic benefits of TU.

Thesis Advisor: Dr. Joseph M. Sussman
Title: JR East Professor
Professor of Civil and Environmental Engineering

Thesis Advisor: Dr. Alvaro E. Pereira
Title: Department of Urban Studies and Planning, Visiting Lecturer

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# 1 Introduction

Throughout history, urban rail has proven its capacity to change not only the shape of the metropolis where it has been built, but more importantly, the economy. New York, London, and Paris are three world class metropolis that would have not been able to sustain their high levels of economic activity without their urban rail systems. Urban rail systems servicing these and many cities in the United States (U.S.) flourished in the first decades of the twentieth century. In those years, urban rail was the leading transportation mode, and it was a major force that shaped metropolises, guiding their growth along the alignment of their systems. It was in the beginning of the century that Collis Huntington, a transit and real estate developer in Los Angeles, said[1]:

> *" It would never do for an electric line to wait until demand for it came. It must anticipate the growth of communities and be there when the homebuilders arrive-- or they are likely not to arrive at all, but go to some section already provided with arteries of traffic."*

In the 30s, the automobile began to play an increasingly important role, and in the following years, especially after World War II, it became the major force shaping the urban and suburban landscape. By then, Huntington's words were no longer valid; the electric line he spoke of was replaced by the *highway*. Urban rail lost its predominant role and unique capacity to affect urban and economic activities in favor of the car. However, as we will be discussing in the following chapters, despite having lost its predominant role, urban rail still has the capability to affect the shape and economy of a metropolis.

[1] Spencer Crump, Ride the Big Red Cars, Los Angeles: Crest Publications, 1962. As cited by Bernick and Cervero, p.21, 1997.

## 1.1 Background

The shape of any metropolis and the presence and evolution of its different economic activities is influenced by various elements. One of the most important is transportation. Economic agents locate relatively close together to benefit from the advantage of urbanization economies. They will do so to increase their accessibility to jobs, if they are job seekers, or to workers, if they are employers. As these areas become more densely populated, a greater variety of products, jobs, and services becomes available. As transportation technologies and transportation infrastructure improve, the monetary and time costs of moving people and goods diminish. This permits further growth of the metropolitan area, and it changes its relationship with the surrounding areas.

Tren Urbano (TU), a 17.2 kilometer urban rail system, will be built in San Juan, Puerto Rico's capital. TU will increase accessibility that will directly and indirectly affect the way in which economic agents conduct their activities. In addition, TU will bring changes that go far beyond the creation of jobs during the construction period. Once operations commence, TU is expected to reduce travel time for transit users and perhaps for automobile drivers. Increased accessibility to the station areas is likely to bring changes in land prices owing to a greater demand for residential and economic activities, including retail, entertainment, and office activity. Also, densification around stations is likely to occur.

There will also be effects that take place as a result of the transit system but do not occur in the physical proximity of the system. For example, we can expect to see the development and export of knowledge. Puerto Ricans exposed to modern techniques for the planning and construction of urban rail may be able to compete in the Latin-American market, but their offices can be located anywhere in the island. Therefore, the direct benefit of their contracts will occur in the areas where their activity takes place, not necessarily within San Juan Metropolitan Area (SJMA).

In the longer term, other effects could occur as a consequence of TU. For instance, households may want to be located close to the stations to reduce their travel time and be better connected to the rest of the SJMA. Retailers may want to be close to those areas as well because of increases in the flow and accessibility of potential clients. Firms may also want to locate close to the stations so as to be more accessible to their clients, and/or to their workers. For different activities some locations may become more attractive than others. These changes may influence the demand for land. The interaction of these forces and land use regulations is likely to bring new land use patterns. More efficient uses of land, with greater densities and mixed uses, might increase the productivity of the SJMA, while reducing pollution, expenses in urban infrastructure, commuting time, etc. Additionally, improvements in the quality of life in the city, combined with an improved labor market, could also attract new investors.

If these changes are of sufficient magnitude they can bring noticeable changes to the economic performance of various economic agents throughout the island. Improvements in performance could then positively influence the economy of the SJMA. These impacts will not be limited to areas close to stations. Gains in efficiency, the creation of a more attractive city, and so forth, could have a positive impact not only on the SJMA but on the entire Commonwealth of Puerto Rico.

It will be a great advantage to be able to anticipate the potential impacts of TU and understand the causal relationship between urban rail and its economic impacts. Then it will be possible to design actions for TU and related policies in order to enhance the quality of life and economic competitiveness of San Juan.

## 1.2 Motivation

Despite the past and present importance of urban rail systems, and their significant contribution to their local and regional economies, there has been little research on this topic. Most of the research that has been done on the economic impacts of transportation

has been centered on the aggregate national effects of transportation infrastructure as a whole. However, some studies have centered on specific regions or on certain transportation elements. In most of the cases it has been highways that have been analyzed, while urban rail has received little attention.

Among the research studies that have been conducted on the economic impacts of urban rail, we did not find studies that had conducted a comprehensive analysis of the different economic impacts of urban rail. In general, we found that these studies only considered part of urban rail's economic impacts.

The economic role of cities is growing, and regions and countries are increasingly dependent on their economic performance. It is precisely now, when cities are becoming so important for the world economy, that traffic, congestion, and environmental degradation are limiting the economic growth of our cities and nations. It appears that we have reached a level at which the car alone cannot support the fast growth in demand for personal mobility in many cities. In this context, urban rail can be one of the elements that can and should be used to facilitate the sustainable growth of our economies.

Despite urban rail's potential economic benefits, recent U.S. experiences tend to indicate that urban rail systems are not capable of fulfilling the expectations that are placed upon them. It is in this context that we have perceived the need for a better understanding of the effects and the causal relationship linking the construction and operation of an urban rail system with its economic impacts; and more importantly, a better understanding of the factors that can determine the success or failure of an urban rail system from an economic perspective.

## 1.3 Objectives

The purpose of this research is to identify and understand the potential economic impacts of TU as well as the urban characteristics, urban rail system design and operating variables, and local policies that can influence these economic impacts. Given the fact that the alignment of TU has been already decided, we are concerned with those local policies and TU's operating variables that we can control and that can have the greatest influence on TU's economic impacts. Our concern is learning how to maximize TU's economic return and not to determine whether TU is the best investment.

The first step of this research is to identify local and regional economic impacts of urban rail and how they take place. The following step is to identify and understand the different factors that can affect the magnitude of these economic impacts. These factors can be grouped into three different categories: urban characteristics of the metropolis, urban rail system design and operating variables, and local policies. Of these factors, we will be mainly interested in those that can be used as tools to maximize TU's economic impact; namely, the operating variables (such as frequency and reliability of the service) and the local policies (such as zoning and parking policies), because they can be altered in the short run. By considering several case studies of metropolitan areas, we will relate the characteristics of urban areas and urban rail systems to the success of various tools. Finally, we will propose actions involving one or more tools to maximize the positive economic impacts of TU, while minimizing the negative economic impacts.

Several questions must be answered. What is the nature of the impacts that a fixed rail facility can have? Are these impacts limited to the area immediately adjacent to the stations and the right of way, or do the impacts have a broader geographical scope? What are the factors that will determine the impact of an urban rail facility? Which of these factors can we influence? Of the factors that we can influence, which will have the greatest positive impact? How do we maximize that positive impact?

We want to note that it will not be our goal to determine

## 1.4 Outline

In answering these questions, this thesis can be divided into two parts. In the first part, based on our review of the literature on urban rail economic impacts, we will analyze three urban rail systems: BART in San Francisco Bay Area, Metro in the Washington DC metropolitan area, and Metrorail in Miami-Dade County. In the second part, based on the results from the first part, we will proceed to analyze TU. The thesis chapters will consist of the following:

**Chapter 1, Introduction:** This chapter includes the introduction, motivation and objectives of the thesis.

**Chapter 2, Literature Review:** This chapter provides a review of the literature on the economic impacts of transportation infrastructure and of urban rail.

**Chapter 3, Urban Rail and Population Densities:** In this chapter, we analyze population density, which in our opinion, is one of the most important factors for the success of an urban rail facility. We discuss the elements that affect population densities, their historical evolution, and their social, psychological, and health impacts on human populations.

**Chapter 4, The Potential Economic Benefits of Urban Rail:** We describe urban rail potential economic impacts and the causal link between the construction and operation of urban rail systems, their ridership, their densification effects, and their economic impacts.

**Chapter 5, Factors Affecting Urban Rail Success: Lessons from Miami, San Francisco, and Washington DC:** In this chapter, we characterize BART, Metro and Metrorail urban rail systems and their metropolitan areas. Based on this

characterization, we assess the importance of the different factors that affect urban rail's success, and we identify the tools that can be used to maximize its success.

**Chapter 6, The Case of Tren Urbano:** This chapter describes the Puerto Rican and San Juan Metropolitan Area (SJMA) economic structure and discusses the potential economic impacts of TU.

**Chapter 7, Conclusions and Recommendations:** It provides a list of recommendations that will help maximize TU's economic impacts.

**Chapter 8, Summary, Findings, and Areas for Future Research:** In this chapter we summarize the major findings of this research and we include a list of future research topics that would further extend our work.

# 2 Literature Review

This chapter will review the literature on the economic impacts of transit and on the factors that can affect urban rail's success. We will discuss transportation infrastructure and urban rail and the factors that affect urban rail's viability, and consequently its economic impacts. These factors have been classified into three groups: urban characteristics, system design and operating variables, and local policies.

## 2.1 Economic Impacts

Literature on transit's economic benefits can be divided into two main groups: those studies that focus on the aggregate economic effects of transportation infrastructure and their measurement, and those that concentrate on the local and regional impacts that transit has on the economy, quality of life, land uses, etc. The goal of this second group of studies is to provide a qualitative discussion of the major impacts of urban rail rather than a quantitative review.

### 2.1.1 Aggregate Studies

There is a common agreement that infrastructure affects economic output in a variety of ways[2]. On the one hand, the availability of infrastructure has direct effects on the economy, enabling increases in production either as a direct input in the production function or because its ability to make other inputs, such as labor and capital, more productive. Increases in the availability of transportation or reductions in its cost may

[2] Michael Bell, Therese McGuire, "Macroeconomic Analysis of the Linkages Between Transportation Investments and Economic Performance," National Cooperative Highway Research Program, Transportation Research Board, Report 389, 1997.

enable firms to switch to more productive and efficient technologies, such as just-in-time technologies, that reduce the level of inventories held by firms[3].

Infrastructure also has indirect effects on an economy's production level. Better or cheaper infrastructure may attract investment and labor from other places. This movement of resources may be desirable from the perspective of the receiving region, though the national economy may lose or gain depending on each particular case[4].

Much of the research has concentrated on the direct effects of transportation. Aschauer[5] and Munnell[6] regression analysis studies conclude that public infrastructure is highly productive. Aschauer asserts that public infrastructure contribution to growth is much greater than that of private investment. Moreover, he states that part of the decline in productivity that occurred in the U.S. in the 70s could be explained by the reduced rate in public capital accumulation during those years. Munnell comes to the same conclusions, though her estimates of public infrastructure contribution to growth are lower.

An important criticism of their argument is the possibility of reverse causality, considering growth in infrastructure investment the effect rather than the cause of economic growth[7].

Nadiri and Mamumeas[8] as well as Glen Weisbrod and James Beckwith[9] researched the economic development impacts of a particular type of infrastructure, highways. Nadiri and Mamumeas, using regression analysis techniques, concluded that highway capital contributed significantly to the economic growth and productivity of the U.S., and found

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[3] Ibid. 2
[4] Ibid. 2
[5] David Aschauer, "Genuine Economic Returns to Infrastructure Investment," Policy Studies Journal, Vol. 21, No. 2, 1993.
[6] Alicia Munnell, "Policy Watch: Infrastructure Investment and Economic Growth," The Journal of Economic Perspectives, Vol. 6, No. 4, 1992.
[7] Ibid. 2
[8] Ishaq Nadiri, Theofanis Mamuneas, "Highway Capital and Productivity Growth," Eno Transportation Foundation, June 1996.
[9] Glen Weisbrod, James Beckwith, "Measuring Economic Development Benefits for Highway Decision-making: The Wisconsin Case," Transportation Quarterly, Vol. 46, No. 1, January 1992.

that the contribution to productivity growth is positive in almost all industries. They estimated that the average rate of return for a highway investment was 28 percent for the period from 1950 to 1989.

Weisbrod and Beckwith's research is different from the previous because of three main reasons. First, this study is "ex ante;" the objective is to estimate the impact of different highway construction alternatives to choose the one with the greatest returns. Second, they do not only consider the direct benefits of highway investments like travel time savings, but also the indirect effects that highway investment can have in the region, like increased investment and greater attraction of tourists. Third, instead of resorting to regression analysis, they use a modeling program that can estimate the impacts of different economic decisions, REMI (Regional Economic Modeling Inc.). REMI uses an input-output model of the state economy to estimate the indirect and induced impacts on the economy given the direct impacts. This program also estimates the relative costs of doing business in the state compared to elsewhere. REMI, provides information on the direct economic impacts of the different highway construction options, and it estimates the final economic impacts of each option in terms of economic and employment changes.

Even though research has provided interesting results, there still are several shortcomings of the current research[10]:

- Infrastructure is only quantified as the portion that is provided by the public sector and this portion varies among states, depending on the degree of participation of the private sector.

- Some of the benefits of transportation, such as time savings and health care cost savings are not included in these aggregate studies.

[10] Ibid. 2

- There is a need for studies that provide a good understanding of the linkages between public capital and private economic activity. "Current research has failed to explore the micro foundations of the macro findings sufficiently."

- Research has not paid much attention to the disaggregate effects of different types of public capital, such as mass transit.

- There is little known about the ways in which private firms use and benefit from public infrastructure.

### 2.1.2 Studies Addressing Local and Regional Effects

One justification for investing in transit has been its potential to contribute to the economic growth of cities. The potential economic impacts of urban rail can be grouped into three major categories:

- Creation and stimulation of economic growth
- Lower consumption of resources and greater environmental sustainability
- Greater attractiveness of cities

#### 2.1.2.1 Creation and Stimulation of Economic Growth

Changes in accessibility can result in greater levels of efficiency and higher productivity. This improvement in accessibility is of special importance in highly congested downtown cores[11]. Consequently, one of the main reasons for the construction of an urban rail facility is often the need to increase capacity of congested corridors. Some authors, like Townroe[12] in his study on the construction of an urban rail system in Sheffield, consider this reduction in congestion as one of the major benefits brought by these transportation

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[11] Roanne Neuwirth, "Economic impact of Transit on Cities," p. 143. Transportation Research Record, No.1274. 1990.

[12] Peter Townroe, "The Coming of Supertram: The Impact of Urban Rail Development in Sheffield," pp. 162-181. Transport and Urban Development, Edited by David Banister, 1995.

projects. However, the benefits of urban rail go beyond reductions in travel time, as Neuwirth explains in greater detail:

> *" Difficulties for employees, residents, and clients in accessing downtowns are increasing and are causing constraints on economic growth and threatening the loss of businesses from the urban core....transit investment has been seen as a positive factor for retaining or improving downtown access and as a significant contributor for maintaining and expanding downtown economies."*

Reductions in congestion and improvements in accessibility have the potential to bring additional benefits. One of the most significant potential impacts of urban rail is its capacity to positively affect the employment market. First, jobs are created during the construction of the system[13]. Second, and more importantly, the improved accessibility it brings allows for an expansion of the labor market[14]. This impact on the labor market will benefit both workers and employers[15]. Employers will benefit by the possibility of recruiting from a larger pool of workers. The economic performance of cities will benefit from an increase in the number of firms they workers can have access to, enabling them to find a more suitable and/or better paying job[16]. An opposite position is held by Semmens[17], who argues that if in the U.S. the money invested in transit had been diverted to finance tax cuts, 7 million jobs would have been created instead of the 0.9 million created by transit. However, he only considers direct jobs created by transit, ignoring other important benefits of transit that ultimately translate into the creation of additional jobs in other sectors of the economy.

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[13] USDOT, "The impact of BART on Economics and Finance (Interpretive Summary of the Final Report)", December 1979.
[14] David Banister and Nathaniel Lichfiled, "The Key Issues on Transport and Urban Development," pp. 1-16. Transport and Urban Development, Edited by David Banister, 1995.
[15] Ibid. 12
[16] Rémy Prud'homme, "Urban Transportation and Economic Development," Observatorire de l'Economie et des Institutions Locales, Working Paper 96-04. January 1996.
[17] John Semmens, "Is Public Transit a Good Investment," Volume 2, pp. 654-677. Proceedings of the 39th Annual Meeting of the Transportation Research Forum, Montreal, Canada, October 16-18,1997.

Retail and consumer business services may also benefit from urban rail because of the improved consumer access and pass-by traffic at station areas[18]. Providers of non-commercial activities such as schools and hospitals can also attain greater economies of scale by concentrating their facilities[19]. As noted by Neuwrith, another important benefit of urban rail is that it permits higher densities and greater concentration of activities, which reduces in transaction costs.

#### 2.1.2.2 Lower Consumption of Resources and Greater Environmental Sustainability

The construction of urban rail reduces the need to build highway infrastructure,[20] and more importantly, it can support greater densities than the auto-city. The higher density transit city is more economically efficient, requiring less inputs of natural resources and producing less waste output while improving livability[21]. Moreover, the transit city, by directing a higher proportion of its capital accumulation into industrial activities,[22] has lower infrastructure and public services costs, as well as lower energy consumption[23].

Another important contribution urban rail makes to the sustainability and livability of cities is the reduction in air pollution that it can bring[24]. Semmens, with a different perspective, suggests that public transit is more polluting per passenger moved because of its low load factors. Semmens is comparing private cars with under-utilized public transit. If we compared private cars with public transit having greater load factors, the result would

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[18] Glen Weisbrod, "Distinguishing Widé and Local Area Business Impacts of Transportation Investments," Transportation Research Record, No.1552, 1996.
[19] International Metropolitan Railways Committee "Benefit Sharing: The Funding of Urban Transport Through Contributions from External Beneficiaries," 1987.
[20] Phillip Shinbeing and Jeffrey Adler, "Land Use and Rail Transit," Transportation Quarterly, Vol.49 No. 3, Summer 1995.
[21] Peter Newman "Sustainability and Density: What is the Link?" UDIA Conference, Sydney, March 1994.
[22] Peter Newman, Jeff Kenworthy and Felix Laube, "The Global City and Sustainability - Perspective from Australian Cities and a Survey of 37 Global Cities," 5th International Workshop on Technological Change and Urban Form, Jakarta, Indonesia, June 1997.
[23] Ibid. 20
[24] Ibid. 21

favor transit and the environment. From Semmens' affirmations, it can be even concluded that a more environmentally friendly solution would be for a greater number of auto users to switch to public transit.

#### 2.1.2.3 Greater Attractive of Cities

The construction of an urban rail facility can increase the attractiveness of a city by creating a world-class city image[25]. Urban rail could have a positive impact on the city's citizens, becoming a symbol of civic pride while sending the message of a serious intent of sponsor regeneration and bring reassurance to local investors. In a global economy, where cities are increasingly competing for footloose investment, urban rail can be used as a marketing tool to attract external investors. This is supported by the evidence collected by Newman, Kenworthy, and Laube, confirming that global businesses are attracted by parks and pedestrian areas, something that is generally viable in high density, transit based cities (Newman et al. 1997). Furthermore, their study for the World Bank suggests that "one of the areas of competitive advantage in global cities is the extent of their transit systems."

## 2.2 Urban Characteristics

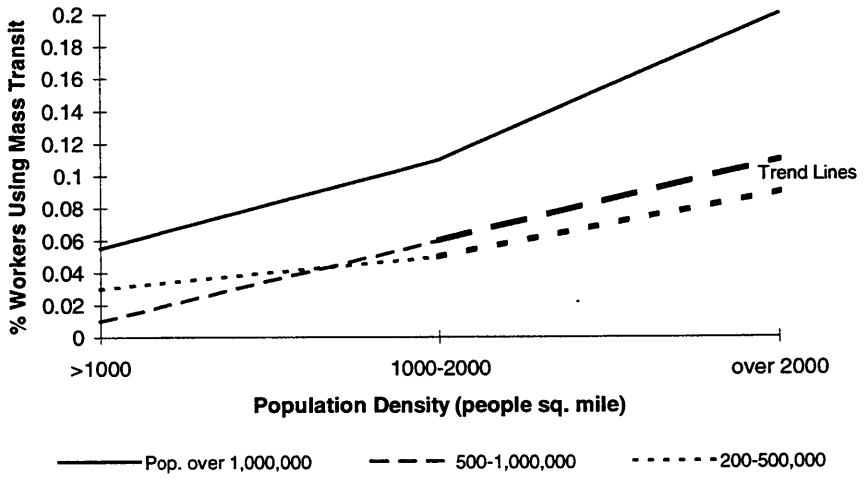
Urban rail is constructed to satisfy the transportation needs of the population that develops its activities in a certain urban area. Depending on the characteristics of the area the benefits and viability of urban rail will vary. Some of the characteristics cannot be changed at all; other characteristics, like population density, may be changed through different policies and incentives. However, in the short-run, all these characteristics will remain constant, and only some of them may vary in the long run if adequate policies are implemented. For the maximization of urban rail's ridership levels the most important urban characteristics are described below.

[25] Ibid. 11

### 2.2.1 Population

One of the necessary conditions for the success of urban rail is the existence of a high-demand corridor which cannot be served by bus transport alone[26]. Urban rail is an expensive piece of infrastructure, and it should provide transportation for sufficient passengers to justify this investment in economic terms. Moreover, according to Rosenbloon and Clifton[27], the population of a metropolitan area is more predictive of higher transit use than its density.

**Figure 2-1 The Relationship of Transit Use to City Size and Density. AHL 1991**




Source: Rosenbloom and Clifton 1996

### 2.2.2 Population Density

Population size is a key determinant, but a large population is not sufficient to ensure the success of an urban rail facility. A large population will generate a large number of trips, but if these trips are dispersed over a vast area, urban rail will be of limited use. Urban rail is a fixed facility; if trips are not concentrated in the corridors it serves, it will only be used by a limited number of riders.

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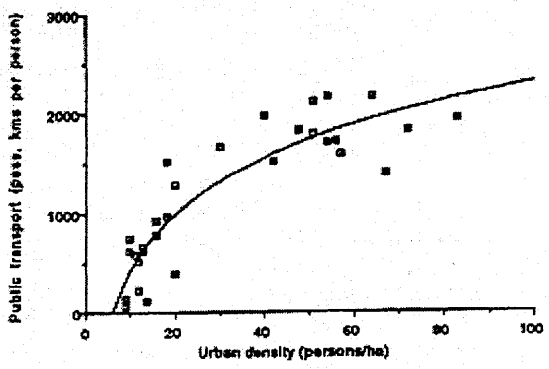
[26] P. R Fouracre and G. Gardner, "Mass Transit in Developing Cities," Journal of Advanced Transportation, Vol. 27 No. 3, pp.251-260, 1993.

[27] Sandra Rosenbloom and Kelly Clifton, "The Puzzle of Income, Race, and Density: Preliminary Evidence on Transit Use from the 1991 American Housing Survey," Journal of Public Transportation, Fall 1996.

We will define population density as the number of people that live and work within a square mile. Population densities can be divided into residential and employment densities. The importance of population densities for the success and viability of urban rail stem from an existing positive relationship between densities and transit use; Figure 2-2 shows this relationship[28]. It has been found that when residential densities rise from 7 to 30 dwelling units per acre, transit ridership can triple[29]. In addition, a 1990 study conducted on BART, the urban rail system that serves the San Francisco Bay Area, showed that an increase in 10 workers for a radius of 1 to 2 miles of a BART station increased ridership by 6.5 per 1000[30]. As population densities decrease there will be a reduction in pedestrian mobility, an increase in trip lengths, and a reduction in the catchment populations for public transport[31].

**Figure 2-2 Relationship Between Densities and Transit Use**




Source: Newman 1993

[28] Peter Newman, Jeffrey Kenworthy and Peter Vintila, "Can we overcome Automobile dependence? Physical Planning in an Age of Urban Cynicism," Cities, Vol. 12. No. 1, 1995.
[29] King Cushman, "Exploring the land development and Transit Connection," Transit, Land Use, and Urban Form, Center for the Study of American Architecture, School of Architecture, University of Texas in Austin, 1988.
[30] Bernick and Cervero, Transit Villages in the 21st Century, McGraw Hill, 1997.
[31] Peter Newman, "Reducing Automobile Dependence," Environment and Urbanization, Vol. 8, No. 1, April 1996.

Densities in these corridors should reach certain levels before urban rail can become viable. According to Peter Newman and Trevor Hogan, urban densities should be at least 40 persons per hectare[32].

### 2.2.3 Income

For the success of an urban rail facility, the existence of a certain population size and population density is not sufficient. An additional requirement is that a minimum income level should have been attained by its population. The construction of urban rail is very expensive regardless of the development level of the country where it is constructed[33]. This is because the materials and technology that are required are very costly and generally provided by the same vendors, and there is a relatively low proportion of local labor in the total cost. Hence, urban rail costs do not vary significantly with city income. Meanwhile, urban rail benefits do vary with income levels. As the level of economic development increases, the value of time and the cost of labor intensive goods and services rises. Therefore, the positive effects or urban rail such as time savings, infrastructure savings, and health improvements will increase as income levels rise. Therefore, the economic viability of these systems strongly depends on the city income.

If a city is to build an urban rail facility, it should have both an aggregate city income and per capita income above a certain threshold. Figure 2 compares several cities in developing countries in terms of population and income per capita. It is interesting to note that the total income curves (population x annual income per capita) show that all cities with incomes above $15 billion (1986) have urban rail, while most below $5 billion do not. According to Fouracre and Gardner, an additional requirement is that the average income of the city's population should be above $1,800 per head (1986)[34].

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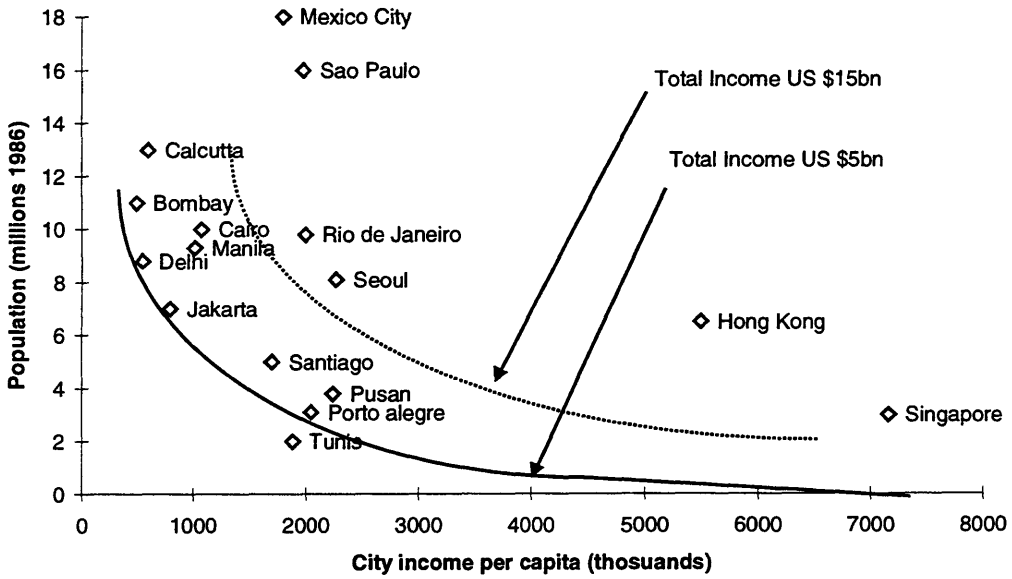
[32] Peter Newman and Trevor Hogan, "A Review of Urban Density Models: Toward a Resolution on the Conflict Between Populace and Planner," Human Ecology, Vol. 9, No. 3. 1981.
[33] P. R. Fouracre, R. J. Allport, and J. M. Thomson, "The Performance and Impact of Rail Mass Transit in Developing Countries," transport and Road Research Report No. 278, 1990.
[34] Ibid. 26

**Figure 2-3 City Income per Capita, Population, and Urban Rail**




Source: P. R. Fouracre, R. J. Allport, and J. M. Thomson, 1990.

## 2.2.4 Economic Conditions

One of the main goals of urban rail is to efficiently direct the development and growth of the metropolitan areas where it is located. The success of an urban rail system in achieving this goal depends on a variety of factors, including the economic conditions of the area. As Roanne Neuwrith[35] says, "A strong economy complete with a demand for new space is the essential ingredient for stimulating new economic growth..." If the economy is stagnant or in recession, urban rail benefits may not be of sufficient magnitude to reverse it. An example can be taken from the Buffalo and Pittsburgh cases; both cities' economies have been stagnant, and the impact of urban rail has been limited[36].

[35] Ibid. 11, p.145

[36] Herman Huang, "The Land-Use Impacts of Urban Rail Transit Systems," Journal of Planning Literature, Vol. 11, No. 1, August 1996.

### 2.2.5 Car Ownership

In the U.S., like in many other countries, there has been a great increase in the number of Vehicle Miles Traveled by automobile (VMT). By 1990, the number of vehicles owned by households had surpassed the number of drivers within households. The number of trips made by private vehicle increased by 15 percent, and the number of trips made by people as drivers increase by 25 percent. About half of this increase in auto dependency was due to lower transit use and the other half because of less carpooling. As a result, trips made by public transit declined by 10 percent from 1983 to 1990[37].

As Peter Newman explains[38], the high priority that is given to the car in Australia and in the U.S. means that there will be a large number of cars, roads, and space used for a parking. Parking and roads take up large amounts of urban space that would be otherwise devoted to housing; hence, more housing is needed on the urban fringe. In addition, more space in the border of roads is consumed by buffer zones and setbacks. This priority for car creates low density suburbs that are non-viable for transit and thus create the need for higher car priority. As lower priority is given to transit, the compact housing that is built around stations also becomes a lower priority, and as transit services are reduced, there is a reduction in the value of urban development that is served by transit.

The higher car ownership is in a metropolitan area, the more likely it is that urban rail will play a minor role, unless additional policies are put in place. Fortunately, the examples of cities like Copenhagen and Stockholm, where high levels of income and car ownership are combined with a high transit share, are proof that it is possible to reduce auto dependence, and that the link between wealth and automobile dependent cities does not always restrain transit-use growth[39].

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[37] Robert Dunphy, Deborah Brett, Sandra Rosenbloon, Andre Bald, "Moving Beyond Gridlock: Traffic and Development," Urban Land Institute, 1997.
[38] Peter Newman, "The Compact City: An Australian Perspective," Built Environment, Vol. 18, No. 4. 1993.

### 2.2.6 City Structure

Historic, regulatory, and physical characteristics also define the location and mix of activities in a metropolis. This distribution of people and activities in space and the existence of corridors of activity has an important influence on a metropolis' transportation patterns[40]. Cities with a strong concentration of central jobs will tend to have better developed public transport systems[41]. As the importance of activity centers decreases with automobile-based sprawl, transit viability also decreases.

**Table 2-1 Characteristics of Cities with Urban Rail**

| City | Population Million (1986) | Per Capita Income US$ (1986) | Vehicle ownership (per '000 pop.) | City structure and form |
|---|---|---|---|---|
| Cairo | 10.0 | 1,100 | 80 | Linear/polynuclear |
| Calcutta | 13.0 | 500 | 35 | Circular/polynuclear |
| Hong Kong | 5.3 | 6,700 | 50 | Semi-circular/polynuclear |
| Manila | 8.9 | 1,000 | 75 | Semi-circular/polynuclear |
| Mexico City | 18.0 | 2,800 | 210 | Circular/polynuclear |
| Porto Alegre | 3.1 | 2,100 | 90 | Semi-circular/polynuclear |
| Pusan | 3.8 | 3,100 | 45 | Linear/mononuclear |
| Rio de Janeiro | 10.0 | 2,100 | 100 | Semi-circular/polynuclear |
| Santiago | 4.0 | 1,700 | 95 | Circular/mononuclear |
| Sao Paulo | 16.0 | 2,100 | 140 | Circular/polynuclear |
| Seoul | 8.1 | 3,400 | 40 | Circular/polynuclear |
| Singapore | 2.6 | 8,200 | 185 | Semi-circular/mononuclear |
| Tunis | 2.0 | 1,900 | 40 | Semi-circular/mononuclear |

Source: Fouracre and Gardner 1993

## 2.3 System Design & Operating Variables

The construction and operation of an urban rail system is a very important and complex task, since urban rail's success in attracting riders and achieving the desired economic impacts will be highly related to it. A modern urban rail system will be useless if it is built in the middle of nowhere. Even if the system is built at the best possible location, it will

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[39] Peter Newman, "From Symbolic Gesture to The Main Stream: Next Steps in Local Sustainability" Institute for Science and Technology Policy, Murdoch University.

[40] Eric J. Miller and Amal Ibrahim, "Urban Forma and Vehicular Travel: Some Empirical Findings," prepared for the 77th Annual Meeting of the Transportation Research Board, January 1998.

hardly attract any riders if it has a frequency of one train every hour, or if trains are unreliable. In the following sections, we will analyze the most important elements in the design and operation of an urban rail system, and we will see how they can affect the final performance of an urban rail system.

## 2.3.1 System Design

### 2.3.1.1 Alignment of the System

The alignment of an urban rail system is essential for the success of an urban rail system. Urban rail must serve trip destinations; therefore, the alignment must go through residential and employment areas, where people want to go. Despite the importance of the alignment, there are many systems where the choice of route appears to be at fault. In those cases, urban rail has failed to penetrate the city center or is badly oriented in relation to high-density residential areas and key destinations[42]. In most of those cases, the alignment was defined to seek cost savings (e.g. land costs) without recognizing a major reduction in benefits. As Fouracre et al. say, this is often the worst error that can be made when urban rail is built: "Misplacing the alignment by only 600 m. to 800 m. from an important destination such as the city center could result in a substantial loss of patronage." An inadequate alignment selection is one of the main reasons that explain why urban rail rarely meets the expectations of its planners[43].

There are many cases of failures caused by a badly chosen alignment. One of the best examples is the Blue Line in Los Angeles that goes through a "deserted" old right of way[44]. The case of Cleveland's Light Rail Transit system is similar. The city saved on construction costs by building the line on a railroad right of way, but this right of way is

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[41] Peter Hall, "Urban Rail Development and The Measurement of Impacts," pp. 65-88. Transport and Urban Development, Edited by David Banister, 1995.
[42] Ibid. 33
[43] Ibid. 26
[44] Anastasia Loukaitou-Sideris, Tridib Banerjee, "There is no There There," Access, No. 9, Fall 1996.

far from the adjacent activities. Moreover, it serves the major employment centers poorly and does not serve any densely populated area[45].

#### 2.3.1.2 Station Location

Choosing the best alignment for the system is of great importance. However, the benefits of a good alignment may be lost if the stations are not well located. Stations not only have to be physically close to where the users are, but they should also be located in such a way that they make urban rail users' trip from the station to their destination as fast and comfortable as possible. The importance of choosing the exact and most convenient location is exemplified by the experience of several stations of Atlanta's MARTA system[46]. Several merchants affirm that if the location of the stations had been moved a few hundred meters there would have been greater development, since it would have avoided problems like dangerous crossings. In the case of BART, as Melvin Webber[47] notes, one of its failures was that most of its suburban stations were isolated from social and economic activities.

#### 2.3.1.3 Station Accessibility

Urban rail stations should be close to their potential riders and to their destinations. However, this physical closeness is insufficient, and the system will not be able to attract riders if they do not have good access to the station. Good access must be provided for pedestrians, transit riders, kiss and ride users, and car drivers. Pedestrian accessibility is especially important to attract development near the stations. According to Huang, development may be lost if the stations are not readily accessible on foot by the

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[45] Ibid. 36
[46] Ibid. 36
[47] Melvin Webber, "The BART Experience - What Have We Learned?" Institute of Urban and Regional Development, UC Berkeley, Monograph No. 26, 1976

surrounding neighborhoods[48]. To ensure this station accessibility, complementary works such as roads and urban improvement works will be needed[49].

### 2.3.2 Operating Variables

#### 2.3.2.1 Level of Service (LOS)

There are several variables that can be used to define the LOS provided by urban rail; the most significant are: vehicle travel time[50], frequency, reliability[51], span of service, safety, and comfort.

- Vehicle travel time is the time between the passenger's boarding at the origin and his/her alighting at the destination. The shorter the travel time, the better the service for the user. There is a positive relationship between the speed of public transit and the probability of its use [52](Newman et al. 1995).

- Frequency or headway can be defined as the time between two consecutive scheduled vehicles in a service[53]. Frequencies will determine passenger's waiting times at the station. Frequencies should be such that total travel times (waiting time + vehicle travel time) make urban rail an attractive transportation alternative.

- These frequencies would be of little use if the system is unreliable. If service disruptions or other incidents are too common, travel times will be unreliable and ridership will suffer.

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[48] Ibid. 36

[49] Oscar Figueroa and Etienne Henry, "Analysis of the Underground Systems in Latin America," Urban Transport in Developing Countries: Lessons in Innovation, PTRC, 1991.

[50] Ibid. 33

[51] An Assessment of tbe BART Impact Program, BART Impact Program Advisory Committee, The National Research Council. 1980.

[52] Ibid. 28

[53] Nigel Wilson, MacDorman & Associates, "Draft Service Evaluation Process. Design of Service Quality Measures and Service Evaluation Standards," Massachusetts Bay Transportation Authority, Conservation Law Foundation, Inc., November 25, 1995.

- Span of service reflects the hours that the service is provided (Wilson, 1995). It is the time between the arrival of the first trip and the departure of the last trip. The span of service should be such that users can rely on public transit to satisfy their travel needs. Span of service can affect the potential number of riders if all or part of their travel needs cannot be serviced during the span of service. Moreover, it may lead potential users to buy private cars. Once the car has been purchased, the marginal cost of using the car can be very low. Therefore, by not servicing a small percentage of the trip requirements of potential users, they may rely on their private cars for all or the majority of their trips.

- If the system is perceived to be unsafe and users fear the possibility of being robbed or assaulted, urban rail will be a less attractive transportation alternative.

- Trip comfort, the cleanliness of stations and cars, and the availability of seats are attributes that are considered by users when they choose their travel mode.

As Denise Pinheiro[54] says, the management of urban rail is of key importance; the LOS of a particular system will have an important influence on its success in attracting riders. The performance of urban rail also depends on the institutional conditions surrounding them. Changes in the local or central government can affect urban rail. Long-term planning can be disturbed by short-term decisions that change all the previous conditions[55].

#### 2.3.2.2 Fares

Another important variable that explains the failure of urban rail systems to match the expectations of their planners is the poor attention that is often given to fare structure and fare integration issues[56]. When there is a lack of fare integration and trips require the use

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[54] Denise Pinheiro Machado, "Urban Impacts of the Metro's Implementations and Management Process in Rio de Janeiro," Urban Transport in Developing Countries: Lessons in Innovation, PTRC 1991.
[55] Ibid. 49
[56] Ibid. 26

or urban rail and one or more transit modes, the introduction of urban rail can mean a large increase in travel costs for the potential users. Monthly passes for one or several local transit systems, as well as discounted fares, can also play a significant role in attracting riders.

#### 2.3.2.3 Inter-modal Integration

The lack of integration with other transportation modes is also an important explanatory variable for the under-performance of urban rail systems[57]. Moreover, the integration with other transport systems is a key element that determines the impacts of urban rail in an urban area[58].

Urban rail systems are usually small networks and can only directly serve a small percentage of the total population; if they are not well connected with the public transportation network, their catchment area will be limited to the distance people are willing to walk to reach public transport[59]. As an example, Melvin Webber[60] signals BART's failure to wait until almost the completion of the system to coordinate it with the public transportation system. Unfortunately, it can often be observed that there is strong competition between transportation modes; this leads to over-capacity and an inefficient use of resources[61]. Therefore, we can find isolated urban rail systems with poor communications to the rest of the transportation system; these systems lack institutional integration, but carry the same original responsibilities and expectations posed on them. As these expectations go unfulfilled, the conditions of isolation are aggravated.

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[57] Ibid. 26
[58] Ibid. 54
[59] Ibid. 33
[60] Ibid. 47
[61] Ibid. 49

## 2.4 Local Policies

Regulations and decisions emanating from different public authorities can directly or indirectly affect urban rail. Some of these decisions, like the construction of a highway parallel to the alignment of the system, will have long-term consequences, while others may be reversed in a shorter time period. As we know, the objective of urban rail is not only to efficiently move people but also to affect the development of the metropolis. For both reasons urban rail cannot be isolated from the rest of the metropolis. On the one hand, urban rail will affect and will be affected by the way people can move and park their vehicles. On the other hand, the way it affects the development of the city will heavily rely on the regulations and dispositions that are approved by the local governments. For example, one station may have the potential to attract office and residential development, but if zoning laws do not allow it, this development will not take place. Local government polices have the potential to seriously affect the economic impact of urban rail. We will review some of the most important local policies.

### 2.4.1 Parking

As we have stated, the private car is public transit's main competitor, especially in developed countries with high levels of car ownership. In the U.S. car users pay around 60% of the cost of providing the infrastructure they use, although this figure would decrease if the negative externalities it causes are also considered[62]. In addition, between 1980 and 1990 the cost of driving fell by 45% in real terms because of lower gas prices. Over the same period, transit fares in the U.S. kept up with inflation because of federal reductions in subsidies. Parking can be one of the tools used to increase the low cost of driving and make urban rail more competitive. According to Newman et al., the reduction in the availability of parking space reduces the convenience of using the car[63]. Parking limits reduce growth in automobile traffic and congestion by shifting demand for auto

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[62] Ibid. 30

[63] Peter Newman, Jeffrey Kenworthy, Paul Barter, and Chamlong Poboon "Is Increasing Automobile Dependence Inevitable in Booming Economies?: Asian Cities in an International Context," IATSS Research, Vol. 19, No. 2, 1995.

travel to transit[64]. The easier it is to drive and park a car the more attractive the car will be with respect to urban rail. This is supported by Robert Cervero's findings after conducting a travel data survey of workers at 18 rail-served office buildings[65]. This survey showed the following: "Only 3% of the station-area workers who received free parking commuted by rail, whereas one-quarter of those who had to pay to park opted for rail commuting." His study also showed that free parking reduces the probability of rail commuting by 10% to 20% for the same employee. The importance of parking policies is clearly stated by Cushman, who cites Miami as an example of failure in enforcing an adequate parking policy[66]:

> *"Some cities, like Miami, have failed in this area (parking costs and parking management). They defeat their own citizens' investment in transit by requiring more asphalt and concrete for moving and parking more automobiles, the foolish result of divorcing parking policy and parking management from transportation and land development policies."*

### 2.4.2 Zoning

Zoning ordinances determine the type and quantity of development that is allowed in a particular site. Therefore, zoning plays a key role in the success of urban rail[67]. Zoning is of special importance in the areas around stations, since it is there where urban rail has the greatest potential to have an impact on urban development[68]. Moreover, if significant land use impacts are to occur, zoning in the station areas must allow for more intense uses. At Ballston and Bethesda's, stations in Washington's urban rail system, several development projects have taken place encouraged by zoning regulations that allowed a floor area ratio

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[64] Ibid, 29
[65] Robert Cervero, "Rail-Oriented Office Development in California: How Successful?" Transportation Quarterly, Vol. 48, No. 1, 1994.
[66] Ibid. 29 p. 28
[67] Ibid. 54
[68] Ibid. 36

of up to 6:1. By contrast, several BART stations have experienced limited development due to restrictive zoning regulations.

### 2.4.3 Availability of Land and Ease of Assembly

The availability of land will be of greater importance in non-downtown stations, since it is likely that most of the land in downtown areas will be already developed. The availability of land that is readily assembled and developed is one of the key factors that, according to Robert Cervero[69], is necessary for urban rail to have a significant and lasting influence on urban form and land uses. Parcels may need to be assembled to create a site large enough to be economically attractive for development[70]. Fragmented ownership may prevent development that would otherwise occur. Having to negotiate the acquisition of parcels with several landowners increases costs, and the opposition of one or more of the landowners may prevent development from taking place.

### 2.4.4 Community Support

Communities can have an important role on the final impacts of urban rail. Among others, they can affect the location of a station and zoning regulations. On the positive side, we encounter the case of Arlington County in Virginia[71]. The county has had a long history of good cooperation and communication between the community and the local government. When the construction of Washington's Metrorail began, neither the alignment nor the location of the stations were questioned. Moreover, the community supported a new zoning district at the station areas that doubled the densities permitted elsewhere in the county. As a result, private office space increased from one million square feet to 22 million, and hotel rooms increased from 1,000 to 8,000. On the other

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[69] Robert Cervero, "Urban Rail Development and The Measurement of Impacts," pp. 136-156. Transport and Urban Development, Edited by David Banister, 1995.

[70] Ibid. 36

[71] Thomas C. Parker, "Community Involvement and Planning for Transit," Transit, Land Use, and Urban Form, Center for the Study of American Architecture, School of Architecture, University of Texas in Austin, 1988.

side, in the case of BART, the opposition of several communities led to new zoning regulations barring high-density land uses[72].

### 2.4.5 Urban Rail Promotion – Marketing

The use of urban rail can be promoted not only by the urban rail operator but also by local and regional authorities, such as municipalities and transportation authorities. The use of different marketing policies such as the advertisement of the system or the use of development incentives in the station areas can have a positive impact on transit ridership[73].

### 2.4.6 Public-private Cooperation

Cooperation between the public agencies and private developers is key for maximizing urban rail's development impacts[74]. With good communication and responsiveness to developers' needs, it is likely that development that is compatible with urban rail will occur.

## 2.5 Conclusion

Urban rail should not be considered in isolation when, as we have seen, it forms part of a broader system. Urban rail does form part of the economic system and it can affect it. However, there are other factors that also form part of the economic system and that can affect urban rail's capability to produce economic growth. Therefore, when urban rail is to be constructed and operated, its alignment and operations should be defined taking into consideration this broader system that is formed by the urban characteristics of the metropolis where it operates, and its local policies. When all these factors that we have

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[72] USDOT, "The Impact of BART on Land Use and Urban Development – Interpretive Summary of the Final Report," BART Impact Program, September 1979.
[73] Richard L. Oram, "Transit Marketing: Successes and Failures," Transportation Research Board, September 1987.
[74] Louis Berger International Inc. "Transportation Investment and Economic Expansion: Case Studies," Vol. 2, October 1995.

analyzed are incorporated into the discussion, urban rail will have higher chances of maximizing its economic impacts.

# 3 Urban Rail and Population Densities

As we discussed in the previous chapter, population densities can be divided into residential and employment densities. Both population and employment densities are a critical factor in determining which transportation alternatives are most appropriate for a metropolitan area. In the previous chapter, we saw that urban rail becomes viable, in terms of ridership, when densities exceed 40 persons per hectare.

As we have noted, urban rail can help concentrate development around station areas[75]. This development will be attracted by the increased accessibility of the site, and it is likely to bring several economic benefits that will be further discussed in the following chapter[76]. Densification is one of the most important positive outcomes of urban rail and it should be encouraged. However, density must not be pushed ad infinitum, since most of the benefits will be progressively lost with excessive crowding that goes beyond the carrying capacity of efficient transportation modes such as urban rail.

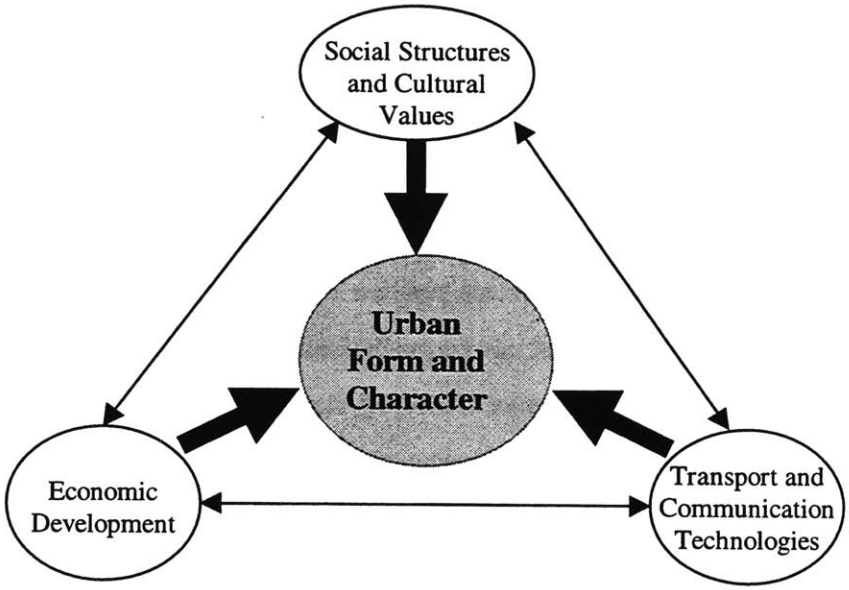
This chapter will provide a better understanding of population densities and of the elements that influence them. First, we will describe the major forces that have determined population densities through time, and second, we will examine psychological and sociological literature to determine what kind of effects high densities have on humans.

[75] Ibid. 11
[76] Ibid. 14

## 3.1 The Evolution of Densities Through Time

If we took a tour of the major metropolises in our planet, we would see that there are significant differences among them beyond geography. These differences can be explained principally by differences in technology, economy and cultural values[77]. We must understand these forces in order to understand why our cities are how they are, to anticipate how they may look in the future, and to be able to influence this.

**Figure 3-1 Forces Shaping Cities**




Source: Newman 1997

### 3.1.1 Technological Forces Shaping Cities

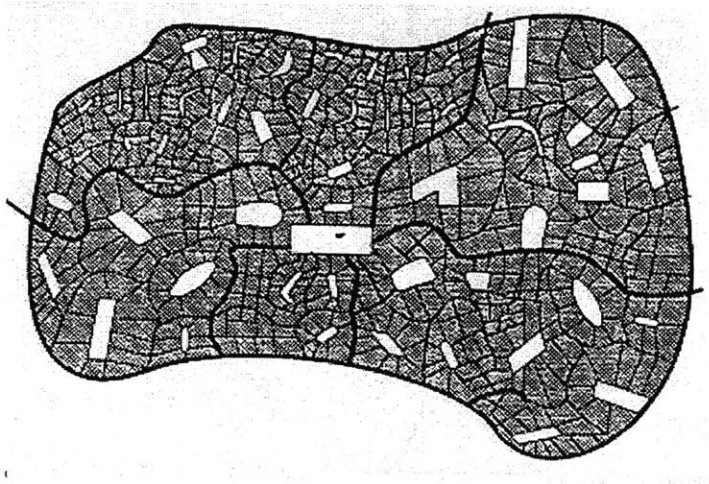
Cities form when people cluster together to do more as a community than as isolated individuals. The shape and size of cities will be directly related to the predominant transportation and communication technologies. One critical element in explaining how this happens is the constancy of time in city travel. It has been shown that people, through different time periods, do not like to spend more than half-an-hour traveling to their

[77] Ibid. 22

destinations[78]. A government study in the United Kingdom found that travel time for work trips had been stable for six centuries[79]. The following typology of cities shows how as technologies enabled faster travel, cities experienced different forms of development[80].

- *The Walking City:* This city developed around 10,000 years ago; it is characterized by high density (100 to 200 people per hectare), mixed land use, a form that fits the landscape, and it has narrow streets. Most cities have some sections with this character, especially in their centers.

**Figure 3-2 The Walking City**



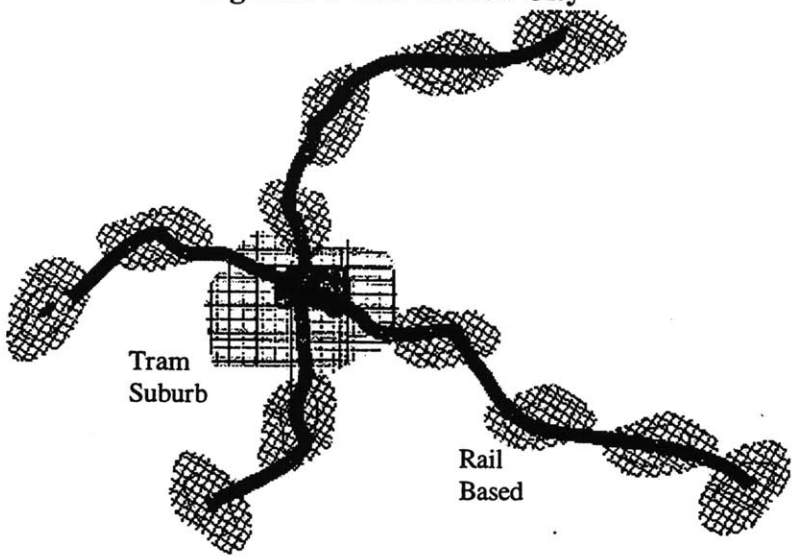
Source: Newman 1994

- *The Transit City:* Cities were pushed outward as train and tram technologies allowed faster travel to occur. At rail stations, trains favored the creation of population sub-centers that were small 'cities' with walking city characteristics. Cities could now spread 20 to 30 kilometers, and they tended to have linear development that followed the routes. They had medium-density residential

[78] Manning, 1978 and Pederson, 1980; as cited by Peter Newman, Jeff Kenworthy, Feliz Laube, 1997.
[79] SACTRA, 1994; as cited by Peter Newman, Jeff Kenworthy, Feliz Laube, 1997.
[80] Adapted from:
- Peter Newman, Jeff Kenworthy, Feliz Laube, June 1997.
- Peter Newman, 1993.

and work locations (50 to 100 people per hectare) and a strong emphasis on the CBD. Many European cities have retained this transit-based urban form, and most North American and Australian cities have transit-based areas in their cities.

**Figure 3-3 The Transit City**

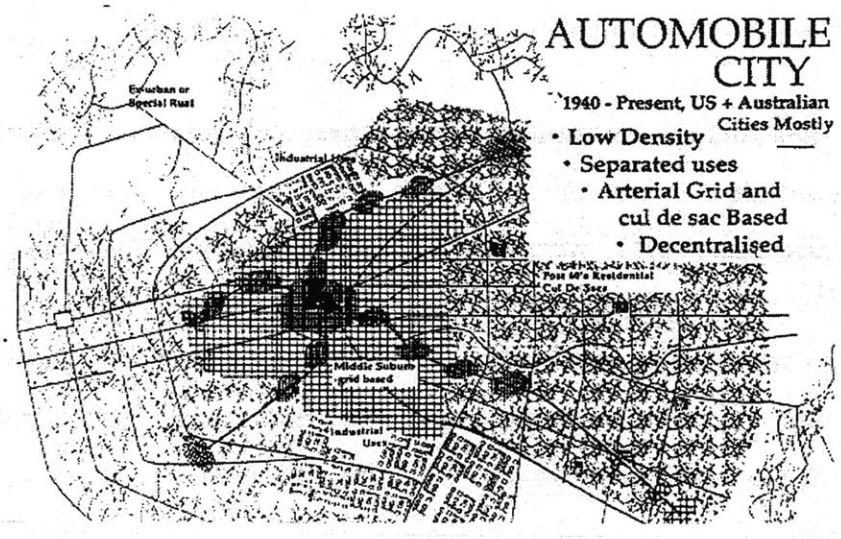



Source: Newman 1994

- *The Automobile City:* After the Second World War, the automobile progressively became the transport technology that shaped the city. The extensive use of the car combined with the bus made it possible for the city to develop in any direction. First, the areas between the train lines were developed, and then development expanded outward as far as 50 kilometers. Under these conditions low-density housing became more feasible. This evolution, combined with a reaction to the polluted industrial city, led to zoning regulations separating functions. This increased travel distances but that was compensated for by the greater speed and flexibility brought by cars and buses.

In these cities, density is much lower (10 to 40 people per hectare), and significant space is taken up for roads and parking. The CBD is an office center, and most other types of work disperse to the suburbs. North American and Australian cities are some of the best examples of this city form.

**Figure 3-4 The Automobile City**




Source: Newman 1994

- *The Nodal/Information City:* This type of city has emerged in the last decades in large global cities where the time of travel, even by automobile or fast train, is beyond the half-hour limit.

### 3.1.2 Economic Forces Shaping Cities

From the previous analysis it may seem that the natural evolution is towards decreasing population densities. However, it is also necessary to have the financial capability, as well as the economic incentives to create those low-density cities. In an attempt to understand those incentives, Frost, following a historical and economic analysis, established a clear and simple typology of cities[81]. He defined two different types of cities in the nineteenth

[81] L. Frost, The new Urban Frontier: Urbanization and City Building in Australasia and the American West. University of NSW Press, Sydney. As cited by Peter Newman, Jeff Kenworthy, Feliz Laube, 1997.

and twentieth century, the main difference between them being the use of their financial capital:

- The 'traditional city' is a dense city that directs a high proportion of its capital into the production of goods and services, leaving very little left for urban infrastructure. The wealth of this city is based on industrial production, import substitution, and innovation.

- The 'new frontier' city which directs a greater proportion of its capital into urban infrastructure, enabling lower densities. This type of city developed its wealth by servicing a large rural area and investing in land for suburb building.

We see the importance of political and economic forces that favor how capital is used: for developing innovation or for developing land. Nowadays we are experiencing the rise of new and strong economic forces mainly in the field of information technologies. These forces may play a significant role in the way cities shape deciding whether capital will be directed into productive innovation or into land for suburb construction. As we will see in the next chapter, this can make a significant different in economic terms.

### 3.1.3 Cultural Forces Shaping Cities

If we look at U.S., European and Asian cities, we will find that U.S. cities have a much greater level of auto-dependency on average. Only a fraction of this difference can be explained by economic differences; this is because in addition to technological and economic forces there are cultural priorities that shape cities[82]. European and Asian cities reflect cultures where the community and social life are highly valued, instead of being oriented towards individual household values. These populations tend to be grouped into higher density housing and are more oriented toward public transport.

### 3.1.4 The Inter-linkages Between Priorities

It is the link between these three forces that we have analyzed that ultimately defines the shape of cities[83]. The distinct priorities that cities and countries have will result in different urban shapes with different predominant transportation modes. The highly auto-dependent American cities have been the result of the interaction between their own particular set of priorities. The following paragraphs will describe the process by which the inter-linkages between priorities can lead cities and countries to follow the U.S. model auto-dependent model.

- *Technological priorities:* If society makes the private car a high priority, cities will have a large number of cars, and will require roads and parking facilities. Both roads and parking take up considerable urban space and often replace housing in that urban core, increasing the need for housing at the urban fringe.

- *Capital priorities:* If the allocation of capital to new suburban infrastructure is made a high priority, low-density suburbs ill-served by transit will emerge, making cars a higher priority.

- *Cultural priorities:* The priority for capital to go into new suburban infrastructure is not only an economic decision; it is also based on cultural preferences for low-density suburban communities.

Many cities around the world seem to be heading towards the U.S. model of auto-dependent city. Technological changes, combined with the U.S. influence on the capital and cultural priorities of their inhabitants seem to be playing an important role in this change.

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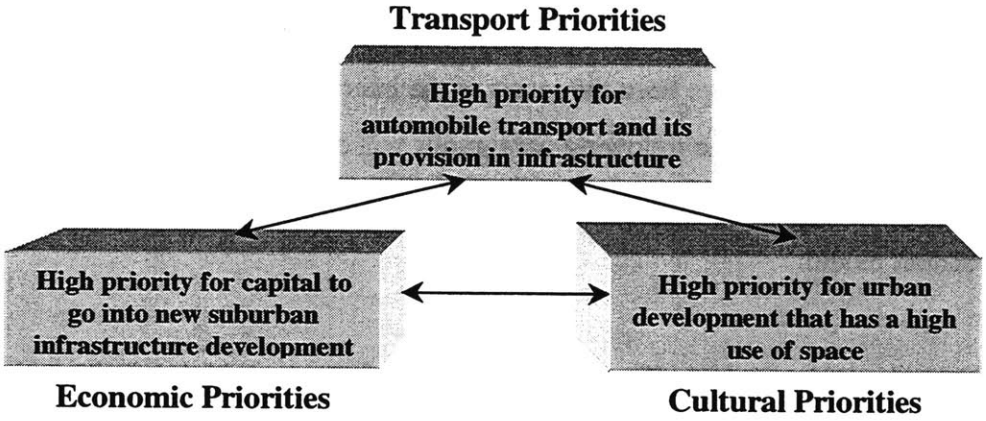
[82] Peter Newman, "The Transport Dilemma in Developing Nation Cities," Social Dimensions of Development, Paradigm Books, 1994.
[83] Adapted from Peter Newman, 1993.

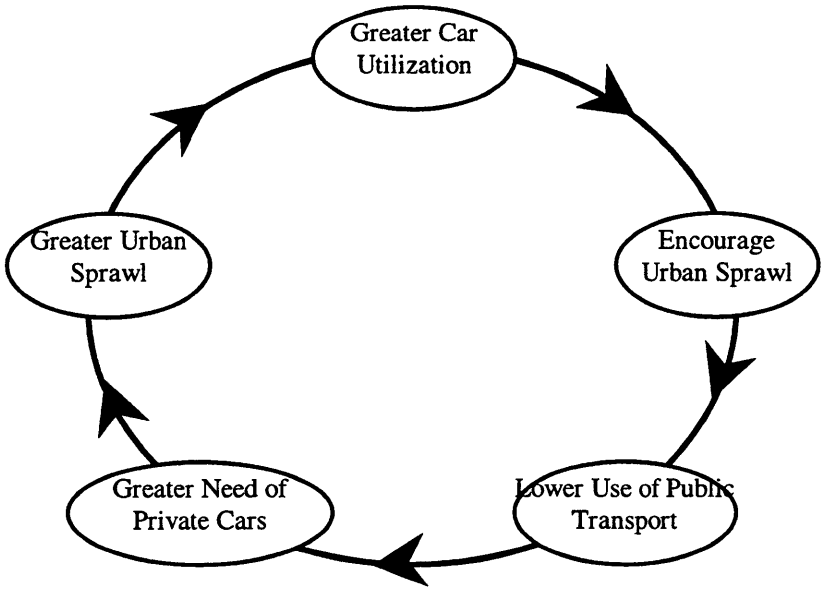
**Figure 3-5 The Inter-linkages between Priorities**




Source: Newman 1997

This situation can create the transportation-land use loop that is represented by Figure 3-6. This loop illustrates how after a certain threshold there is a self feeding process by which increases in car ownership and low density development fosters greater suburbanization and higher auto-dependency. The role of the private car and low density development is increasingly reinforced to the detriment of public transportation and high density development.

**Figure 3-6 The Transportation-Land Use Loop**




Daniel Freire, 1998

To counteract the strong inertia of this loop it is necessary to change these priorities. As Edmonston says,[84] the challenge of reducing the dependence that American cities have on automobiles, and hence on oil, "... would require an expansion of rapid transit with the concentration of employment." Once a certain structure is achieved it is very difficult to go backwards. Edmonston states that it will be necessary to work on several fronts to break this loop. However, another option may be to accept sprawl and modify it following other models, such as the transit village model. This model suggests that high urban rail ridership levels can be attained if dense, well-designed villages that combine different housing types and land uses are built around its stations[85].

[84] Edmonston, B.1975, as cited by Peter Newman and Trevor Hogan, 1981.
[85] Ibid. 30

### 3.1.5 The Emergence of a New City Form, the Advanced City

Information technologies could be seen as an additional force towards the dispersal of people that need only to telecommute instead of going to their offices. Other approaches recognize instead that there is a need for quality human interactions, and that the new economic system will highly depend on creativity often requiring personal interaction.

According to Peter Newman, a concentration of urban activities and a conversion of urban cores into centers of activity may occur instead of the dispersal of cities, and will be possible due to a combination of elements[86]:

- Industrial activities are leaving urban centers. With this free space the concentration of information-oriented jobs can occur more easily.

- The growing need for interaction and cooperation between professionals for solving international economic issues will require in-person communication for the critical phases of any project.

- The purchasing of easy access to quality urban environments at central or edge city centers by those with higher incomes will increase the demand for denser residential development.

Like Newman, Kobayashi states that advances in technology have minimized the cost of moving goods and messages, but that the movement of people still remains an important constraint[87].

Technological forces are not necessarily directing our cities towards sprawl. The need for face-to-face communications, combined with different capital and cultural priorities can

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[86] Adapted from Peter Newman, Jeff Kenworthy, Felix Laube, June 1997.
[87] Kiyoshi Kobayashi, "The Emerging New Arena," pp. 27-44, The Future of Transportation and Communication: Visions and Perspectives from Europe, Japan, and the U.S.A., Germany, 1993.

help to stop and even reverse the trend towards decentralization that was experienced after World War II in most cities in the world, and especially in the U.S.

## 3.2 Review of Urban Density Models

As we have seen, high population densities are positively correlated with urban rail use. This positive correlation with transit use and the existence of other economic benefits brought by increased densities would be useless if living in densely populated environments were damaging for human beings. Therefore, before supporting an increase in metropolitan densities it is key to ascertain that high densities do not bring negative impacts that could offset their potential transportation and economic benefits.

Historically, since urban civilizations appeared, urban density has been in the range of 100 to 200 people per hectare. Few cities were less dense but many were denser; Babylon is though to have been around 300 people per hectare in 430 B.C. and Rome 500 in 100 A.D. Nowadays, most cities in developing countries and many European urban centers have densities of 100 to 200 people per hectare. However, during this century these historical patterns have experienced an important change with the rise of the low-density cities, especially in North America.

These low densities are very uniform, ranging from 10 to 30 people per hectare. This trend towards lower density is encouraged by the belief that high-density is unhealthy, unpleasant, unsafe, and stressful. The concern for the need for lower densities is mostly focused on residential densities. As it can be appreciated in the U.S., higher employment densities are more accepted than residential densities, especially if workers, after their work journey, commute to their lower density residencies. However, this desire for more space conflicts with the conclusions of many urban planners who are beginning to call for an increase in urban densities.

In the following paragraphs, following Newman and Hogan[88], we will discuss several physiological and sociological models concerning the human aspects of urban density. The purpose will be to assess the validity of the belief that high population densities are unhealthy and negative for the individual.

### 3.2.1 Ethological Models

Ethology is the study of animal behavior. Ethological models are the means by which the theoretical findings from animal research are applied to human society. We will analyze the two main concepts that are used by ethologists to examine urban density: physiological pathology and territoriality.

#### 3.2.1.1 Urban Density and Physiological Pathology.

Studies conducted on animals in crowded environments have found that animals suffer from physiological over-stimulation, including decreases in disease resistance, greater proportion of miscarriages, and average physical size decline. These results have been partly attributed to the lack of space leading biologists to suggest that low-density living is a biological necessity for animals[89].

However, no evidence has been found to consistently correlate density with disease susceptibility. Moreover, we should question the relevance of animal behavior to explain that of humans. As it would be a mistake to conclude that dogs act in certain ways because monkeys do, there is enough difference between humans and the other animals to make it more difficult to conclude anything about humans from what other animals do.

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[88] Ibid. 32

[89] Morris D. The Naked Ape. McGaw-Hill, New York, 1968. As cited by Peter Newman and Trevor Hogan, 1981.

#### 3.2.1.2 Urban Density and Territoriality

Many studies show that territoriality is a basic component of animal social organization, and when territories are disrupted there is an increase in aggression and social order breakdown[90]. Social biologists have used this finding to support that humans also have an innate territoriality that is violated in high-density situations, resulting in greater levels of aggression.

It is not certain that territoriality is necessarily an instinctive characteristic of animal behavior. In some animals aggression only appears in circumstances in which the animal's survival is threatened. Moreover, there is little evidence that territoriality is a universal characteristic in the animal kingdom. Studies on chimpanzees, and orangutans indicate that the closest relatives to the mankind show few, if any, signs of a territorial instinct.

Some authors have thus concluded that territoriality is a learned behavior. If instincts develop and persist because they provide an evolutionary advantage, then territoriality cannot be applied to humans, who survive best by living together and not by spreading themselves through the landscape.

### 3.2.2 Sociological Models

Sociology attempts to identify trends in society and find causal explanations to these trends or explain them in terms of cultural beliefs. Sociology has suggested the existence of causal links between high density and social disorder and between high density and ill health. In terms of cultural beliefs sociology suggests that there is a link between urban factors like density and the loss of rural innocence.

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[90] Lorenz, K. S., On Aggression, Harcourt Brace Jovanovich, New York, 1966. As cited by Peter Newman and Trevor Hogan, 1981.

### 3.2.2.1 Urban Density and Social Disorder

Several authors maintain that there must be a relationship between urban density and social disorder due to genetic and hormonal factors. The major index that has been used to establish this link has been crime rates. Other factors such as educational performance and drug taking have also been used to associate high-density living with social disorder.

This association has two major shortcomings. First, a correlation based on aggregate data does not imply causal relationships, and when other variables such as ethnicity, poverty and education have been controlled this correlation becomes less obvious. A study for the Australian Institute of Urban Studies analyzed the relationship between different density levels and mental health and concluded that housing characteristics did not cause any of the social behavior patterns that were considered[91]. Other studies have shown that there are not significant relationships between household and neighborhood crowding and patterns of family relationships including spousal relationships, reproductive behavior, and child development. The second shortcoming is that urban densities have been historically very high until very recently. Moreover, in U.S. cities, while urban densities have been declining, crime rates have soared.

The link between high density and social disorder is blurred. Some studies have begun to adopt the opposing argument, suggesting that the fragmentation of society may instead be partly a consequence of low-density urban populations[92].

### 3.2.2.2 Urban Density and Public Health

Public health authorities have generally seen high urban density to have a negative effect on health[93]. This position appears to be based on the belief that infection spreads more

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[91] Pak-Poy, P. G. and Associates, "Inner Suburban-Outer Suburban: A Comparison of Costs," No. 42, Australian Institute of Urban Studies, Canberra, 1973. As cited by Peter Newman and Trevor Hogan, 1981.

[92] Schneider, K. R., On the Nature of Cities, Jossey Bass, San Francisco, 1979. As cited by Peter Newman and Trevor Hogan, 1981.

[93] American Public Health Association, Housing: Basic Health Principles and Recommended Ordinance, APHA, Washington D.C., 1974. As cited by Peter Newman and Trevor Hogan, 1981.

quickly in high-density areas, where people are in closer and more frequent contact. It is true that the often-cited high-density industrial city without any sewage system, solid waste collection, or water treatment was an unhealthy environment. However, recent studies have failed to demonstrate a consistent relationship between high urban density and bad health. Statisticians have concluded that the relationship is too complex to isolate high-density as the cause of poor health conditions.

The few diseases that spread through the air are too prevalent to be altered by changes in the spacing of houses. Moreover, significant health improvements in high-density cities in developing countries appeared where purified water, waste collection and good diets were available. This shows that the connection between low-density and health is lacking a serious basis.

#### 3.2.2.3 Urban Density and the Loss of Urban Innocence

Many urban sociologists see the city as an unnatural environment while the country is seen as natural and idyllic. This belief encouraged the desire to enjoy rural values via the garden suburb. This anti-urban tradition seems to be more confined to the English-speaking world, while continental Europe's tradition seems to be more urban.

However, the city, and especially the high-density city can be positive for culture and for human experience. Therefore, a new doctrine that stresses the positive aspects of dense cities has risen recently.

#### 3.2.2.4 Urban Density and Crowding

Crowding is defined by sociologists as the level of density where some form of abnormal behavior can be observed. However, there is not a uniform level of density at which these behaviors occur. One approach suggests that while density is physical and spatial, crowding is a perceived phenomenon. A second approach defines crowding as an

information overload. Crowding is seen as perceptual and subjective, depending on the information processed by the individual.

These models do not recognize the relativity of cultural norms over time. The present "need" for low density in the U.S. is very recent. Furthermore crowding can be positive, and it intensifies relations between people.

## 3.3 Future Trends

We see how in the U.S. and in Puerto Rico as greater levels of wealth are achieved, auto-dependency and urban sprawl increases. Between 1975 and 1995 the number of people per vehicle went down from 1.51 to 1.22 in the U.S. and from 5.78 to 2.30 in Puerto Rico[94]. At the same time income per capita grew in both territories[95]. Accordingly, the use of the car has also increased, and transit use decreased. However, there are examples from around the world showing that there is not a direct link between wealth and auto-dependency, and that this movement towards automobile-based suburbanization can be reversed[96].

> ***Zurich:*** Zurich, Switzerland's financial center, is a wealthy city that has experienced substantial increases in per capita incomes. Despite this growth in per capita incomes, it has experienced a spectacular increase in the use of public transit and has contained its auto use. This city expanded its old tram system and upgraded its services so users never had to wait for more than six minutes and trams had total right of way at traffic lights. At the same time, attention was directed towards public amenities, providing the city with enhancements that made transit more appealing.

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[94] Bureau of Transportation Statistics, Highway Statistics Summary To 1995 http://www.fhwa.dot.gov/ohim/Summary95/section2.html.
[95] U.S. Department of Commerce, "Statistical Abstract of the United States, 1997."
[96] Ibid. 31

***Copenhagen:*** This wealthy city did not have a strong urban culture, and private auto use was growing. The city's reaction was to reduce car parking by 3 percent every year while central streets were pedestrianized and made more attractive to users through landscaping, sculptures, and seating. Street musicians and street festivals were increasingly introduced. This lead to a tripling of social and recreational activities in Copenhagen's major streets. This turnaround from what seemed to be a strong trend towards auto-dependency took only 20 years.

## 3.4 Conclusion

In this chapter we have described the forces that determine population densities and we have reviewed the literature on the effects of densities, which has led us to conclude that densities are not negative for humans.

In the following chapter we will discuss the potential economic benefits of urban rail, several of which are related to the increases in density that urban rail can help promote.

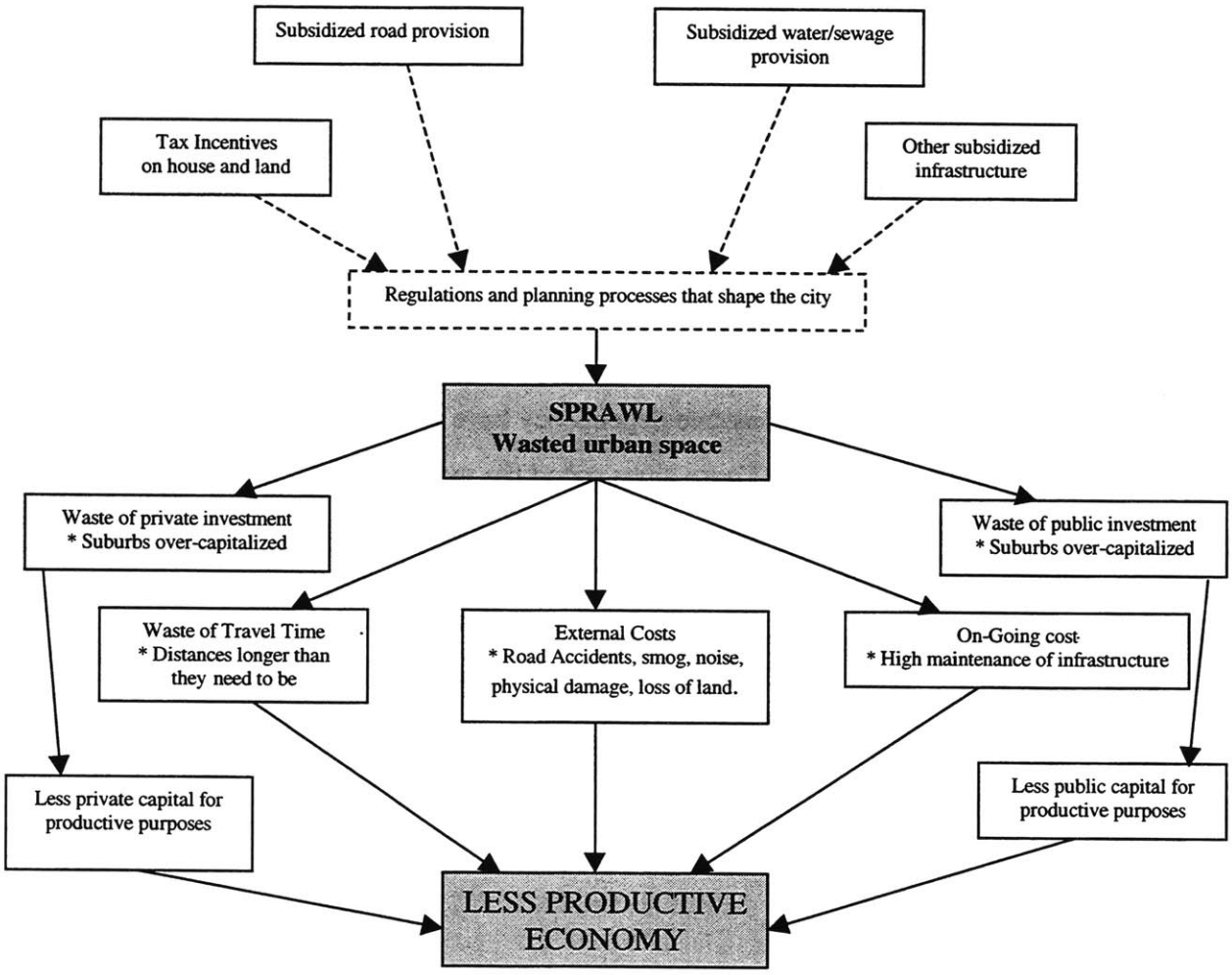
# 4 The Potential Economic Benefits of Urban Rail

In most countries, urban areas account for more than 50 percent of gross national product[97]. An effective transport system can help maximize the economic efficiency of any city while an inferior system will retard its economic progress. Urban rail, by providing an efficient transportation alternative, can affect a region's economy in a variety of ways, some of which are not always clearly recognized.

Cities with the highest automobile dependency have the least overall economic efficiency in their transport systems. Those cities spend the most on roads; they have to subsidize their transit the most; they have the most indirect costs to factors like road accidents, and pollution, and overall they are devoting a higher proportion of the city wealth for the non-productive purpose of passenger transport[98].

[97] Margaret Heraty, "International Overviews," Urban Transport in Developing Countries: Lessons in Innovation, PTRC 1991.
[98] Ibid. 22

**Figure 4-1 Economic Aspects of the Urban/Transport System**




Adapted from: Newman, 1994

Figure 4-1, shows the relation between several of the elements that we will analyze in this chapter. Because of particular cultural, political, and economic preferences, combined with the current transportation technologies, regulations and planning have lead the U.S. to a sprawl model of development and are also driving many other nations in this direction. The sprawled pattern of development is characterized by land and infrastructure over-spending both for the private and public sector. In addition, low density sprawl

development, requires greater auto-dependency which brings additional costs including congestion, accidents, and air pollution. Table 4-1 which only considers some of these costs, provides with a good quantitative description of the economic impacts of the sprawled and auto dependent development pattern that is followed in the U.S. and Australia versus the European and Asian development patterns.

**Table 4-1 Economic Transportation Data on Global Cities, 1990**

| | Australian Cities | US Cities | European cities | Wealthy Asian cities | Developing Asian cities |
|---|---|---|---|---|---|
| **Amount Spent on Roads per $1000 of GRP** | $7.19 | $9.84 | $4.26 | $4.13 | $14.76 |
| **% Transit Cost Recovery** | 40% | 35% | 54% | 119% | 99% |
| **Transport Deaths per 100,000 Persons** | 12.0 | 14.6 | 8.8 | 6.6 | 15.0 |
| **% GRP Spent on all Transport Modes** | 13.2% | 12.4% | 8.0% | 4.7% | 15.0% |

GRP: Gross Regional Product

Adapted from: Newman et al., 1997

We can see from Table 4-1 that transportation priorities matter. The major U.S. cities spend on transportation on average 4.4 GRP percentage points more than their European counterparts. U.S. and Australian sprawl is very costly. The fact that a significantly high percentage of their resources is devoted to transportation means that the productivity and efficiency of their cities could be higher than it is. Economic benefits would come not only from lower transportation costs but from the benefits derived from the additional growth and productivity fostered by a more efficient use and investment of the resources previously devoted to transportation.

The economic impacts of transport in general and of urban rail in particular are very difficult to measure. The lack of data is the main problem. This is because it is not possible to isolate the effects of urban rail from other events that take place simultaneously. Another reason is the difficulty in identifying the beneficiaries. Many of the economic benefits of urban rail are most likely to occur in close geographic proximity

to its physical alignment; however several may not. Individuals and firms that benefit from the construction and operation of an urban rail system are not always located in the area. Furthermore, through second and third round effects the direct beneficiaries may pass some of their benefits to other firms and persons, making measurement even more difficult. Finally, because of the intricate ways in which these benefits occur, it may be difficult to avoid double counting of the economic benefits.

In this chapter we will identify the most important economic benefits of urban rail with the objective of providing a better understanding of the process by which the construction and operation of an urban rail system can benefit an economy. Given the aforementioned difficulties, we will not try to quantify these benefits. In the following pages we are going to analyze the potential economic impacts that urban rail can bring. As we will see, the importance of some of these impacts will depend on the levels of ridership or on the density increases that urban rail has fostered, or on a combination of both. In addition, some of the benefits, for example the creation of construction jobs, will relate only to the construction of the system, independent of the system's success.

Before we begin our analysis we have to be aware that urban rail cannot be conceived independently of the social, economic, and physical characteristics of the location where it is to be built. Urban rail cannot be an element of change by itself. If significant economic benefits are to be achieved, urban rail development must be accompanied by a variety of factors, including supportive planning and development agreements, which we will further examine in the next chapter.

## 4.1 Transaction Costs

It has not been until recently that the great and growing importance of the flow of information and of transaction costs has been acknowledged. In the following pages we will introduce and describe the concept of transaction costs and how urban rail can affect

them. As we will see, a reduction in transaction costs is one of the most important economic contributions that urban rail has the potential to bring.

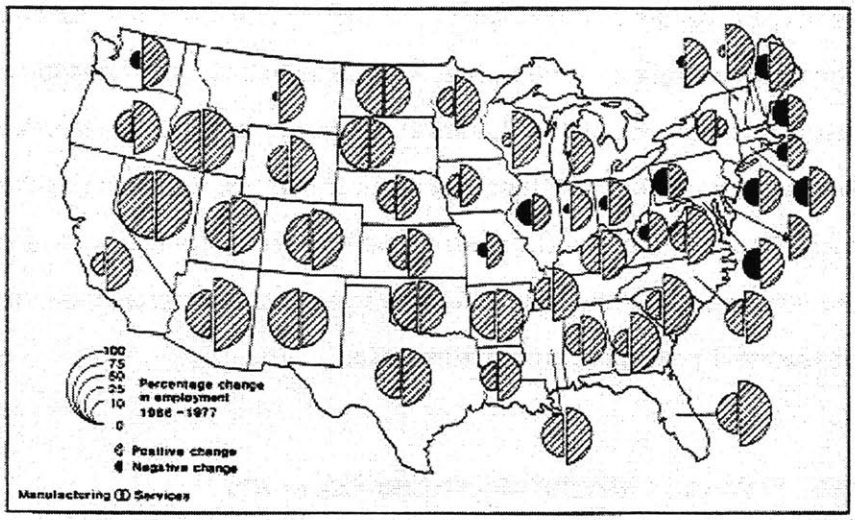
Following Allen Scott's analysis, we will then consider how the organization of economic production processes and their related costs can lead to functional and spatial aggregation or disintegration of economic activities, and how this affects large metropolises[99]. We will see how the large-scale movement of manufacturing processes from metropolitan areas to their hinterlands and the accompanying growth of the service sector in these metropolises can be explained by the evolution of these transaction costs. Finally, we will show the growing economic importance of large dense metropolises and the role that urban rail can play to foster growth by reducing transaction costs.

### 4.1.1 Recent Trends in Metropolitan Development

We can define the city as the locus of consumption activities and social reproduction. According to this definition, in terms of the activities that take place within them, most major U.S. cities have gone through important changes during the last decades. Manufacturing employment has declined in the large industrial cities of the Frostbelt, especially in their city centers. By contrast, as we can see in Map 4-1, Sunbelt cities have performed better, though manufacturing growth in central-city areas has been curtailed. At the same time the service sector has experience a significant growth. The number of white-collar jobs has increased very rapidly, and even within manufacturing the percentage of blue-collar workers (production) has declined fairly regularly over the last decades.

Nowadays, as a consequence of this shift away from blue-collar manufacturing employment towards white-collar service employment, all major metropolitan areas in the U.S. contain large and growing numbers of white-collar workers, and this type of employment is heavily concentrated in the central-city areas. High-level office and service activities are particularly inclined to locate in the center of large metropolises.

**Map 4-1 Changes in U.S Manufacturing and Service Employment by State, 1966-1977**




Changes in U.S. manufacturing and service employment by state, 1966–1977.
Based on data in Norton and Rees (1979, p. 143).

Source: Scott 1988

### 4.1.2 Industrial Organization and Transactions Between Firms

We can see a firm's production of activities as a series of processes linked by means of transactional interconnections. We can then think of production as a network of complex transactions. Internally, there is a set of transactions within the firm that are guided by administrative procedures. Externally, every firm transacts with other firms and their transaction behaviors are mainly guided by price signals. As Coase said[100]:

> *" A firm will tend to expand until the cost of organizing an extra transaction within the firm become equal to the cost of carrying out the same transaction by means of an exchange on the open market."*

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[99] Allen J. Scott, Metropolis: From the Division of Labor to Urban Form, University of California Press, 1988.

Depending on the nature of these transactions and their costs, industries may organize in two different ways:

***Vertical Integration:*** integration of the series of economic activities necessary for the production of a final good or service. Vertical integration tends to occur when the internalization of the costs associated with different labor processes results in cost savings. This especially occurs when market failures in external transactions are the rule. Some of the most frequent failures appear in situations where (a) important information is unequally distributed and (b) costly future contingencies are likely to arise in the context of (c) a complex and unpredictable future.

***Vertical Disintegration:*** outsourcing of economic activities necessary for the production of a final good or service. When internal transaction costs are greater than the external transaction costs productive processes are susceptible to vertical disintegration. The limit in the number of functions that a firm can perform depends on its management and internal information processing capabilities. Some of the cases in which internal transactions costs are greater than external costs occur (a) when markets for final outputs are very uncertain, (b) when a production process can only achieve economies of scale by serving several clients, and (c) where segmented labor markets exist.

### 4.1.3 Industrial Linkages and Transaction Costs

Any increase in the disintegration of production processes will cause a wider network of linkages between industries, all of which incur various costs. These costs range from the purely organizational (such as those incurred when there are increased errors in external transactions) to the purely spatial (such as the movement of goods). Reductions in organizational costs encourage greater disintegration. Disintegration of the production processes increases the level of interaction between economic agents in a geographical space. This interaction will entail transaction costs since it requires (a) direct interpersonal

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[100] Coase R. H., "The Nature of the Firm," Economica 4. 1937. As cited by Allen J. Scott, p. 34. 1988.

contact during which information is exchanged and/or (b) some kind of physical flow of goods and/or people occurs. Therefore, the disintegration of production process brings transaction costs that increase with distance. There are five major elements that will affect the level of these transaction costs:

- Transaction costs generally decline as the goods or information transported are standardized.

- If transactions are recurrent and stable over space and time several setup costs can be lowered, since repetition can be reduced to simple routines.

- Some transactions between business require careful and time-consuming contacts and linkages cannot be set up as simple low-cost orders or routines.

- Transactions often do not involve the physical movement of goods, but the more expensive personalized exchange of intangibles.

- The more complex and difficult the transaction tasks the more experienced and highly paid workers need to be. Therefore, face-to-face contacts over complicated business decisions will involve important time and space costs.

#### 4.1.3.1 Transaction Costs and Location

The location of economic activities will be highly influenced by the characteristics of the different elements that determine transaction costs. It is where linkages between firms are minimal, non-standardized, unstable, and requiring personal contact that they will show high distance-dependent costs per unit of flow. Hence, firms and industries in which this type of transaction predominates will tend to locate near those business with which they have greater distance-dependent transaction costs. On the other hand, when linkages are

large, standardized, stable, and easy to manage, they will incur low transaction costs per unit of flow, and firms will locate at greater distances.

Transportation and communication costs are important components of many firms' transaction costs. The fall in these costs has stimulated the loosening of geographical bonds across industries. However, there remain sectors where producers must cluster together to reduce costs. Moreover, with the increasing importance of just-in-time delivery, the tendency towards concentration is strengthened. This tendency towards concentration is especially significant in office and service functions. These office functions are often linked by costly and often intangible transactional relations that induce their spatial clustering.

#### 4.1.3.2 Office Functions and their Importance in the Modern Metropolis

Office functions are a very important component of the service sector that, as we have seen, have increased significantly in importance, while, at the same time, the contribution of manufacturing activities to total employment has been going through a steady decrease during the last decades. As we noted before, this type of employment is heavily concentrated in the metropolises' central business districts. Thus, in economic terms, the role of cities has grown far more important than several decades ago. Economic growth and global competitiveness of countries and firms are increasingly dependent on the office activities that take place in their cities.

Office functions result from the division of labor that separates executive and clerical jobs from physical production of goods and services. These functions are labor intensive and rely heavily on decision making and personal interaction. Because of the many small and changing transactions that they carry out, office activities tend to fragment into highly specialized units. Consequently, individual office units require access to many external inputs for which demand is constantly changing. These services may include legal advice, management consulting, banking services, software support, and accounting.

**Figure 4-2 Internal Production Space of the Metropolis**

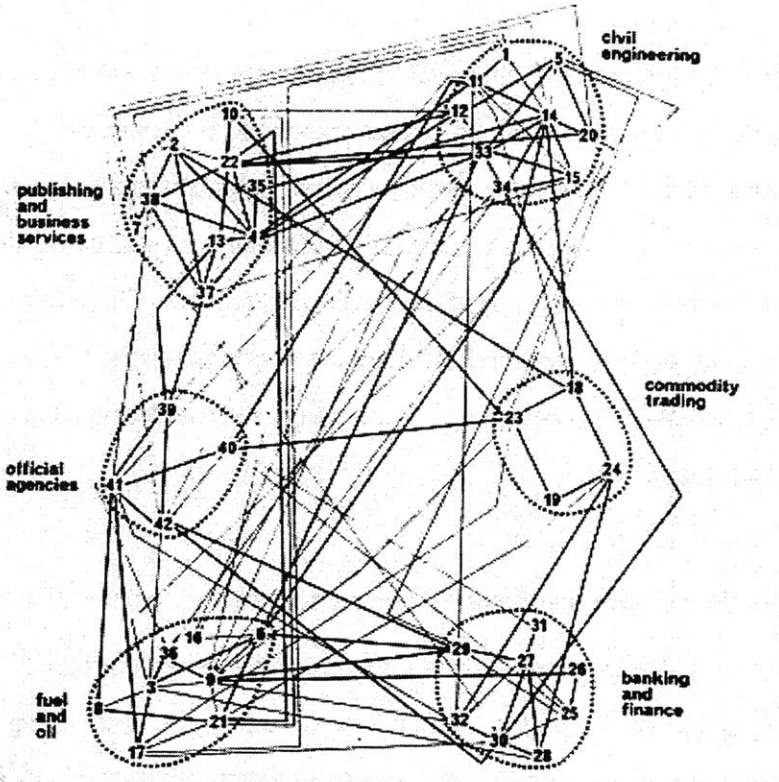


**Figure 5.15.** Telephone contacts in central London. Key: 1. Primary industry. 2. Food, drink, and tobacco. 3. Fuel and oil. 4. Chemicals. 5. Metals and metal goods. 6. Mechanical engineering and machinery. 7. Precision engineering. 8. Electrical engineering. 9. Transport equipment. 10. Textiles, leather, and clothing. 11. Bricks, pottery, glass, and cement. 12. Other manufacturing. 13. Paper, printing, and publishing. 14. General construction. 15. Specialist contracting. 16. Gas, electricity, and water. 17. Transport and communications. 18. Transport services. 19. Food wholesaling. 20. Other specialist wholesaling. 21. General wholesale merchants. 22. Retailing. 23. Export and import merchants. 24. Commodity brokers. 25. Insurance companies. 26. Other insurance. 27. Banking. 28. Stockbroking and jobbing. 29. Other finance. 30. Property. 31. Accounting. 32. Legal services. 33. Consulting engineers. 34. Architects. 35. Other specialist consultancy. 36. Nonprofit services. 37. Advertising and public relations.

Source: Scott 1988

Most of the transactions that office activities carry out do not involve the flow of material inputs and outputs. They mostly consist of flows of information via telephone, personal contact, and other forms of communication such as electronic mail. Face-to-face meetings are characteristic of inter-office contact systems. These systems are generally costly and this cost increases with the number of parties involved and with the degree of complexity. These systems are generally quite costly, engaging large numbers of people paid salaries

related to their varying skills and experience. The high cost of these office transactions explains much of the clustering of inter-related offices in the central business districts of large cities. By clustering office functions highly paid labor costs will be saved and skilled professionals will be more productive by incurring in less distance-dependent costs.

It is true that back offices perform routine activities such as payroll, billing, and accounting that require little external contact. These offices do not need close contact with other offices, and they can locate in the suburbs of the metropolis where land and labor are cheaper. Nevertheless, this process has not stopped the growth of the large central office complexes which will remain the central element of the metropolitan economic landscape, as Scott notes[101]:

> *" Much of the industry has decisively decentralized to suburban and peripheral areas in response to rising land and labor costs at the core and to falling transport costs generally. Not-withstandingly the systematic decentralization of this element of the urban economic base, and despite occasional crisis of the urban system, cities in the major capitalistic countries continue to grow as the division of labor moves forward and as new innovative sectors of production make their historical appearance. The tendency toward massive urbanization of the economy in capitalism will undoubtedly continue to manifest itself so long as the logic of fragmentation, interaction, and agglomeration proceeds within growing segments of the economy.*
>
> *This same logic leads not just to generalized urban agglomeration but also to the emergence of multiple dense industrial districts within the metropolis."*

Office activities will keep growing in importance in the city centers and will also contribute to the creation of new specialized sub-centers of activities within cities, where firms cluster to reduce their transaction costs.

### 4.1.4 Urban Rail and Transaction Costs

Urban rail has the potential to reduce the monetary and time costs of many of the transactions that take place in a metropolis. An efficient urban rail system will provide its users with fast and reliable connections between different origins and destinations. Moreover, if the system helps reduce road congestion, it will also reduce road travel times. These potential reductions in travel time are likely to bring down the distance-dependent component of transaction costs. Workers will spend less time moving between places which will leave more time to perform more productive activities.

Urban rail will have a greater impact on transaction costs if it enables higher densities. If densification is achieved, a firm located in the area will be physically closer to many of the externally supplied inputs that it requires. This easy access to clients and suppliers would further reduce their distance-dependent costs since their workers' face-to-face communications costs would decrease. An additional advantage is that greater densities may increase the size of the market. Firms have a greater pool from which they can chose their suppliers of goods and services. As this brings greater competition, firms are likely to become more efficient. An additional advantage of this increase in market size, owing to the combined effect of densities and greater accessibility, can come from the provision of new services. Consequently, the supply of additional goods and services in the area would further reduce the transaction costs for firms located in the metropolis, which would increase their economic competitiveness.

As we have seen, an increase in density has great potential to bring savings in transaction costs. However, urban rail can further reduce part of these costs by providing an efficient transportation alternative that reduces firms' monetary and time costs.

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[101] Ibid. 99 p. 63

Urban rail is also uniquely suited to major metropolises, as Scott mentions, because in these metropolises there will appear not one, but several dense districts, and urban rail, with stations in these districts, can provide tighter linkages between them and help them achieve even greater reductions in transaction costs.

## 4.2 Labor Market (Non-construction)

Metropolises are major loci of human and economic activity, and most of the economic activity of most countries takes place in urban areas. In the following paragraphs we will analyze two key related elements that affect firms' urban location and their profitability; one is the availability of a large supply of labor, and the other is the commuting cost of this labor. As we will see later, urban rail, by expanding the size of the labor market and by reducing transportation costs, can bring significant benefits both for employers and employees.

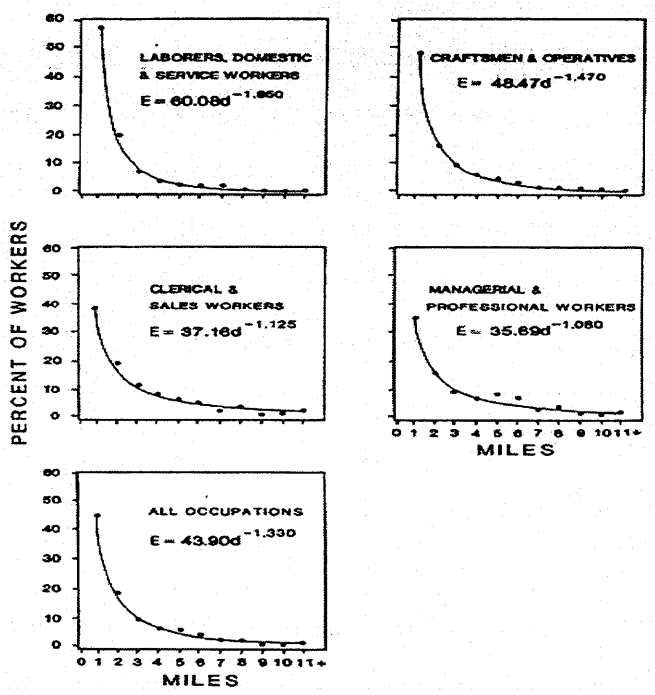
***Cities and labor pool:*** As Prud'homme says, cities are more productive than rural areas[102]. Cities have a higher output per worker per unit of private capital. Consequently, urban growth can be a source of economic growth by moving people from low productivity areas to higher productivity areas, and hence, increasing the productivity of the country. It is precisely the size of their labor markets that explains this greater productivity. The larger the labor market, the greater the probability an employer can find exactly the workers it wants, and the greater chances a worker will find the job he or she wants. In addition, this larger labor market facilitates specialization of workers and jobs, which in turn will increase productivity.

The size of the labor markets is critical and can be defined by three elements: Size, Sprawl, and Speed. Size is the overall population size of the metropolis that we consider. Sprawl refers to the relative location of jobs and households; all things equal, the labor market of a dense metropolis will be larger than that of a dispersed one. Speed is determined by the

efficiency of the transportation system. Hence, the larger the population of the city, the lower the sprawl, and conversely, the greater the efficiency of the transportation system, the larger the size of the labor market will be.

***Commuting Costs:*** Modern metropolises can be seen as a system of production and social spaces tied geographically through workers' commuting habits. Within this urban space, there is a common pattern by which employers tend to locate close to suitable supplies of labor and workers' residences tend to be near major places of work in an effort to attain high accessibility to work places. Consistent with this, observed work trips are short on the average, and commuting distances are related to socioeconomic status. As we can see in Figure 4-3, the residences of lower socioeconomic groups are clustered closer to their places of work than those of higher economic status.

**Figure 4-3 Empirical Distribution of Work Trips, 1964**




Source: Scott 1988

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[102] Ibid. 16

The model used by Scott[103] suggests that wages will increase as the demand for labor increases and firms have to recruit from a wider labor pool. This is because wage rates are positively correlated to the time and out of pocket commuting costs of workers. There are some sectors and occupations whose wages are very sensitive to commuting costs. Hence, the location of employment will tend to reflect these issues. As we saw before, different firms tend to cluster together to reduce their transaction costs and will locate close to the geographical center of their main labor force to avoid upward pressures on wage rates. Those aggregates of producers that have very large labor needs will find locations near the center of the metropolis especially attractive. Two examples are clothing manufactures and office locations. These findings are supported by the research conducted by Darren Timothy on the Boston labor market[104]. His study shows how wage differences between work zones within a city are partly explained by commuting time differences.

### 4.2.1 Urban Rail and Employment Benefits

Urban rail can have two major positive impact on the labor market. First, it provides a fast and cheap transportation alternative. Households that rely on urban rail will be able to limit their purchases of and expenditures on private cars. This will reduce workers' commuting costs. If workers pay less to commute to work, firms can take advantage of this reduction and reduce wages, since wages are positively related to commuting costs. As a result, a more abundant and cheaper labor force can increase profitability of firms and can attract additional investment into the area.

Second, it allows for an expansion of the labor market. Urban rail, by increasing the transportation efficiency and carrying capacity of the area, can allow for an increase in the population size, and it can play a key role in increasing workers accessibility to jobs in a

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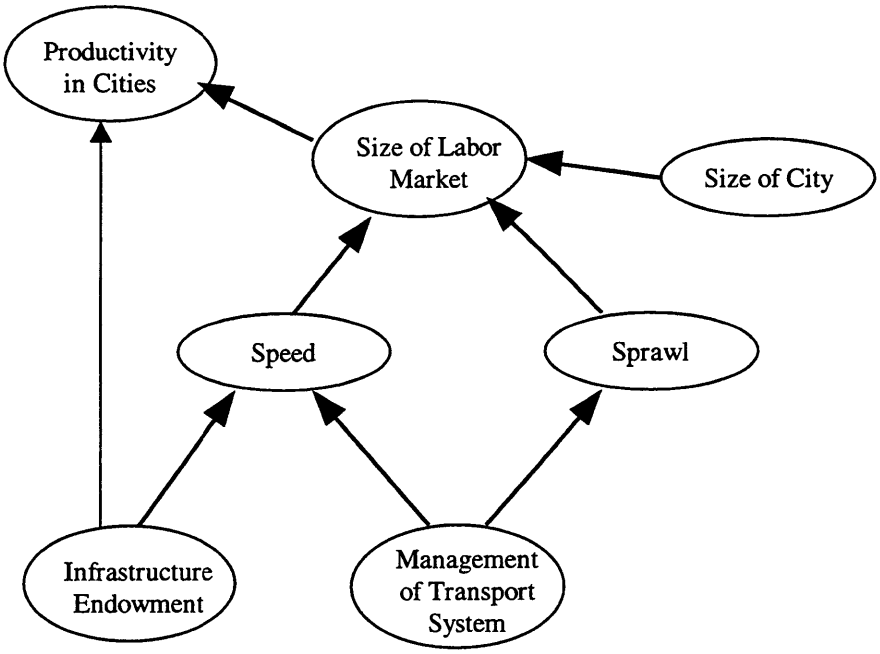
[103] Ibid. 99

[104] Darren Timothy, "Interurban Wage Differentials and Commuting Time," Chapter 3, MIT Phd Dissertation, August 1995.

given area. Furthermore, if this is accompanied by increases in population densities, the reduction in sprawl, as noted by Prud'homme, will also increase the size of the labor market. As workers gain access to a greater number of jobs their employment choices will increase, and they will be able to find jobs for which they are better prepared. There will be a better match between job supply and demand, and firms will be able to hire workers whose skills are more valuable to them. As a result, the economy will benefit from increased productivity achieved through better job allocation efficiency. The larger the labor market, the more productive a city will be.

However, this relationship between city size and productivity is not immediate. Bigger cities are more difficult to manage than small cities. Effective management of a city is crucial to ensure that potential gains in productivity are not lost because of an inadequate use of resources. According to Prud'homme[105], transportation can play an important role in this relationship between potential and effective urban productivity. Therefore, urban rail, by providing an efficient transportation alternative, can help a city achieve a greater level of productivity.

**Figure 4-4 Transport and City's Productivity**




Source: Adapted from Prud'homme, 1996

As we saw in Chapter Two, John Semmens, in his article "Is Public Transit a Good Investment[106]" has an opposite vision. He claims that investing in transit has a negative effect on employment. Semmens says that if the money invested in transit had been diverted to finance tax cuts, 7 million jobs would have been created instead of the 0.9 million created by transit. However, he only considers direct jobs created by transit, ignoring other important benefits, that, as we have seen, are likely to improve, not only the living conditions of the area, but also its economic efficiency and productivity. Ultimately, these effects will translate into creation of jobs in sectors that not being within the transit sector are directly and/or indirectly benefited by it.

[105] Ibid. 16
[106] Ibid. 17

Urban rail benefits come mainly from increased and affordable accessibility to jobs. Secondly, by helping to attain greater densities, it increases the size of labor markets and further reduces commuting costs.

## 4.3 Construction & System Operation Jobs

The immediate benefits brought on by the construction of an urban rail facility are very apparent, but not necessarily the most important. The construction generally requires an important inflow of funds that will be used to pay for local labor and for the purchase of certain local goods and services. However, due to the highly specialized skills and equipment that is required, an important percentage of the cost of the project often goes outside the area, to pay for goods and services that are not available in the area. The construction impacts of urban rail can be divided into three main groups:

- ***Construction:*** Any urban rail infrastructure project is a very labor-intensive task. However, we must remember that local labor will be a relative low proportion of the total cost. Most of the jobs that will be created will be construction jobs. Once the facility is finished, the jobs will disappear. This increased labor demand may seem to many a vital opportunity to join the formal labor market.

- ***Supplies & Services:*** As we saw, most of the inputs will probably come from outside the region. However, it is likely that some percentage of the total, such as gravel, maintenance of equipment, some professional services, can be drawn from within it.

- ***Operation & Maintenance:*** Once construction finishes, the operation of the system begins. Permanent jobs for driving, managing, and maintaining the system will be created but their number will be much lower than the construction jobs.

The impact of the construction is limited in time though once construction finishes new jobs are created to operate and maintain the system. However, as we will see, construction impacts can be greater if local workers use the opportunity to increase their skills and productivity. Most of these impacts are linked to the construction of the system; therefore, they will be independent of the densities and ridership levels that are achieved. However, increased ridership may translate into additional jobs for the operation and maintenance of the system.

## 4.4 Buildup of Skills and Export of Services & Labor

In general, we can expect employment benefits to go beyond the creation of thousands of temporary construction jobs, and a lower number of permanent jobs for the maintenance and operation of the system. Another positive effect is likely to come from an upgrade in the job skills of the local workers that participate in the design and construction of the system. It is often the case that international contractors with unique expertise that is not available in the region will work on the design and construction of the system. The degree of the skills upgrade will be related to the level of cooperation and technology transfer of international contractors to local workers and professionals that get involved in the design and construction of the system. Consequently, the construction of urban rail can bring three major benefits:

- Local engineers, designers, and contractors can learn from their exposure to advanced skills and technologies and use it to secure a competitive commercial position. If international projects are awarded to locals, exports of services will rise. This would have a positive impact on the region's trade balance.

- An additional benefit from this exposure to more advanced techniques and the strengthening of worker's skills will come in the form of increased productivity and efficiency; both for professionals and construction workers. By building

and designing better and/or cheaper pieces of infrastructure, the region is likely to enjoy better and/or cheaper infrastructure. More can be obtained with less resources that can be devoted to additional projects.

- These skilled workers will increase their chances of finding jobs outside the region. This type of migration can have two positive impacts if there is surplus of labor and their skills are not under-supplied.

    - Reduction of unemployment and welfare expenditures.

    - An increase in the inflow of remittances. If migrant workers maintain links with the region, part of their income will be channeled as remittances to relatives or as leisure expenditures.

The potential economic benefits brought by the buildup of skills and export of knowledge are independent of the density and ridership impacts of urban rail. However, should the system succeed in changing the urban form and attracting a high number of riders, it would be an important marketing tool, proving the quality of its designers and planers.

## 4.5 Densities and Land, Infrastructure, and Housing Costs

In this chapter we will see that land developed at greater densities, closer to existing developments, and using already developed infrastructure, can provide significant land and capital cost savings over traditional sprawl-type development, whose densities range typically from one to three households per acre. Finally, we will see how urban rail can help achieve those cost reductions. Our goal is to show that increases in density can have positive economic effects. We will not define the optimal density levels. However, we must note that increases in densities will not always be positive. Depending on the characteristics of the area, there will be a certain density level beyond which further increases in density will be negative.

The implications of these two types of development will be focused in the following three areas: *land consumption*, that involves the use of land for development while considering the loss of agricultural land and the intrusion of development in frail environmental lands; *infrastructure consumption*, that considers the capital investments necessary to provide new developments with roads, utilities, schools, and other facilities; and finally *housing costs*, that considers the costs per residential unit.

### 4.5.1 Types of Development

For this analysis, we will follow Robert Burchell and David Listokin[107], who compare the resource consumption implications of the traditional U.S.-style sprawled development with a planned dense development. A *traditional development* is one that presently dominates the U.S. landscape and is becoming increasingly popular in other countries. This type of development generally includes subdivision-style development in the form of 0.33 to 1.0 acre lots. *Planned developments* attempt to contain new growth around existing centers and limit development in agricultural and environmentally-fragile lands. They seek to reduce road construction and water/sewer infrastructure provision through more contained developments. This would be done by increasing densities of development in areas close to existing developments and by decreasing the share of development in the outer areas.

#### 4.5.1.1 Traditional Development

This type of development is characterized by an outward movement of development towards the outer ring of the metropolitan areas. Associated with this outward movement is a requirement for more land and public infrastructure to serve this new development and a growing under-utilization of available land and infrastructure in the central area. This type of development is also associated with the creation of 'edge cities,' often at the

intersection of interstate highways. These edge cities become the employment and service centers of the region.

This type of development brings another consequence; which is the creation of 'bedroom counties' and communities whose purpose is to service these areas by providing more peripheral residence. This happens because land prices decrease as we move further from the metropolitan center.

The result is a highly homogeneous metropolitan area with industrial, commercial, and residential development either on or immediately off the main road spokes that radiate from the center of the metropolitan area. Meanwhile, the core of the metropolitan area is progressively abandoned and becomes home to poor residents that cannot follow the upper-income residents to the suburbs. However, this trend is being reversed in some U.S. cities such as Boston, which experienced a growth of 14,000 people in its inner city between 1980 and 1990, compared to a shrinking of 75,000 people in the previous decade[108].

This type of development causes two major costs. One comes from the need to provide new additional infrastructure for those that are moving outward. The second is the cost of maintaining the old infrastructure for the people who are left behind in the core. This causes taxes and development costs to rise in the entire metropolitan area, which increases the costs of living or doing business in the area.

This option, in the short-run, is not bad for the region. Firms and people are distributed to locations that minimize their individual out-of-pocket costs. Moving from the old core is an easy individual decision. However, when firms or individuals choose a location, they are trying to maximize their individual benefits; they do not consider the larger societal

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[107] Robert W. Burchell and David Listokin, "Land, Infrastructure, Housing Costs and fiscal Impacts Associated with Growth: The Literature on the Impacts of Sprawl versus Managed Growth," Lincoln Institute of Land Policy Research Papers, 1995.
[108] Ibid. 22

costs of their location decisions that define this development pattern. Therefore, in the long-run these decisions may have a negative impact.

#### 4.5.1.2 Planned Development

The goal of planned development is to maximize development while limiting its costs by containing growth within locations that can be served more efficiently. This type of development reduces the use of undeveloped peripheral land and limits the costs of providing public infrastructure to this land. The infrastructure savings that are achieved can be invested in the central areas to upgrade decaying neighborhoods, and to provide incentives for the development of new replacement structures, greater safety, and other features. Consequently, the contrast between the old and new is moderated and old core areas are better prepared to compete with the suburbs.

Why this more efficient approach is not pursued in the U.S. or other countries like Australia? This is related to the confluence of technological, economic and cultural priorities that we saw in the previous chapter. The U.S. has been characterized by its investment in the development of land and a preference for low density. Other countries, helped by economic and technological advances, and a greater contact with the U.S., have progressively changed their preferences towards the U.S. model.

### 4.5.2 Development Patterns and their Costs

These two types of development have different land, infrastructure, and housing requirements. Costs will vary depending on these requirements. As we are going to see, traditional development patterns are more resource intensive than planned development; hence they are more costly.

#### 4.5.2.1 Land Consumption Costs

A land consumption study was done by Rutgers University for the state of New Jersey[109] to estimate its land development requirements from 1990 to 2010. As a result, it was estimated that traditional development would require 40 percent more land than planned development. It was also estimated that it would require 60 percent more agricultural land and 17 percent more development on environmentally-fragile lands.

The lower land requirement of planned development has several positive consequences. First, it achieves a more productive utilization of a finite resource, such as land. Second, it is more beneficial for the environment since it disrupts fewer frail lands, and it covers less land with houses and roads. Third, by consuming less land, especially agricultural land, the output of this land is not lost.

#### 4.5.2.2 Infrastructure Costs

Development in a particular area needs to be accompanied by the provision of additional infrastructure. Utilities, water and sewage pipes, roads, schools, are some of these infrastructure needs without which development is not viable. According to Duncan et al[110]. "Compact, infill, and higher density development is more efficient to serve than scattered, linear, and lower density sprawl."

Several studies support the importance of achieving greater densities as a means of reducing infrastructure costs. Planned development, by fostering compact infill, and greater density development can achieve costs savings in capital facility provision. The Rutgers University study of the state of New Jersey indicated that New Jersey could save $1.3 billion in infrastructure costs for roads, utilities, and schools over a twenty-year

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[109] New Jersey State Planning Commission. Communities of Place: the Interim State Development and Redevelopment Plan for the State of New Jersey. July, 1991. As cited by Robert W. Burchell and David Listokin, 1995.

[110] James Duncan et al. "The Search for Efficient Urban Growth Patterns," Tallahassee, FL, Florida Department of Community Affairs, 1989. As cited by Robert W. Burchell and David Listokin, 1995.

period if a state plan managing growth were followed, as opposed to the present traditional sprawl patterns of development.

There are three reasons that explain the lower infrastructure cost of planned development:

- Need: Better managed development is more efficient and requires less infrastructure because development is directed to areas where there is surplus capacity. This includes schools that can accommodate additional pupils, and sewage plants with additional treatment capacity. On the other hand, traditional development does not fully utilize existing infrastructure and instead requires the provision of additional infrastructure.

- Distance: Even when a planned development requires new infrastructure, its greater density means that it will be built over smaller areas than with sprawled traditional development. Fewer miles of roads, utilities, and water and sewer lines will be built. In U.S. cities, roadways and parking lots consume over 30% of developed land, and up to 70% in downtown areas[111]. In 1988, the U.S. averaged 82 feet of roadway per capita, twice more than in western Europe.

- Efficiency: The greater densities of planned development bring together larger amounts of people and create the potential for achieving economies of scale since larger and more efficient sewage treatment plants and schools can be built. In addition, the return on infrastructure such as roads can be higher since they would be more intensively utilized.

Cost estimates from the New Jersey plan show that planned development is cheaper than traditional development. According to their study, planned development relative to traditional was: 75 percent as expensive with respect to roads, 95 percent with respect to

[111] Ibid. 30

schools and 85 percent with respect to utilities, and it was at parity with respect to other infrastructure.

#### 4.5.2.3 Housing Costs

Estimating the impacts of greater development densities on housing costs is not simple. There are several studies that support that housing prices increase in areas where there are restrictions (such as the ones that may be brought by planned growth). However, these studies have been concentrated on the effects not on an entire region, but on a particular community. This shortcoming was avoided by the Rutgers study by considering the overall housing affordability in a larger area governed by planned development where development would be restricted in some localities while encouraged in others.

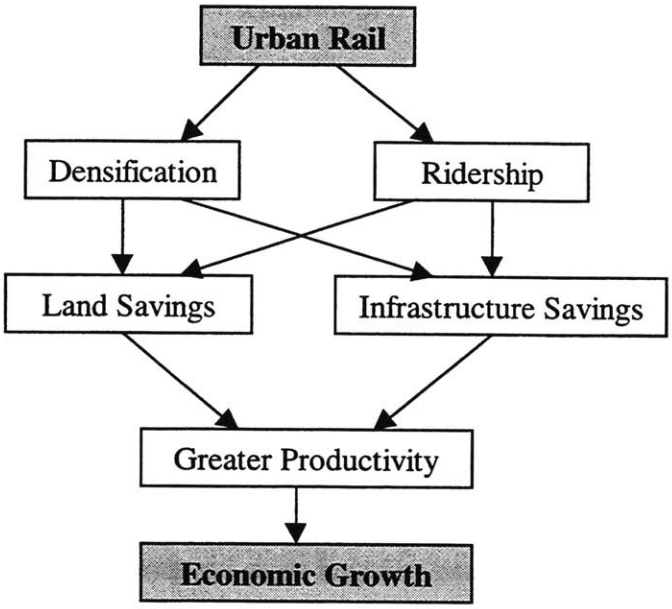
To allow for decreases in housing costs preservation efforts, which encourages increases in prices should be offset by increases in densities in areas that accommodate new development near existing developed areas. The study showed that planned development does not increase housing costs and may even bring small savings.

### 4.5.3 Urban Rail and Land and Infrastructure Benefits

The potential reductions in infrastructure benefits that we discussed above will materialize if a more dense development pattern is achieved. Urban rail with its capability to encourage greater development densities can be a very effective instrument to help concentrate development in the most adequate and achieve significant infrastructure costs savings.

These benefits will be almost entirely correlated to urban rail's capacity to encourage greater densities; ridership alone will have little influence on these impacts. However, if significant ridership levels are achieved, road infrastructure and land covered by roads could begin to be reduced.

**Figure 4-5 Urban Rail and Land and Infrastructure Benefits**




Daniel Freire, 1998

- *Land benefits*: Less land is used, therefore it is possible to achieve the same or a greater level of output with less of this resource; productivity is increased. The preservation of environmentally-fragile lands in beneficial to the environment and health benefits may be derived to people. In addition, preservation of green areas can preserve or increase tourist attractive and the quality of life for the local population. Finally, if agricultural land is not used agricultural output will not be reduced.

- *Infrastructure benefits:* With more dense development there are lower infrastructure requirements. The same or greater output level can be achieved with less infrastructure.

The combination of these savings has the potential to increase the economic attractive of the area. Lower land and infrastructure savings will decrease the cost of these inputs to firms and, at the same time, the efficient utilization of the infrastructure is likely to lower tax pressures. All these elements reduce the cost of doing businesses in the area and can bring a competitive advantage over other areas, which can generate economic growth and also attract investment.

## 4.6 Environment

Cities around the world are increasingly suffering from the problems associated with urban sprawl and high automobile dependency. In many cities, the most directly observable problems are air and noise pollution caused by a growing number of vehicles on the roads. Technological improvements have reduced these negative impacts; however, they have not been eliminated. In the following pages, we will examine how auto dependency negative environmental impacts go beyond air and noise pollution, and more importantly, how urban rail systems can help reduce these negative effects.

### 4.6.1 Environmental Costs of Auto Dependency

Automobile dependency is growing throughout the world, and very intensively in less developed nations. Automobiles provide good mobility and excellent point to point connections, and they are not subject to wait times. In addition, it is an increasingly comfortable transportation mode. Automobile reliability and excellent connectivity are important characteristics that have surely brought economic gains and productivity increases. Despite these positive attributes, the current high utilization of the car has many negative effects that could be grouped into the following categories:

- *Consumption of natural resources:* The production of the final goods that we can buy to satisfy our transportation requirements requires the use and consumption of finite resources such as oil and iron. The extraction and processing of these

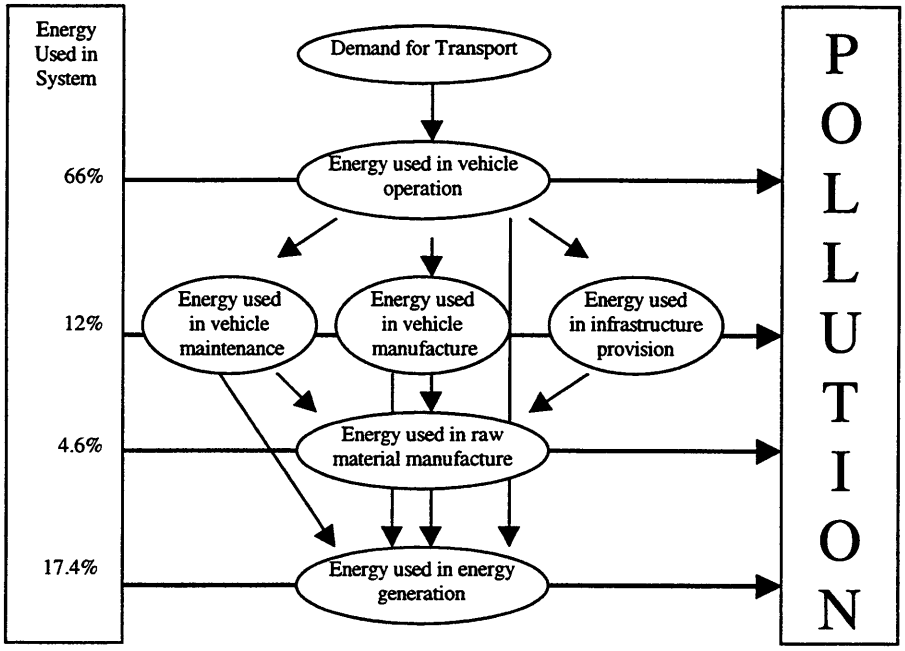
resources to obtain these final products is negative for the environment. Oil pipelines through the jungle are an easy access to poor farmers that within a generation destroy valuable natural resources. The processing of steel, oil or plastic is not clean and it has negative effects on the environment

- *Energy Consumption*[112]: Transport requires energy. Vehicles consume energy when they move between their origins and destinations. However, for every vehicle that is produced energy is consumed in producing steel, glass, plastic, and other components. For every mile that a vehicle is driven, more energy is required for the production of inputs for the construction and maintenance of infrastructure in the form of bitumen, stone, concrete, and so on. This indirect consumption of energy is of special importance since as we can see in Figure 4-6, it makes up a significant percentage of the total road transport energy use.

  Critics say that when energy expenditures for the construction of rail systems are considered, rail investments turn out to be net energy losers[113]. Therefore, unless high ridership levels are attained, energy savings benefits of urban rail will be highly suspect.

[112] R. S. Tolley, B. J. Turton, Transport Systems, Policy and Planning: A Geographical Approach, Longman Scientific & Technical, Singapore, 1995.
[113] Ibid. 30

**Figure 4-6 Energy and Pollution**




Source: Tolley and Turton, 1995

- *Oil Vulnerability:* The U.S. is an oil producer county, but its production is not sufficient to satisfy an increasing oil demand. Countries with no production of oil are completely dependent on foreign sources of oil. Consequently, sudden changes in the price of oil can cause Gross Domestic Product losses[114]. If a new oil crisis or another conflict of greater impacts than the one of Kuwait in 1989 were to come these oil dependent countries could find themselves in a very fragile situation.

- *Global Warming*[115]*:* There are increasing pressures to reduce $CO_2$ emissions, these pressures will turn more towards transport as it is the fastest growing user of fossil fuels and the least able to switch to other fuels. In the near future, it is likely that

[114] Mark A. Delucchi, "The Annualized Social Cost of Motor-Vehicle Use in the U.S., Based on 1990-1991 Data: Summary of Theory, Data, Methods, and Results," pp. 27-68. The Full Costs and Benefits of Transportation: Contributions to Theory, Method and Measurement, Edited by David L. Greene, Donald W. Jones, and Mark A. Delucchi, Springer, New York 1997.
[115] Ibid. 21

international agreements to curb $CO_2$ emissions will require the introduction of costly technologies and other measures to reduce the use of the private car. Highly auto-dependent cities will suffer the greatest costs.

- *Air Pollution:* Transport is a major source of air pollution, and in many developed countries it is the fastest growing. Clean air is fundamental for a city's well being, however many cities regularly exceed the limits. Transport is an important source of $CO_2$ and Volatile Organic Compound (VOC) emissions[116]. Illnesses such as asthma, and other respiratory problems can be caused by air pollution.

- *Noise Pollution:* Noise is any disagreeable sound[117]. Its effect will depend on the individual's sensitivity, its location, the time of day and on existing noise levels. It is estimated that in 1988 20% of the European citizens suffer unacceptable road noise levels. Noise disrupts activities and sleep, it can slow the learning process at schools and impede verbal communication, and it can be a cause of property price fall.

### 4.6.2 Urban Rail's Environmental Benefits

These environmental problems can be reduced if the purchase and use of private cars is decreased. Urban rail, by providing an alternative to the use of the car, enables reductions in car use and purchase that can bring environmental benefits. This is because, all things remaining equal, there is a percentage of urban rail users that would have resorted to the private car if urban rail had not been an alternative.

Urban rail's positive environmental impacts can be increased because of its capacity to direct urban growth and sustain greater densities in the areas it serves. As we noted in Chapter Two, as population densities increase, public transit ridership is likely to increase.

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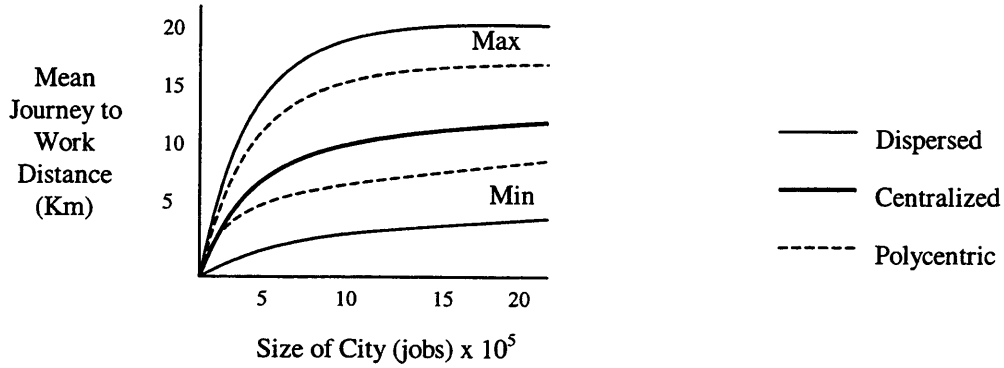
[116] Ibid. 112
[117] Ibid. 112

As a result of this higher density, a greater number of services and economic activities can be performed in the same area. Therefore, automobile travel needs can be reduced, and a greater number of trips from one location to the other can be done walking or using public transportation.

Both impacts will have positive environmental consequences. Increased urban rail ridership and lower transportation needs brought by densification will mean that private auto-ridership and single occupant vehicles will be lower than they would had been otherwise.

It may be argued that the dispersal of activities is occurring because job opportunities are following housing into the suburbs and the need for travel is then reduced[118]. However, this dispersal of activities is not moving cities towards greater efficiency. Dispersion can lead to either shorter commute if home and work are close or it can lead to a much longer commute if they are not. Figure 4-7 shows that if the distribution of jobs in an urban area is dispersed or polycentric, mean journeys to work, depending on the residential locations relative to those jobs, can have a wide range of variation. Hence, an urban area with a dispersed job distribution can have a mean journey to work that can range from a minimum of five kilometers to a maximum of twenty. Evidence from Melbourne, Australia and from San Francisco, California, where commutes actually increased with dispersal, suggests that dispersal leads to greater automobile dependence and less efficient metropolises.

**Figure 4-7 Relationship Between Travel Distances and Dispersed, Centralized, and Polycentric Distribution of Jobs**




Source: Newman & Kenworthy, 1992

The attraction of car riders to the urban rail system is likely to be beneficial for the environment and sustainability of cities. Urban public transportation systems are more efficient than private cars in terms of the resources they require. With a 50% load factor bus and rail energy consumption per passenger-kilometer is approximately five times lower than for private cars. In addition, public transportation produces less polluting emissions, and less noise per passenger-kilometer[119] than private cars. In 1987 it was estimated that in Germany for every mile traveled per passenger, cars produce more than twice as much $CO_2$ as rail, four times as much Nitrogen Oxides (NOx) and seven times as much in the form of Volatile Organic Compounds (VOC)[120].

If urban rail is used, the same or greater levels of activity will be achieved without the corresponding increases in automobile use and purchase. This is likely to bring several benefits, including:

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[118] Ibid. 28
[119] Commission Européenee, "Un résaau pour les Citoyens: Comment Tirer Parti du Potentiel des Transports Publics de Passagers en Europe, Bruxelles - Luxembourg, 1996.
[120] Ibid. 112

- *Lower consumption of energy and resources:* The same activities can be performed using less resources. In other words, with less inputs the same or more outputs can be produced, hence, productivity can be increased. According to Michael Breheny[121], energy savings can be achieved through greater densities accompanied by significant improvements in public transport.

  By reducing the demand for transportation infrastructure, the environmental costs involved in the extraction and processing of the resources used to produce that infrastructure can be lowered. These environmental damages will tend to be more localized and they will mostly affect the areas from where the inputs come and the areas where the products are processed. However, we must not forget that, ultimately, negative environmental effects have a global impact.

- *Reduced oil vulnerability:* A region that does not produce sufficient oil to satisfy its local demand is very vulnerable to oil scarcity and price increases. The more oil dependent that a region is the more likely that its economy will negatively by affected by oil price increases. In the case that oil supply was not sufficient to satisfy demand, the economic disruptions would be greater, and it could have negative impacts in the quality of life, as the case of Cuba is presently showing us.

  Authors like Delucchi suggest that there are additional costs derived from oil dependency such as military expenditures that are incurred to protect and defend strategic oil providers as it was in the Gulf War, and the cost of the strategic petroleum reserves[122].

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[121] Michael Breheny, "Transport Planning, Energy and Development. Improving Our Understanding of the Basic Relationships," pp. 89-95. Transport and Urban Development, Edited by David Banister, 1995.
[122] Ibid. 114

By reducing the energy needs the economic costs of oil price increases or oil supply shortages will be lower. In addition, a region with lower oil dependency will more attractive to investors that want to avoid the economic risk of oil scarcity.

- *Reduced air pollution, noise pollution, and global warming:* Several studies conducted in 1991 and 1992 have attempted to estimate the economic costs of pollution at the local level in Europe, with results ranging from 0.15% to 1.05% of the Gross National Product (GNP)[123]. Urban rail is more efficient and less polluting than the private car. Regions and cities that are highly dependent on the automobile will be the least able to respond to this challenge. Reducing these emissions will be costly if a similar level of service is to be maintained. However, even though greenhouse effects are less localized, the existence of these emissions is also costly to everyone. Climate changes are already imposing economic costs via temperature, and rain variations among others. Reductions in air and noise pollution will reduce health costs and productivity losses associated with bad health conditions.

In 1990 the National Resources Defense Council conducted a study on the external costs and subsidies for typical urban trips in the U.S[124]. This study estimated that air pollution, noise pollution, water pollution, and energy imposes a cost that ranges from 5.7 to 12.3 cents per passenger mile traveled for autos and from 2.1 to 5.6 cents per pmt for urban rail. We have to note that urban rail costs are related to ridership. Since the marginal cost of carrying an additional passenger is very low, certain ridership levels should be achieved so the positive impacts of carrying its users will be greater than the negative impacts that

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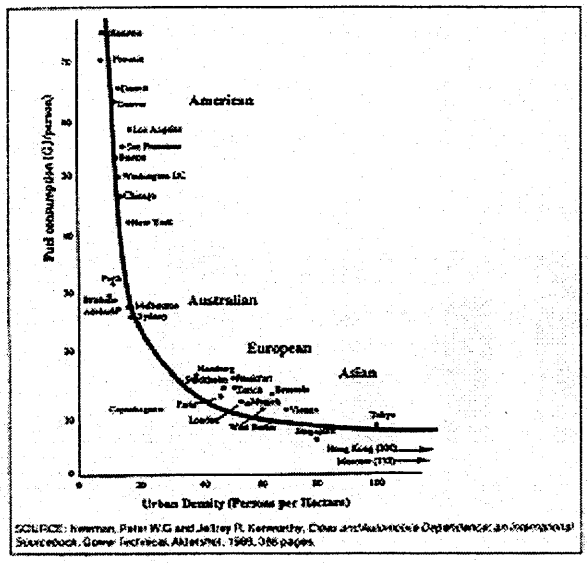
[123] Emile Quinet, "Full Social Cost of Transportation in Europe," pp. 69-112. The Full Costs and Benefits of Transportation: Contributions to Theory, Method and Measurement, Edited by David L. Greene, Donald W. Jones, and Mark A. Delucchi, Springer, New York 1997.

[124] Jose A. Gomez-Ibañez, "Estimating Whether Transport Users Pay Their Way: The State of the Art," pp. 149-172. The Full Costs and Benefits of Transportation: Contributions to Theory, Method and Measurement, Edited by David L. Greene, Donald W. Jones, and Mark A. Delucchi, Springer, New York 1997.

also has. In addition, as we can see in Figure 4-8, these benefits will also be related to density. The denser a metropolis is the higher transit ridership will be. Therefore, the consumption of gas and of other transportation resources will be lower.

**Figure 4-8 Population Density and Gasoline Consumption per Person for 32 Cities (data for 1980)**




Source: Newman, 1996

We have seen how, overall, urban rail is more efficient and environmentally friendly than the private car. Nevertheless, we must remember that this will not apply to all cities. Urban rail also affects the environment; it requires natural resources and energy to be built and operated. This energy generally comes from the combustion of oil or coal; hence it also contributes to global warming and air pollution. In addition, it causes noises. The environmental advantage of urban rail is that, if it is not underutilized, its negative environmental impacts per passenger mile will be lower than that of the private car. The higher its ridership levels, the greater its environmental benefits will be. Therefore, it will only make economic sense to resort to urban rail in those metropolises where there are residential and employment corridors that can provide enough ridership to make urban rail's costs per passenger mile traveled lower than for the car.

## 4.7 Sustainability

There is evidence that larger and denser cities tend to have lower per capita use of resources and production of waste[125]. These cities have better access to markets and recycling technologies. They have greater resources and leverage to acquire more advanced waste treatment facilities and more energy efficient public transport infrastructure. It is true that these larger cities reach air, water supply, and waste limits sooner, but they also have greater ability to tackle these issues.

As Manhattan and Tokyo show us, urban rail can help a metropolis attain greater population and employment densities. In turn, these greater densities can help metropolitan areas achieve a critical size that enables them to acquire more efficient and environmentally friendly transportation and waste treatment infrastructure. Larger and denser cities, if well managed, are in a better position to minimize the negative environmental impacts related high auto use that we discussed above. In addition, they can minimize other negative environmental costs related to their production of non-transportation waste.

## 4.8 Congestion, and Travel Time Costs

Often, the first advantage that comes to mind when talking about urban rail is the reductions in travel time that it enables. Congestion is an increasing concern in many cities where ownership and car use are growing at a faster pace than the provision of road infrastructure, which makes vehicles spend longer hours 'stuck in traffic.'

This time lost could be divided into (a) monetarily compensated work time that could be used more productively, and (b) personal travel time; this is not paid time but rather leisure or uncompensated household production time (Delucchi, 1997). Time spent by cars and trucks on the road has several negative economic impacts. Goods and services take

[125] Ibid. 22

longer to be delivered, increasing their costs. In addition, under slower stop and go traffic conditions, air emissions are greater[126], and ultimately, overall quality of life decreases not only for drivers but for the entire population of the metropolis. Furthermore, a city with important congestion problems is likely to lose new investments in favor of less congested areas[127].

As Figueroa & Henry note[128], urban rail is often conceived as a means to alleviate congestion. Some authors insist on the economic importance of travel time savings. For Fouracre & Gardner,[129] travel time savings account for almost 75% of urban rail benefits, especially in developing countries. Similarly, Peter Townroe[130], for the case of Sheffield in the U.K, affirms that road congestion relief is the main external benefit of public transit. However, several authors state that we should not expect reduced travel time by road as a consequence of the operation of an urban rail facility. As Banister & Lichfield say[131], the construction of new roads generates new traffic and congestion will remain unchanged, especially in developed countries.

A more realistic vision may be the one coming from the BART Impact Program Advisory Committee[132]. The BART study states that urban rail is not likely to have significant impacts on traffic. According to the study, the impacts at the regional level are likely to be small, and the most significant reductions in travel time will probably be achieved in local bottlenecks, like the impact that BART had on the Bay Bridge traffic.

However, benefits will occur even if congestion remains unchanged. If this is the case, it means that the space that is freed by urban rail users is taken by cars or trucks. Hence, because of urban rail, a greater number of trips can take place, allowing for an increase in

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[126] Nancy W. Sheldon, Robert Brandwein, The Economic and Social Impact of Investments in Public Transit, Lexington Books, Lexington, MA, 1973.
[127] Ibid. 31
[128] Ibid. 49
[129] Ibid. 26
[130] Ibid. 12
[131] Ibid. 14
[132] Ibid. 51

the economic and social activities in the metropolis. In addition, by reducing transit travel times urban rail can also benefit those transit users that before had to resort to slower buses, jitneys or other transit modes.

Investment in urban rail should not be solely be seen as a way to reduce congestion, since increases in traffic are likely to absorb the capacity freed by urban rail users. However, depending on the incremental improvement in transportation provided by urban rail, especially at specific bottlenecks, travel time savings may occur.

### 4.8.1 Urban Rail's Congestion & Travel Time Benefits

Urban rail has greater carrying capacity than buses and cars. The increased carrying capacity brought by urban rail will benefit the metropolis by reducing congestion and travel times and/or by increasing the total carrying capacity of the entire network. As urban rail is more utilized there will be benefits in terms of increases in activities and or in travel time savings for car drivers and transit users.

The city, with the increased carrying capacity brought by urban rail, can sustain a greater number of economic activities that otherwise would not 'fit' in the metropolis. Hence, more investment can be attracted. At those points where congestion is reduced there will be economic benefits in terms of less work hours lost in traffic and lower inventory costs due to a faster flow of goods. This is of great importance; in 1994 it was estimated that congestion costs had already increased trucking costs by 15 to 20 percent[133]. Urban rail, by providing a fast and comfortable transportation alternative, and by reducing congestion, can help improve the attractiveness of the city for investors.

These benefits would increase with ridership and would improve even more if urban rail helped achieve higher densities. As we have stated, there is a positive relationship between high densities and transit use. If densities increase, a greater number of trips that

[133] Ibid. 74

would have been done by car will now use urban rail; according to Miller and Ibrahim, vehicle kilometers traveled decrease with centralization of activities[134]. Firms and service providers are closer and trips that in a low density area would require a car, can now be done walking or by transit. Therefore, even if congestion remained unchanged travel times would be reduced. However, if urban rail helps reduce congestion it would benefit car drivers and firms in their road delivery of goods and services. We should note that these benefits are also positively related to ridership. If ridership increases, even if densities remain unchanged, most of these benefits are likely to occur too.

According to Prud'homme[135], we must be careful in how we reduce congestion. As we previously discussed, if congestion is reduced, all things equal, it would contribute to an expansion of the labor market. Nevertheless, if congestion is reduced by introducing other changes, such as dispersement of jobs and people, it can lead to a contraction of the labor market that would fragment into several smaller labor markets, which would decrease the efficiency of the entire urban area.

Finally, as congestion increases, urban rail will provide an increasingly attractive transportation alternative that will especially benefit firms for which travel times can be an important cost element. As Neuwirth notes for the case of Atlanta, airport access is important for firms, and the city is running out of office sites that are accessible to the airport by highway in less than one hour[136]. MARTA stations, by providing a 20-minute connection from the downtown and midtown stations to the airport, will become increasingly attractive locations for firms. Atlanta exemplifies the importance of urban rail's time savings for firms and the benefit that it can bring to a city by enabling economic growth that could be otherwise diverted to other cities with office space at a reasonable distance from an airport, or other significant facilities.

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[134] Ibid. 40
[135] Ibid. 16
[136] Ibid. 11

## 4.9 Import Substitution

Import substitution occurs when resources devoted to the purchase of foreign produced goods and services are switched to locally produced goods and services. In those countries that do not have an auto industry the vehicles they purchase, most of their parts, accessories, and in many of them even gasoline, have to be imported. As a result, payments for these goods will entirely benefit foreign producers, with the exception of the margins for local dealers and maintenance shops.

Reductions in the consumption of this type of goods and services are likely to have a positive effect on the local economy. This could be demonstrated using an input-output model. Input-output models represent the economic structure of a region, the linkages between its industries, and linkages with other regions. Therefore, the effect on the local economy of a change in consumption patterns can be shown. In our case the change would be a different allocation of resources. Resources, instead of being used to pay for almost entirely foreign produced goods, would be used for the purchase of a new mix of goods and services or saved. Given the high foreign component of auto-related payments, it is very likely that a greater percentage of this new mix of goods would be locally produced. Hence, the local economy would benefit from an increase in demand. This could translate into higher employment, higher competitiveness through economies of scale, or other positive impacts whose nature and amount would vary depending on each particular case. This would encourage economic growth throughout the region, not only in the areas where auto-related expenditures are reduced.

The economic impacts will be related to urban rail's success in reducing the purchasing and usage of private vehicles. This impact will increase with ridership and it will be greater if densities are increased and, as a result, transportation needs reduced. However, it is important to remember that a significant percentage of the cost of an urban rail facility goes to pay for imported goods and services. Consequently, unless certain import reductions are achieved, it may happen that urban rail has a negative effect on the trade balance.

## 4.10 Accidents

Worldwide, more than a quarter of a million people are killed in transport accidents and more than 13 million are injured every year. A 1995 study for the OECD countries, estimated that these accidents cost 1.5 percent of GDP[137]. However, safety depends on the transportation mode that is used. Road travel is by far the most dangerous transportation mode, being responsible for more than 90 percent of these casualties[138]. Automobile travel is the more dangerous modes that transit; in 1971 it was estimated that for every hundred million miles traveled, there were 5.3 automobile fatalities compared to 0.19 bus fatalities and 0.07 passenger train fatalities[139].

The cost of these accidents can be divided into direct and indirect costs[140]. Direct costs include medical costs, mental health care for the injured and its family, emergency services, property damage, legal, and administrative costs. The indirect costs are productivity losses, including travel delay of people that were not directly involved in the accident, the cost of secondary accidents, and employer productivity losses. Finally, there are insurance costs to distribute the financial burden of accidents between drivers, and inspection costs that are established to reduce the risk of those accidents. These costs are not related to any accident in particular, but they exist because accidents occur, and their number and importance justify the existence of these procedures. According to the National Defense Resource Council, estimations for the U.S. auto-urban accident costs

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[137] T.R. Lakshmanan, Peter Nijkamp. Erick Verhoef, "Full Benefits and Costs of Transportation: Review and Prospects," pp. 387-406, The Full Costs and Benefits of Transportation: Contributions to Theory, Method and Measurement, Edited by David L. Greene, Donald W. Jones, and Mark A. Delucchi, Springer, New York 1997.

[138] Ibid. 112

[139] Ibid. 126

[140] * Ted R. Miller, "Societal Costs of Transportation Crashes," pp. 281-314, The Full Costs and Benefits of Transportation: Contributions to Theory, Method and Measurement, Edited by David L. Greene, Donald W. Jones, and Mark A. Delucchi, Springer, New York 1997.

* Ibid. 123

suppose 3.3 cents per passenger mile traveled (pmt) versus 0.6 cents per pmt for rail transit[141].

Urban rail, by attracting a greater number of passenger miles that would have otherwise been done by car, helps reduce the number of accidents, and consequently, the costs that are related to them. Population densities, by reducing transportation requirements and by making both rail and bus transit more attractive, further reduce the potential costs of road accidents.

## 4.11 Retail and Entertainment

The greater accessibility of an area served by an urban rail station and the flow of transit riders entering and exiting the system can benefit businesses that locate in the area. The importance of urban rail for these activities can be shown by the fact that in 1979, seven years after BART began its operations, a survey prepared for the USDOT stated that 18% of the merchants in downtown San Francisco affirmed that BART was helping their sales[142]. Similarly, after the construction of Portland's urban rail, its downtown saw an increase in share of the city's retailing, form 5% to 30%[143].

As was noted in Chapter Two, several authors, including Roanne Neuwirth[144], suggested the possibility that retail and entertainment investment at stations may not be a real but often an apparent growth, merely constituting a relocation of activities. If this is the case, output per unit of input would remain unchanged independently of location. However, retail and entertainment centers can achieve several benefits by locating at or close to urban rail stations, especially if the station areas are densely developed. They can attract a greater number of customers, for which the time and monetary costs of choosing their store is lower. By serving a larger number of customers, they can attain greater sales by

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[141] Ibid. 124
[142] Ibid. 72
[143] Ibid. 31
[144] Ibid. 11

square feet and/or employee; economies of scale and higher levels of productivity can be achieved. If a critical number of customers or sales level is achieved, it may become feasible to commercialize new goods or services.

Customers can also benefit. As we said before, the monetary and time costs of getting to those merchants is lower, they can buy the goods and services they require in less time, and as retail options increase they will be able to enjoy a greater variety from where to choose. Their 'productivity' can be increased and the service they receive has the potential to improve.

The economic impact of urban rail for retail and entertainment activities will be related to ridership; the greater the number of riders, the more attractive the location will be for businesses. However, it is important to note that if retail and entertainment activities are to be highly dependent on urban rail, ridership levels of the system should reach certain minimums. According to Cushman, transit line ridership at a given station must be impressive to attract interest from the private sector; he also estimates that system ridership has to exceed 100,000 daily passengers to attract businesses[145]. Densities, as they contribute to higher ridership levels, will also increase these benefits. Furthermore, greater residential and employment density may also increase the potential number of customers, even if they do not use the system.

## 4.12 Providers of Non-commercial Activities

These benefits related to the greater accessibility of the businesses to clients are not limited to the private sector. Urban rail can be an important advantage for providers of non-commercial activities "who can achieve economies through greater concentration of activities[146]. Schools, government services, and health facilities can concentrate their services in smaller number of locations to take advantage of economies of scale. The

[145] Ibid. 29
[146] Ibid. 19

result will be that a similar level of service will be achieved with less resources that can then be spent in other productive activities.

When choosing to locate one of these facilities close to a station, it is not ridership but accessibility that should guide the decision. As long as accessibility is provided and urban rail frequencies and reliability are reasonable, these services can be located close to the stations, independently of the system's ridership levels. They will not draw benefits from greater ridership; it will be urban rail that will benefit from the ridership they generate. Benefits will increase with population densities. The denser the station area and other station areas within the alignment the greater the number of potential users that a single facility can serve.

## 4.13 Quality of Life

Practically all of the benefits that have been stated could be ultimately translated into an improvement in people's quality of life. However, it is important to be aware of the relevance of the quality of life per se and how it affects not only people but also the economy. Both Roanne Neuwirth[147] and Peter Newman[148] state the importance of public transit as a means to improve the quality of life in a metropolis. The increase in auto-dependency has brought several negative consequences that urban rail can minimize. These negative impacts can be organized into the following:

***Accessibility:*** An auto-dependent city requires a car to have access to its different services and activities. However, there are important segments of the population that cannot have access to a car, and therefore their mobility and quality of life is seriously curtailed. According to Tolley and Turton these groups could be divided into[149]:

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[147] Ibid. 11
[148] Ibid. 22
[149] Ibid. 112

- *The poor:* There is an important percentage of people that cannot access jobs because their lack of access to adequate transport, which they cannot overcome because of their lack of income. This poverty can be also associated with health. There is a connection between the ease of access to medical facilities and their use, and therefore with mortality and morbidity. Therefore, their limited capability to access jobs and health service negatively affects their economic productivity and increases health costs.

- *The disabled:* It is estimated that in the United Kingdom (U.K.), 12 percent of the population suffers different degrees of disability. Many of the disabled suffer from limited mobility that is further reduced as they cannot drive and their other transportation choices are very limited. In addition, their ability to enter the labor force and being productive is curtailed.

- *The elderly:* Health and personal capabilities decline with age. Driving a car becomes more dangerous and walking more challenging. Furthermore, as their retire their income reduces. Both for physical and monetary reasons an auto-dependent city can seriously isolate them and reduce the number of activities they can perform.

- *The young:* The benefits of higher car ownership are offset by constraints on parents' freedom. Greater distances, lack of urban rail and other transit facilities, and the dangers of traffic result in an increased need to drive or escort their children. As a result, in the U.K. over one quarter of women's trips are as chauffeurs. Hence, time and resources are used inefficiently. Another effect is that it limits the opportunities for children to develop their independence.

The more accessible that a metropolis is the better quality of life for their inhabitants, especially those that do not have access to a private car because of economic or physical

reasons. In a transit-friendly metropolis, the elderly, the handicapped, the poor, and the young can expand their horizons and urban rail can open to them a greater number of activities. Without depending on others they can enjoy theaters, museums, cafes, clubs, meeting friends and many other activities that are less accessible to the sprawled population; or, as we discussed before, they can find a job more easily and increase the overall regional economic productivity.

***Congestion:*** Urban rail, well integrated with other modes, can provide convenient and fast access to destinations, eliminating the hassle of driving and the costs and inconveniences of congestion.

***Safety:*** Peter Newman signals that auto-dependency has a negative impact on cities[150]. The use of private cars reduces pedestrian activity, which can decrease public safety. Urban rail, by reducing auto dependency, encourages this pedestrian activity. The presence of a greater number of people on the streets increases safety. With more people on the streets, there are more potential witnesses if a criminal act were to be committed, which discourages these criminal activities. Consequently, there is greater freedom for women, men, and children to enjoy the city without fear during most of the day and the night.

***Urban Vitality:*** Auto-dependency reduces pedestrian activity, causing a decline in urban centers' vitality and attractiveness. Such environments decrease the pleasure of walking and lower the possibilities of social interaction, **which** has a negative impact on the 'spirit' of the city. This can be reversed with urban rail's contribution to greater urban activity.

### 4.13.1 Urban Rail and Quality of Life Benefits

Quality of life is closely related to the existence of pedestrian activity. People like to live in places they can enjoy, where they can have easy access to entertainment activities, and

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[150] Ibid. 38

preferably in a nice setting; a walk through Michigan Avenue in Chicago will probably be more pleasant than a walk through Massachusetts Avenue in Cambridge. The combination of all these factors not only increases the quality of life for the residents, but also enhances the attractiveness of the city.

The quality of life benefits that we have cited are positively correlated with system ridership and urban densities. The more people that use urban rail, the more pedestrian activity that will take place, at least at their destination. The greater the densities urban rail helps achieve, the more the city will be open to activities that can be performed walking, cycling, or using transit.

As ridership increases and urban centers become more dense and pedestrian-oriented they can attract investment from new or expanding industries, especially from the service sector. This is because firms, to attract highly-skilled workers, have to provide them not only with good salaries and professional opportunities, but also with an attractive place to live, for themselves and their families. Furthermore, there are several studies that show how global firms are attracted to European-style pedestrian-oriented environments[151].

One industry than can especially benefit from urban rail investment is *the tourism industry*. As a city becomes safer and more lively, it is likely to attract more recreational expenditures. There may be a greater number of tourists that come from distant origins, or just local and regional residents that now see walking through a safe and pleasant city with different entertainment options. Therefore, retail can be encouraged, and other entertainment activities can flourish in the light of vibrant urban centers. These benefits can be enhanced if urban rail stops are conveniently located for hotels, rail and airport facilities[152].

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[151] Ibid. 22
[152] Ibid. 74

## 4.14 Ridership and Density Impacts

If we want to maximize urban rail's benefits, it is important to be aware of the relationship between ridership and density levels and urban rail economic impacts. Both ridership and densification are linked, ridership and the increased accessibility of stations attract development. In turn, development generates more ridership, and it is can also attract additional development.

Despite the fact that some of the impacts that we have analyzed will depend more on ridership than on density levels, or vice-versa, it is not possible to draw a clear line separating them. For instance, it seems clear that the benefits of reducing congestion or decreasing the number of accidents will be directly related to urban rail's ridership. However, if urban rail helps increase density levels, it will reduce the need for automobile trips, what will decrease congestion and accidents. In the case of transaction costs, they will be reduced as a consequence of greater densities; however it is unlikely that densification would occur without high ridership levels.

## 4.15 Distribution of Benefits

We have discussed the potential economic benefits of urban rail. As it is of key importance to describe and understand these benefits, it is also important to identify who the main direct beneficiaries or urban rail are, and where they are located, especially if we want to design actions that will maximize these benefits.

**Table 4-2 Distribution of Urban Rail Direct Benefits and Disbenefits**

| BENEFITS | Benefits | | |
|---|---|---|---|
| | Individuals | Firms | Society |
| Transaction costs | | X | |
| Labor Market | X | X | |
| Construction & Operation | X | X | |
| Buildup of Skills and Exports of Services and Labor | X | X | |
| Densities and Land, Infrastructure, and Housing Costs | | | X |
| Environment | | | X |
| Sustainability | | | X |
| Congestion and Travel Time Costs | X | X | |
| Import Substitution | | X | |
| Accidents | | | X |
| Retail and Entertainment | X | X | |
| Providers of Non-commercial Activities | | | |

Daniel Freire, 1998

Table 4-2, contains a distribution of the direct recipients of the different types of benefits that urban rail can bring. We have selected the direct benefits because they are the most important and visible; although we are aware that the final distribution of benefits will change as a consequence of the re-distribution of benefits that it is likely to happen through second and third round effects. As we can see from Table 4-2, urban rail benefits individuals by increasing their employment opportunities. As members of society they are also benefited by being able to enjoy a better environment. Firm's benefits will not be equally distributed. Even the import substitution effects and the benefits of being able to recruit cheaper and better prepared workers, that will benefits the majority of the firms, will benefit some firms and activities more than others. It will be firms with high level of decentralization that will benefit the most from transaction cost reductions, these firms, together with firms that move freight, will also be the major beneficiaries of reductions in congestion. Higher accessibility to retailers will only benefit some retail firms, and design and construction contracts will only benefit construction and design firms.

In Table 4-3 we can see how most of the benefits occur at the local level. However, because of second and third order effects it is likely that these benefits will extend beyond

the metropolitan area. However, it is the direct benefits that are the most visible, and urban rail, in general, is not exclusively financed with local resources, and an important percentage of the cost is usually financed with national or regional funds. Due to data limitations and calculation difficulties we are able to provide a numerical estimation of these benefits.

**Table 4-3 Geographic Distribution of Urban Rail's Benefits**

| | Benefits | |
|---|---|---|
| **BENEFITS** | **Local** | **Regional** |
| **Transaction costs** | M | m |
| **Labor Market** | M | |
| **Construction & Operation** | M | m |
| **Buildup of Skills and Exports of Services and Labor** | M | m |
| **Densities and Land, Infrastructure, and Housing Costs** | M | |
| **Environment** | M | |
| **Sustainability** | M | |
| **Congestion and Travel Time Costs** | M | |
| **Import Substitution** | M | m |
| **Accidents** | M | |
| **Retail and Entertainment** | M | |
| **Providers of Non-commercial Activities** | M | |

M: major benefit
m: lower benefit
Daniel Freire, 1998

If a metropolis wants to maximize the economic benefits of an urban rail project, the main potential beneficiaries should be identified so their concerns and needs can be incorporated into the project. These potential beneficiaries should also integrate the construction of the system into their decisions.

## 4.16 Conclusion

Urban rail, by increasing accessibility levels and by helping direct urban growth, can foster a series of benefits that can give one area greater levels of efficiency and productivity, which in turn can result in a new competitive advantage over other areas. However, as we

have already said, urban rail cannot be an element of change by itself; it must be accompanied by a variety of factors if significant benefits are to be achieved.

With this chapter we conclude the theoretical analysis of urban rail' potential economic impacts and the factors that affect them. In the following chapter we will begin our empirical discussion with the analysis of three recent urban rails systems in the U.S.

# 5 Introduction

As we discussed in the previous chapter, the benefits of urban rail are related to the physical construction of the system, its ridership levels, and the dense development it helps achieve. By analyzing three urban rail systems in the U.S., we will be able to better asses how successful they were in attracting riders and encouraging dense development.

It is important to note that when we talk about development we are referring to preferably dense development of 10,000 people per square mile, that encourages urban rail ridership. In general, it will not be difficult to attract at least some development to a station area, but this development will be a failure if it does not contribute to moving the metropolis towards a more efficient form. Development space around the stations is limited, and there will be a big opportunity lost if for example a 'car dealership' that serves few people for the space it occupies is built in the place where a high-rise apartment building could be.

In the following pages we will describe and analyze each of the three recent urban rail systems from the U.S. that we selected for our study: Metrorail in Miami-Dade county, Bay Area Rapid Transit (BART) in the San Francisco Bay Area, and Metro in the Washington DC metropolitan area. Based on these three case studies, we will outline our view of the most important factors determining the success and economic benefits of an urban rail system; then, we will describe some of the tools and policies that are likely to be most effective in maximizing these benefits.

## 5.1 Metrorail and Miami-Dade County

Metrorail is a 21 mile long heavy rail system that began its operations in 1984, and currently carries an average of approximately 50,000 passengers on weekdays. Metrorail is located in Miami-Dade County, which is along the southeast tip of the Florida peninsula.

The county encompasses more than 2,000 square miles (larger than the states of Rhode Island and Delaware). One-third of this extension is covered by the Everglades National Park. Miami-Dade county is bounded by Biscayne Bay and the Atlantic Ocean to the east, Everglades National Park to the west, the Florida Keys to the south, and Broward County to the North.

Miami-Dade county, with more than two million inhabitants, has experienced a fast population growth during the last five decades. Like San Juan, Miami is an important tourist destination. Its cruise port, with more than 3 million annual passengers is the world's busiest. Additionally, approximately 5.6 million of cargo move through the Port of Miami, ranking first in Florida and eighth nationally[153]. Another similarity with San Juan is that with more than 30 hospitals, Miami has a strong health care industry. Miami International Airport is an important source of economic activity. Finally, since the 70's, growth in the financial sector has made Miami an important financial center.

Miami-Dade county experienced significant population growth of more than 40% in the 15 years prior to the Metrorail's opening. This impressive growth took place when automobile was the predominant transportation technology, sprawl was the result. It was easy to disperse activity elsewhere because Miami did not have a solid and mature downtown center with a high concentration of activities. Therefore, it has adopted an auto-dependent form, lacking important subcenters of residential and economic activity that could attract a high number of patrons by acting as origins and destinations. The only exception is Government Center station in the city of Miami. However, even employment densities within the city of Miami, that are the highest in the county, are far from the recommended minimum of 10,000 jobs per square mile[154].

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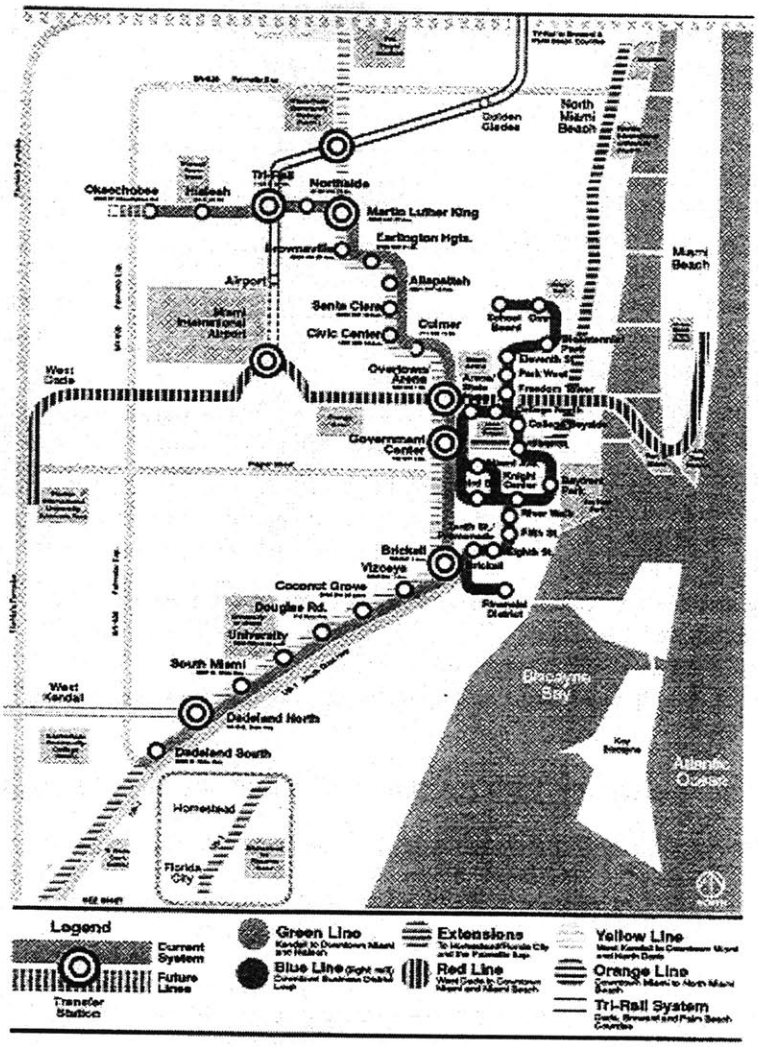
[153] Miami-Dade county: http://www.co.miami-dade.fl.us/
[154] Ibid. 32

**Map 5-1 Metrorail System and Planned Extensions**




The most important areas of economic activity in Miami-Dade county are its downtown, that is covered by the Metromover, the Miami International Airport area, and the corridor along the Palmetto Expressway to the west of the airport. Lower income populations are concentrated in the north and around downtown Miami, and the wealthier in the south.

**Table 5-1 Miami-Dade County Urban Characteristics**

| | 1984 / 1985 | 1989 / 1995 |
|---|---|---|
| **Total Population** | 1,755,553 | 2,046,078 |
| **City of Miami, FL *** | 373,940 | 367,016 |
| **City of Coral Gables, FL *** | 41,850 | 41,021 |
| **City of Hialeah, FL *** | 161,760 | 191,702 |
| **Population Density**** | 1,300 | 1,515 |
| **City of Miami, FL *** | 10,902 | 10,309 |
| **City of Coral Gables, FL *** | 3,321 | 3,476 |
| **City of Hialeah, FL *** | 8,338 | 9,984 |
| **Employment Density**** | 578 | 834 |
| **City of Miami, FL *** | 5,677 | 6,148 |
| **City of Coral Gables, FL *** | 1,887 | 2,018 |
| **City of Hialeah, FL *** | 4,614 | 4,994 |
| **Income per Capita** | 13,276 | 21,058 |
| **City of Miami, FL *** | 8,904 | 9,799 |
| **City of Coral Gables, FL *** | 21,089 | 30,852 |
| **City of Hialeah, FL *** | 8,256 | 8,914 |
| **Persons per Automobile** | 1.53 | 1.59 |

Sources: Regional Economic Information Service, Bureau of Economic Analysis.
County and City Data books, 1988, 1994.

* Data from 1985 and 1989 respectively

** Population density in Miami-Dade county excluding the Everglades area.

Miami's and Hialeah's relatively high residential densities are close to 10,000 people per square mile, however, the highest employment densities are much lower, reaching a maximum of 6,148 jobs per square mile in the city of Miami.

As of now, the most significant development projects that have occurred around Metrorail stations have been at Dadeland South and Dadeland North stations, which are in one of the highest per capita income areas of Miami-Dade County. On the other hand, no significant development has occurred around the northern section of Metrorail that happens to be in an economically depressed, and low income area

Miami-Dade County, like many other areas in the U.S. was negatively affected by the economic downturn that occurred at the end of the 80s, beginning of the 90s. The Douglas Road station case, is an example of how development is more likely to occur under favorable economic conditions. After Metrorail began its operations, a real estate

firm, the Babcock Company, reached an agreement with Miami-Dade county to construct a mixed use development; during that time the economic conditions changed, and at the end, the project did not go through because the 'window of opportunity' had passed[155].

### 5.1.1 Alignment of the System

From a ridership perspective, Metrorail's alignment is not optimal. Important concessions were made in order to secure funding and political support for the project[156]. The most important destinations are the CBD Government Center, Civic Center, and Brickell that serves the financial district. Dadeland South and Dadeland North are important origin stations. The stations that are served by the section of the alignment north of Civic Center station are predominantly poor minority residential and commercial districts. The northern part of the alignment does not serve corridors of activity that are complementary with the rest of the system. People living in the area are not likely to travel to work or shop at downtown, and vice versa.

The problem of alignment inadequacy is heightened by Metrorail's small network size of only 21 miles. The alignment only goes through one major employment center, Government Center[157]. Miami International Airport and the Palmetto Expressway corridor are not served by urban rail. By not serving these two major centers of economic activity, the number of trips that Metrorail can serve is significantly reduced.

### 5.1.2 Location of Stations

Some of the stations are well-located such as Government Center or Dadeland North and Dadeland South stations whose appropriate location was confirmed by the development projects that have been integrated with the station. On the other hand, Okeechobee and

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[155] George Brown, phone interview, Manger, Green Construction Company, March 9, 1998.
[156] Bill Cowart, "Miami's Metrorail: Lessons and Differentiation Strategies for Tren Urbano," Working Paper, April 1994.
[157] Clark Turner, phone Interview, Director of Planning, City of Miami, January 29, 1998.

Colmer stations do not attract the number of car riders they were expected because they do not have a good access to the highway system.

### 5.1.3 Level of Service

Metrorail frequencies range from 5 to 15 minutes, and are perceived by users as insufficient. The Datrans office complex in Dadeland South Station was negatively affected by reductions in train frequencies and reliability. The competitive advantage to attract certain types of office activities was lost when frequencies decreased[158].
Bus frequencies, ranging from 10 to 70 minutes, are too low and are perceived as unreliable[159].

The span of service is 19 hours and it goes from 5:00am to 00:00am.

### 5.1.4 Inter-modal Integration

The limited size of Metrorail's network is further limited by its inadequate modal integration with the bus system. The proposed feeder buses that would have increased Metrorail's ridership were not introduced. There are two main reasons that explain this failure: Metrorail's poor alignment, and the lack of resources of the Miami-Dade Transit Agency. Due to low ridership levels, Metrorail has been running budget deficits. These deficits resulted in cut in Metro-Dade bus service. In addition, the poor alignment has contributed to a lack of coordination between Metrorail and Miami's jitneys. The only exception is the successful 8.2 mile busway that serves Dadeland South station.

This constitutes further explanation for the low ridership it has achieved, averaging 50,000 weekday passengers.

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[158] Ibid. 155
[159] Center for Urban Transportation Research, University of South Florida, "Profiles of U.S. Fixed Guideway Systems and Operators," Data Book 2, April 1997.

### 5.1.5 Station Accessibility

Because of poor alignment, some stations do not have good road accessibility, as is the case for Okeechobee station. On the other hand, Dadeland North and Dadeland South are very accessible for vehicles. Furthermore, one of the most important elements that led developers to select this site was its superior road accessibility; these stations are located at the confluence of three major freeways. Pedestrian accessibility should be improved in several of the stations, including Dadeland North.

### 5.1.6 Parking

Parking in downtown Miami costs on average $70 to $100 per month[160]. To this price we must add the cost of driving; however, this price is very difficult to estimate, since, in general, drivers only perceive the marginal cost of driving. Nevertheless, if we compare the $100 to $150, that may be perceived as the total cost of driving to work to downtown, with the $50 that it would cost to ride Metrorail, it results that auto, because of its much higher LOS, is a very attractive alternative. Furthermore, because of the poor alignment of the system, Metrorail will often only provide one leg of the trip. Therefore, the time and monetary costs of using urban rail will be even greater.

In addition, Metrorail provides 8,633 parking spaces in 18 of its 21 stations at a price of $2 per day. The goal of these stations is to reduce congestion and increase ridership by attracting auto users that would, otherwise drive all the way to their destinations.

### 5.1.7 Availability of Land and Ease of Assembly

In general, land availability has not been a problem around suburban Metrorail stations. Large lots of land were available at Dadeland North and Dadeland South. These lots have been partially developed since the opening of the system. At Douglas Road and Civic Center stations, among others, there remain large tracts of land with development potential.

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[160] Telephone survey, April 1998.

### 5.1.8 Urban Environment

Miami-Dade county is a highly auto dependent city. Streets outside downtown areas are not designed for pedestrian use.

### 5.1.9 Zoning and Community Support

In 1978, to encourage development the area around Metrorail was declared as a "Rapid Transit Zone," and a *Fixed-Guideway Rapid Transit System-Development Zone* ordinance was enacted. The high density, mixed used development at Dadeland South Station was achieved without community response. This lack of response was good in the sense that there was not opposition, but it is bad in the sense that community cooperation could have helped achieve a better integration of the project with the surrounding neighborhood.

In general, Metrorail has not experienced significant community involvement. The inadequate location of several of Metrorail's stations, combined with its low ridership levels, have limited development interest to a few stations. The most important stations have been Dadeland North and South and Douglas Road, and in none have communities been very vocal for or against the projects. The fact that a large percentage of the population are new arrivals to the county may explain this lack of significant community participation.

### 5.1.10 Public-private Partnerships

The environment at Miami-Dade county and its municipalities is very politicized[161]. An additional problem that developers mention is the lack of political interest in development projects[162]. Urban rail development projects are big at a local scale but become relatively small at the county level; therefore, they are given lower priority.

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[161] Ibid. 155

According to George Brown, a real state developer, it is good to negotiate with transit officials, as he did for the Dadeland South project, since both the developer and the agency share the same interest in attracting greater ridership. When the role and negotiating powers of the transit officials was reduced, an understanding with the private sector was more difficult, as occurred with the failed development agreement with the Babcock company for Douglas Road station.

### 5.1.11 Conclusion

Metrorail's current ridership level, averaging less than 50,000 weekday passengers, is well below the expectations. There are a combination of factors that can explain the present failure of Metrorail and it low ridership level, including:

- Poor alignment of the system
- Small network size
- City structure that is not conducive to the use of transit services
- Lack of dense residential and employment subcenters
- Rail and bus frequencies are low and jitneys are not integrated with rail
- The LOS provided by the private car is significantly higher than urban rail's LOS, despite the fact that the cost difference does not completely compensate for it

### 5.1.12 Before and After Metrorail

Metrorail is a relatively new system; only 14 years have passed since it began operations in 1984. A longer period of time should pass before urban rail can have a noticeable impact on a metropolis. Despite this short period of time and the low ridership levels it has reached, it is already possible to notice some of its impacts. The first and most noticeable impact is the high density office and hotel development that took place at Dadeland South station, that has been followed by commercial development in Dadeland North station.

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[162] Ibid. 155

This development shows how urban rail can be a driving force of urban change, helping create a subcenter of activity in a previously, low density suburban area. Helped by current positive economic conditions, private developers are interested in development projects in the proximity of Douglas Road and Civic Center stations. Metrorail has also increased downtown accessibility and strengthened its position as a metropolitan center of activity, acting as a force against the dispersal of activities. Finally, Miami-Dade's growth is being increasingly constrained by the Everglades. As vacant land becomes scarcer, and densities increase, the attractiveness riding Metrorail and locating near it will increase.

## 5.2 Bay Area Rapid Transit (BART)

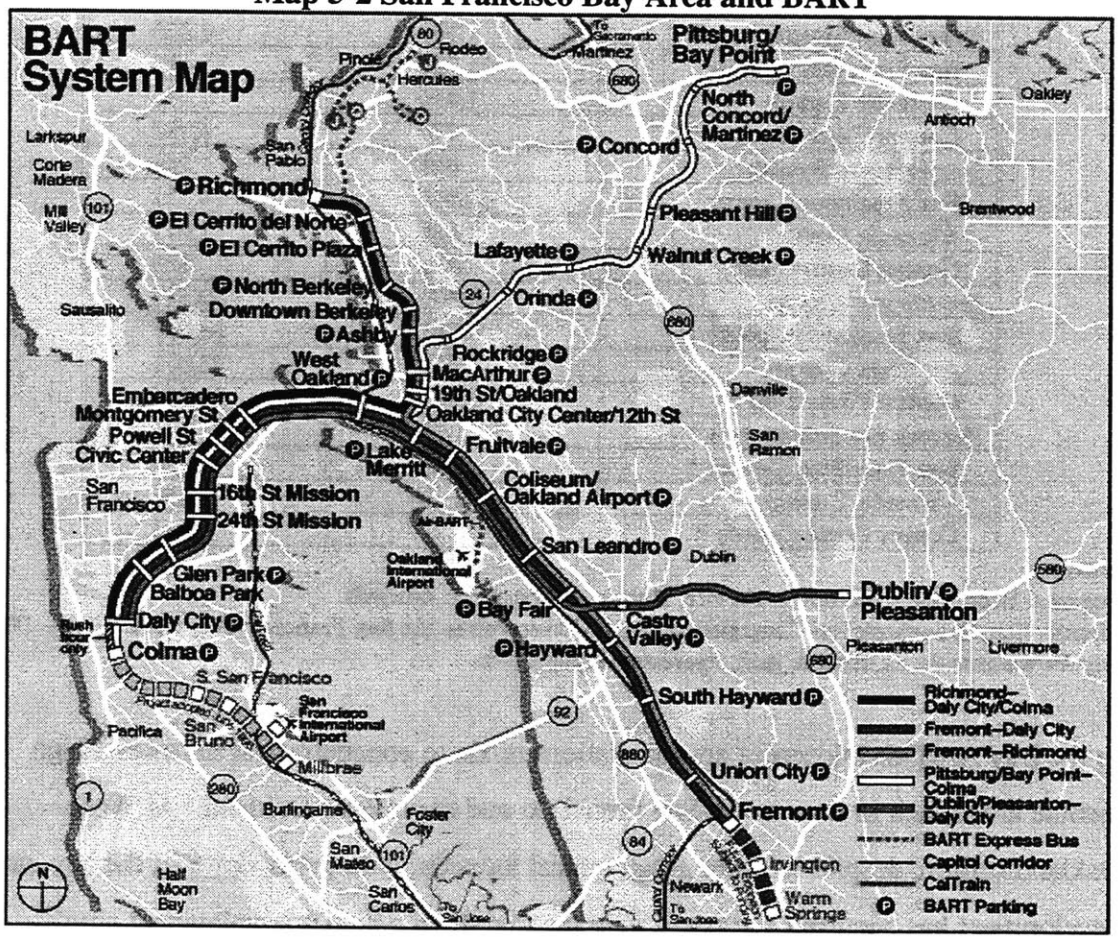
BART is a 80.9 mile long heavy rail service that began its operations in 1972. BART's four route system serves 34 stations in San Francisco, Alameda, and Contra Costa counties, in northern California, and carries an average of 260,000 weekday riders. These three counties encompass more than 1,500 square miles and have a combined 1995 population of 2.9 million, that increases to 6.2 million if we consider the entire San Francisco Bay area.

The Bay area is a very important center of knowledge and technology. Silicon Valley is a world center of information technologies, and Stanford University, as well as the University of California at Berkeley, are world recognized universities that educate highly skilled researchers and professionals, many of whom end up working in the area. In addition, the finance, insurance, and real estate sectors account for 10 percent of the local economy.

Downtown San Francisco has historically been a major regional center, with a high transit use by U.S. standards. Its high residential and employment densities, well above 10,000 people per square mile, make of it a very important destination around which BART gravitates. In addition to San Francisco, there are other important subcenters including downtown Oakland and Berkeley. Densities in these other subcenters are far from San

Francisco's, but we have to note that a large portion of Alameda and Contra Costa counties is covered by hills, therefore effective population densities are higher that the figures that appear on

**Map 5-2 San Francisco Bay Area and BART**




Downtown San Francisco is the main area of economic activity, followed by downtown Oakland. Higher income populations are concentrated in San Francisco and in the suburbs of the Bay Area. Concentrations of lower income populations are found in the west and south of Oakland.

**Table 5-2 San Francisco Bay Area Urban Characteristics**

| | 1972 | 1995 |
|---|---|---|
| **Total Population** | 2,367,408 | 2,923,364 |
| **San Francisco County** | 700,199 | 730,628 |
| **Alameda County** | 1,099,590 | 1,321,987 |
| **Contra Costa County** | 567,619 | 870,749 |
| **Population Density** | 1,566 | 1,933 |
| **San Francisco County** | 15,222 | 15,883 |
| **Alameda County** | 1,494 | 1,796 |
| **Contra Costa County** | 777 | 1,192 |
| **Employment Density** | 825 | 1,241 |
| **San Francisco County** | 12,027 | 14,723 |
| **Alameda County** | 688 | 1,075 |
| **Contra Costa County** | 256 | 559 |
| **Income per Capita** | 6,070 | 30,561 |
| **San Francisco County** | 7,262 | 36,061 |
| **Alameda County** | 5,420 | 27,071 |
| **Contra Costa County** | 5,861 | 31,246 |
| **Persons per Automobile *** | 1.96 | 1.56 |
| **San Francisco County *** | 2.22 | 1.96 |
| **Alameda County *** | 1.90 | 1.50 |
| **Contra Costa County *** | 1.71 | 1.41 |

Sources:
Regional Economic Information Service, Bureau of Economic Analysis.
Metropolitan Transportation Commission: Auto Ownership in the San Francisco Bay Area: 1930 – 2010.
http://www.mtc.dst.ca.us/facts_and_figures/ao/aopaper.htm

In the Bay Area, development around stations tends to concentrate at dense and high income areas such as downtown San Francisco and downtown Oakland. At West Oakland station, despite its great geographical location, with great views of the bay, no development has occurred because it is in the middle of a high unemployment area[163]. Fruitvale station, situated in another low income community, also failed to attract private development, despite the community's interest.

[163] Iris Starr, phone interview, City of Oakland Community and Economic Development Agency, March 17, 1998.

### 5.2.1 Alignment of the System

The radial structure of BART provides with very good service to downtown San Francisco and downtown Oakland. In 1990, of the Bay Area census tracts with population densities above 7.5 persons per acre contained a BART station or some segment of a BART line[164]. The provision of a good service to downtown San Francisco was the main goal that was pursued by BART. From this perspective the alignment is optimal.

However, from an economic development perspective this alignment is not adequate. The goal of providing a fast connection to San Francisco lead to the selection of an alignment and location of stations that would effectively serve car commuters. Large portions of the alignment are in the median of highways, as it is the case of BART's orange line from Fruitvale to Freemont. This line uses an old railway right of way that runs several hundred yards parallel to an important street. In addition, several of BART stations are located in the middle of highways or surrounded by large parking lots.

### 5.2.2 Level of Service

BART's frequencies range from 5 to 15 minutes. For some trips effective frequencies are even higher, since some lines share parts of the alignment; thus, if there is a 12 minute headway in the section that is shared by three different lines, on average, a train will be passing every 4 minutes. Improvements in schedule compliance can also improve the LOS, by reducing uncertainty and travel times.

The span of service is of 20 hours on weekdays, 18 on Saturdays and 16 on Sundays, providing service from 4:00am until 00:00am, from 6:00am until 00:00am, and from 8:00am until 00:00am respectively. This span of service has been changing through time

[164] Robert Cervero and John Landis, "Twenty Years of the Bay Area Rapid Transit System: Land Use and Development Impacts," Transport Research-A, Vol. 31, No. 4, 1997.

adapting to users needs. For special events, like New Year's Eve, the system stops operating later.

### 5.2.3 Inter-modal Integration

The frequencies of the different transit systems that operate in the Bay Area and that provide service to BART vary from system to system. In general, frequencies are high, and when they are not, buses try to coordinate departures and arrivals with BART. BART's reliability and schedule adherence should be improved to provide a better LOS, especially to transfer passengers.

### 5.2.4 Station Accessibility

BART downtown stations provide good access to pedestrians and transit users. As we move outside downtown areas, parking for private autos is given a high priority. Pedestrians and transit users, with the exception of those patrons that ride buses with a stop right by the station entrance, often have to 'enjoy' an unattractive walk through the parking lots of stations like Ashby and North Berkeley. Pedestrian accessibility should be improved in several stations; however, some stations, because of their location, will never attract large number of pedestrians.

### 5.2.5 Parking

Parking in downtown San Francisco costs on average $185 to $310 per month[165]. To this price we must add the cost of driving; however, this price is very difficult to estimate, since, in general, drivers only perceive the marginal cost of driving. Nevertheless, if we compare the $200 to $400, that may be perceived as the total cost of driving to work to downtown, with the $40 to $160 that it would cost to ride BART twenty days a month, it results that BART, because of its lower price and fast service, is a very attractive alternative. This attraction is much lower for those people that have to use a bus or other

[165] Telephone survey, April 1998.

public transportation to get to the station. Transfers increase the transportation cost and decrease the LOS; hence, BART's attraction with respect to the car is reduced.

To encourage ridership, BART provides more than 42,000 free parking spaces in 20 stations, and for 25 cents per day in Lake Merritt Station. BART drivers that park their cars at the stations save the high parking fees of downtown and benefit of a high LOS. In other words, they are getting the best LOS at the lowest cost. Because of the high cost of parking in downtown San Francisco, it may be possible to charge for BART parking without decreasing demand.

### 5.2.6 Availability of Land and Ease of Assembly

In general, land availability has not been a problem around BART stations. Development has already occurred at Downtown Oakland, Walnut Creek, and especially at downtown San Francisco. Land is still available for development, and there has been a growing interest in development around stations; even in less affluent neighborhoods, like Fruitvale. However, the stations that are located in the middle of freeways are not likely to become attractive development sites.

### 5.2.7 Urban Environment

San Francisco is a highly pedestrian-oriented city. Downtown Oakland, Fruitvale, and El Cerrito del Norte, are examples of the efforts that have been conducted to improve the urban environment and stimulate community life. However, as we have said, there are several stations that are not located in urban areas, like the ones in highway medians.

### 5.2.8 Zoning and Community Support

At many of the BART station areas, neighborhoods opposed to BART-induced growth succeeded in enacting new zoning regulations that barred high-density land uses[166]. The

[166] Ibid 72

BART's Pleasant Hill Station project to build a movie theater and recreation complex was not approved because of the opposition of the local and surrounding communities. The local community did not want the complex to attract people from outside the area and the surrounding communities were opposed to what they saw as an attraction that would compete with their local firms[167]. This complex was to take advantage of the accessibility provided by: BART, an existing bikeway, and a bus hub. In addition, it would have used BART's empty parking lot at off-peak times. This transit-oriented development would have generated ridership for BART and decreased auto dependency, especially for the young, but it had to be abandoned because of this strong community opposition. This parcel will now take longer to be developed. Time has been lost, and there is an economic cost in the stream of benefits that could have occurred earlier. Finally, a project to build an office building was approved. This project will surely increase BART ridership, but, unlike the entertainment project, it will be necessary to build additional parking spaces, and it will not increase entertainment accessibility for the young, who are the potential drivers of tomorrow.

On the other hand, there are several examples in which communities have been supportive and cooperative to take full advantage of urban rail. One of the most exceptional cases is the development project next to BART's Fruitvale Station. This development will occur because of the commitment and hard work of a low-income community, that alone, has obtained the resources to develop a site next to the station.

### 5.2.9 Public-private Partnerships

BART does have a joint development department; however some of its regulations constrain development, instead of helping it. The Spanish Speaking Unity Council development project for Fruitvale station is a good example. The financial viability and economic benefits of the project have been seriously reduced by BART's regulations. These regulations require that each parking spot lost due to development in the station

[167] Bill Mohr, phone interview, Catalist Investment Group, Oakland, CA, March 30, 1998.

area should be replaced with a new one. Parking is given priority over a project to build a community center and a clinic that will generate greater ridership and provide more economic benefits than the parking it substitutes for[168]. Regulations like this, curtail urban rail's capacity to generate economic benefits. In addition, according to Cervero and Landis "BART's board did not have the authority or entrepreneurial leanings to assemble extra land and leverage private real estate investments[169]."

According to Bill Mohr, a real estate developer, a project, like the one they had at Pleasant Hill station, to succeed, must be supported by politicians[170]. The BART's Pleasant Hill station project intended to build a movie theater and a recreation complex. The project was not approved because of the opposition of the local and surrounding communities, and the lack of political support. The fact that BART does not have supportive regulations for development around its stations, and the lack of political support, can be two of the factors that explain why far more office construction in the Bay Area has occurred in freeway-oriented suburbs than in BART-served ones[171].

### 5.2.10 Conclusion

BART has benefited downtown San Francisco, downtown Oakland, Walnut Creek, and a few other locations. Nevertheless, an investment of that size could have had a greater impact on the Bay Area communities and be carrying more than its current 260,000 weekday riders. The most important characteristics that have determined BART's ridership levels and its development impacts could be summarized in the following:

- The urban shape, the total population of the area, and population of the area served by BART were adequate for an urban rail system.

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[168] Carlos Castellanos, phone interview, Spanish Speaking Unity Council, Oakland, CA, March 17, 1998.
[169] Ibid. 164
[170] Ibid. 167
[171] Ibid. 164

- Densities were not sufficiently high in several of the stations but it served several important centers of activity and with a dense downtown, especially San Francisco.
- The alignment of the system is not efficient. San Francisco is very well served, but it has missed to provide a better access to other centers of activity.
- The level of service is, in general, good.
- Riders that drive to the stations are often given preference over those that access the station walking or by transit. Improving access for pedestrians and subsidizing transit users may also have a significant impact on ridership.
- Development has been concentrated in a few sites. The lack of community and political interest to attract development and densification to many station areas has curtailed BART's potential benefits.
- Some regulations are inadequate and there is a lack of political support.

### 5.2.11 Before and After BART

BART began its operations in 1972, more than a quarter of a century ago. When it was built it was expected that it would strengthen the Bay Area's urban centers and it would guide growth along radial corridors, leading to a multi-centered metropolitan form[172]. Despite the fact that it has not fulfilled these expectations, it has had several noticeable impacts on the Bay Area. It has helped to strengthen downtown San Francisco as a major center of economic activity, and part of its growth has extended to the other side of the bay to downtown Oakland. In addition, an increasing number of projects are being developed at several of its stations like in Walnut Creek, Pleasant Hill, and Freemont. Hence, it has played a role in the emergence of a multi-centered metropolitan form[173]. However, with the exception of downtown San Francisco, population and employment gains have grown faster in non-BART districts, and far more office construction has occurred in freeway-oriented suburbs.

[172] Ibid. 164
[173] Ibid. 164

## 5.3 Washington Metropolitan Area Transit Authority: Metro (Metrorail)

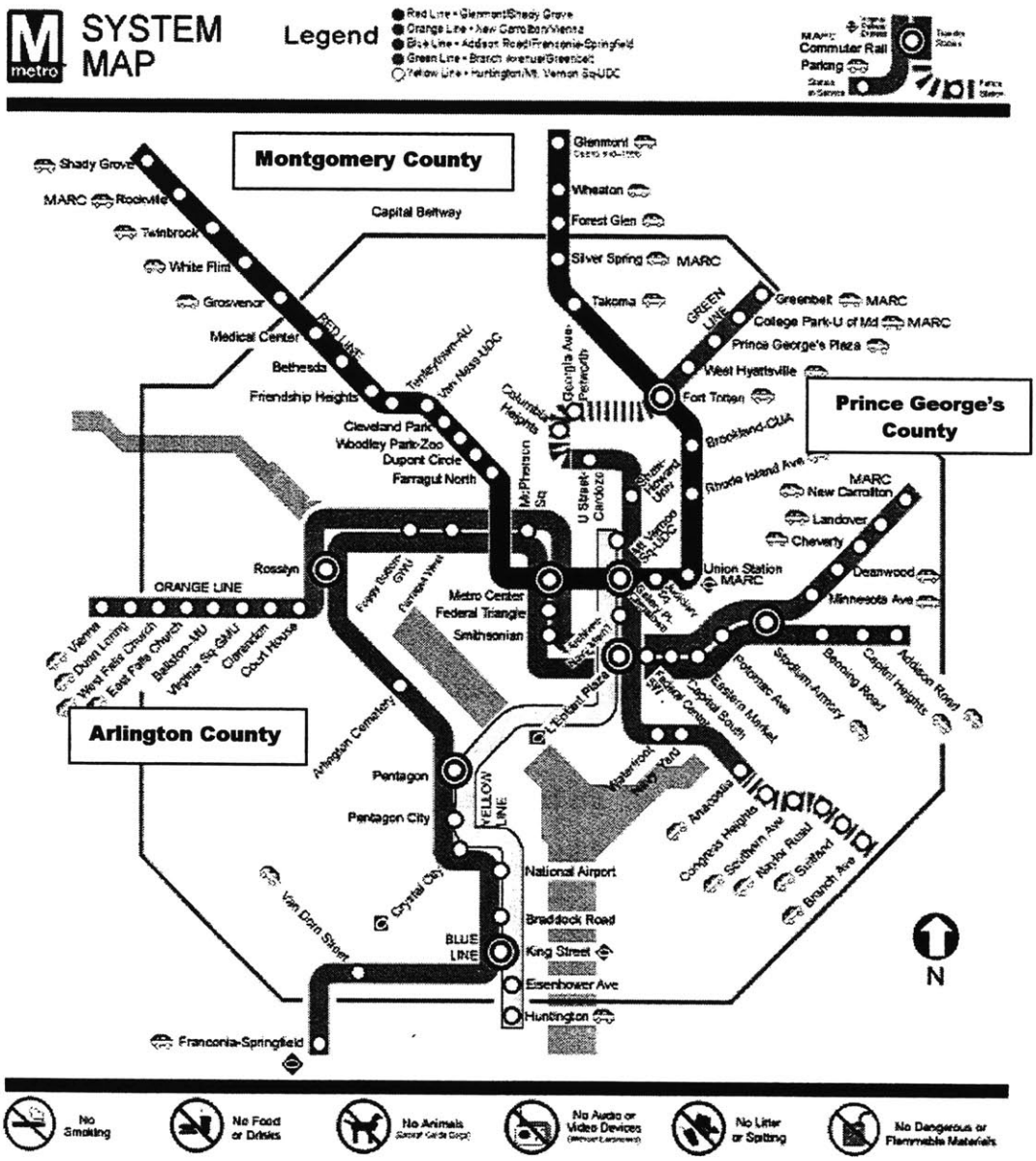
Metro is a 90 mile long heavy rail service that began its operations in 1976, and it is operated by Washington Metropolitan Area Transit Authority (WMATA). Metro's 5 route system serves 75 stations in the District of Columbia, Maryland, and Virginia. The District of Columbia with a population of 0.6 million inhabitants is just part of a larger 3.2 million people metropolitan area that extends into Maryland and Virginia.

Washington metropolitan area has experienced a rapid growth in the last decades. The region's employment growth has been primarily in the white collar sectors, which has made this region the second largest office market in the U.S. As the nation's capital and headquarters of the federal government, the major part of this employment growth has been in government-related and support services.

The Washington metropolitan area experienced a rapid growth in the post-war auto-dependency era. All this growth has occurred in the counties that surround the District of Columbia, while the District itself, has been losing population. Despite the District's population loss, it has remained as a dense population center and its already high employment density, especially in the CBD, has kept rising though at a lower pace that the suburbs.

In the surrounding counties there are several residential and employment subcenters, located within suburban developments. Some of these subcenters are Rosslyn and Tysons Corner in Virginia, and Bethesda and Silver Spring in Maryland. However, none of these subcenters has achieved a significant size that could be comparable to other subcenters such as downtown Oakland in the San Francisco Bay Area.

**Map 5-3 Washington Metropolitan Area and Metro**




The main center of economic activity is in downtown DC, mainly in the area between Metro Center, Farragut North, and Farragut West stations. A vertical line going through Metro Center station would separate the high income neighborhoods from the low income areas, that are situated to the west and east of this hypothetical line respectively.

**Table 5-3 Washington Metropolitan Area Urban Characteristics**

| | 1976 | 1995 |
|---|---|---|
| **Total Population** | 2,686,344 | 3,224,129 |
| **District of Columbia** | 696,305 | 554,528 |
| **Arlington County, VA** | 158,937 | 175,035 |
| **Fairfax County, VA** | 571,297 | 919,331 |
| **Montgomery County, MD** | 579,536 | 808,229 |
| **Prince George's County, MD** | 680,269 | 767,006 |
| **Population Density** | 1,834 | 2,202 |
| **District of Columbia** | 11,274 | 8,802 |
| **Arlington County, VA** | 6,112 | 6,732 |
| **Fairfax County, VA** | 1,450 | 2,333 |
| **Montgomery County, MD** | 1,170 | 1,632 |
| **Prince George's County, MD** | 1,400 | 1,578 |
| **Employment Density** | 1,091 | 1,668 |
| **District of Columbia** | 10,837 | 11,754 |
| **Arlington County, VA** | 5,583 | 7,894 |
| **Fairfax County, VA** | 607 | 1,522 |
| **Montgomery County, MD** | 602 | 1,058 |
| **Prince George's County, MD** | 483 | 767 |
| **Income per Capita** | 8,721 | 33,316 |
| **District of Columbia** | 8,054 | 11,754 |
| **Arlington County, VA** | 10,456 | 37,981 |
| **Fairfax County, VA** | 9,080 | 36,090 |
| **Montgomery County, MD** | 10,159 | 38,160 |
| **Prince George's County, MD** | 7,120 | 23,986 |
| **Persons per Automobile *** | 2.14 | 1.82 |
| **District of Columbia** | 2.84 | 2.66 |
| **Arlington County, VA** | 1.74 | 1.45 |
| **Fairfax County, VA** | n.a. | n.a. |
| **Montgomery County, MD** | 1.78 | 1.56 |
| **Prince George's County, MD** | 2.09 | 1.82 |

Sources:
Regional Economic Information Service, Bureau of Economic Analysis.
Virginia Department of Motor Vehicles,. County/City Vehicle Registration Count.
State of Maryland Department of Transportation, Maryland Motor Vehicle Administration, Vehicle classifications by political subdivision.
n.a.: non available

### 5.3.1 Alignment of the System

The Metro system provides a partial coverage of the District of Columbia. However, with the exception of Georgetown, coverage will significantly improve when the system is completed in 2001. The radial structure of the system, as it goes into the surrounding

counties provides a link with some important subcenters of activity such as the Ballston-Rosslyn corridor in Arlington County, and Bethesda in Montgomery county. However, other important centers of activity such as McLean or Tysons Corner, in Virginia are not served by Metro. In addition, it provides a direct connection to National airport, Union Station, and several stations provide commuter rail connections.

It is interesting to note that as the Washington Metro network was expanded, its average weekday ridership increased from 134,000 in 1977 to 517,000 in 1991, a significant increase that lead it to reach high ridership levels[174].

### 5.3.2 Level of Service

Metro frequencies during weekdays range from 3 to 5 minutes in peak hour and 7 to 16 in off peak hours. Peak hour frequencies are adequate, but off peak hour frequencies, increase significantly total travel times. Bus peak hour frequencies are high, but during off- peak hours they are significantly lower for many bus lines. Metro is a modern, and comfortable system that contrasts well with many of the old and poorly kept public buses.

An additional element that helped Metro experience such a significant ridership increase in the 1977 to 1991 period was, not only the expansion of the system, but improvements in its LOS variables, such as higher frequencies and longer span of the service.

### 5.3.3 Inter-modal Integration

Within the District, bus integration is good. In addition, it provides fare reductions and acceptable frequencies for many inter-modal trips. However, integration with the WMATA bus network, commuter rail, and suburban bus operations in Maryland and Virginia could be improved.

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[174] Public Relations Office, Metrorail Passenger Surveys. Average Weekday Passenger Boardings 1977-1997.

### 5.3.4 Station Accessibility

Good pedestrian and transit accessibility in downtown stations and some subcenters such as Bethesda and Rosslyn, has been further improved through system interface agreements by which private developments have contributed to the construction of direct access to their buildings. In suburban locations, road accessibility is good, but the distance from centers of activity, the preeminence of parking lots, and the location of some stations in the middle of highways reduces pedestrian accessibility. Nevertheless, accessibility alone is not a sufficient advantage. New Carrollton station exemplifies this point; it is situated at a very good location, right next to the intersection of two major arteries, I-95 and US 50, and coincides with a commuter rail stop. Despite its convenient location, the only important development that has occurred since the station opened in 1979 has been the IRS office building that was opened in 1996.

### 5.3.5 Parking

Parking in downtown Washington D.C. costs on average $120 to $210 per month[175]. To this price we must add the cost of driving; however, this price is very difficult to estimate, since, in general, drivers only perceive the marginal cost of driving. If we compare the $150 to $300, that may be perceived as the total cost of driving to work to downtown, with the $44 to $160 that it would cost to ride Metro twenty days a month, the result is that for many riders, price may not be enough of a reason to choose Metro. Because of high congestion levels during peak hours, Metro's travel time is competitive with private car's. However Metro's attraction is much lower for those people that have to use a bus or other public transportation to get to the station. An additional factor that favors the use of Metro is that car ownership in the district is the lowest of all the systems that we have analyzed. This low auto ownership can be partly due to the high density population levels in the District and a good provision of public transportation. However, the low income levels in the area tells us that there are many households that rely on transit because they do not have the financial capability to buy and maintain a car. If Metro's

[175] Telephone survey, April 1998.

competitive position with respect to the private car does not improve, it is likely that its use will reduce as income levels of the population increase.

To encourage suburban ridership, Metro provides more than 34,000 parking spaces and the price it charges range from $1.00 to $2.25. This may be a good strategy if this price covers the capital and operating cost of the parking facilities, and it does not encourage further suburbanization. If parking has to be subsidized, whether the same resources could be used more efficiently to attract other type of riders should be studied.

### 5.3.6 Availability of Land and Ease of Assembly

Metro has had a good policy for acquiring and assembling land[176]. In the 60's, the federal government established the National Capital Transportation Agency that assembled land for WMATA. As a result, by 1976, WMATA had in its possession 1,900 properties that has been using for parking, leases, and development projects. However, the case of Greenbelt station is a good example of the potential development that can be lost if land is not available. This well-located station is at the end of the green line, next to the beltway, and it has a large and undeveloped plot of land devoted to sand extraction. It was not until after the parcel became available that several developers began to show their interest in it[177].

### 5.3.7 Urban Environment

The District of Columbia can be considered a pedestrian city. However, most of the suburban areas outside the district do not have a pedestrian orientation. Metro has been a positive influence and the urban environment has been improved in several station areas, of which Bethesda is one of the best examples. On the other hand, many suburban stations, surrounded by large parking lots or in a highway median, do not provide that urban environment.

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[176] Paul Clark Greenberg, "Delivery of Tren Urbano Stations as Strategic Urban Nodes," MS CEE & MS T Thesis, May 1996.

### 5.3.8 Zoning and Community Support

Metro is often cited as one of the most active agencies in promoting development and attracting private sector investment. This commitment is shown by the existence of an Office of Property Development & Management that is in charge of the Joint Development program. One of the results has been the completion of 22 joint development projects throughout the Washington metropolitan area.

Several counties and municipalities have had a positive attitude towards Metro, and have implemented strategies to integrate the system into their urban and economic landscape. The most important exa7mple is Arlington County, Virginia. With the support of the local community, Metro's orange line experienced significant development and densification around the four stations that fall within the county. Another example of the important role that the community can play is the Bethesda Urban Partnership. This partnership was established by Montgomery County in 1994, and is governed by a board of directors representing business and civic interests. This partnership develops different activities to increase the attractiveness of the area such as planting trees, organizing community events and developing programs to promote the businesses of the area. Finally, the growing awareness of the important role that stations can play in becoming activity centers is shown by Prince Georges county. The county, and the state of Maryland, concerned with the lack of development around Greenbelt and New Carrollton stations, are now designing strategies to attract development to the stations[178]. This will increase their development attraction, especially if the zoning regulations are changed[179].

An interesting new experience is taking place in Bethesda. In 1994, the Bethesda Urban Partnership, was established by Montgomery County, and is governed by a board of

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[177] Joe Chang, phone interview, Maryland National Park and Planning Commission, February 11, 1998.
[178] The Maryland National Capital Park and Planning Commission, "Greenbelt Metro Area Study (draft)," 1998.
[179] Gary Berman, phone interview, Berman Enterprises, February 1998.

directors representing business and civic interests. This partnership develops different activities to increase the attractiveness of the area such as planting trees, organizing community events and developing programs to promote the businesses of the area. By promoting and enhancing the community they will increase the attractive of the area what may increase its development attractive.

On the negative side, the Georgetown area does not have a station because of the community opposition.

### 5.3.9 Public-private Partnerships

WMATA's Office of Property Development & Management, which is in charge of the Joint Development program, has been responsible for the completion of 22 joint development projects throughout the Washington metropolitan area. Developers have a good opinion of how it works, but there is a concern that development around stations could have been higher if WMATA was not asking for a selling price that is above the market[180]. In addition, Arlington and Bethesda are two successful examples in which the community, the private sector and the local authorities have partnered together to achieve important development investment and economic benefits in the region. This success may explain the growing interest of other public authorities in cooperating with the private sector to attract investment to the station areas. On the negative side, the modest development that has occurred at Greenbelt and New Carrollton stations, which are located in Price George's county, can be partially explained by the county's lack of interest in the development of its station areas[181].

### 5.3.10 Conclusion

Metro, with its 500,000 weekday users is a case of partial success. With a population size that is close to the one in the San Francisco Bay Area, it has managed to attract a greater

[180] John Funk, phone interview, Maryland National Park and Planning Commission, February 11, 1998.
[181] Ibid. 179

number of patrons, and has had a more profound urban impact. Several of the characteristics of the urban area were conducive to the construction of urban rail including a large population and high-density urban core with low auto ownership. However, when the system opened in 1976, the suburbs of the Washington metropolitan area had been already developed with low densities and for automobile based populations. Nevertheless, Metro has been able to foster some changes in the urban landscape as the high development densities in Bethesda, and the Rosslyn-Ballston orange line corridor show.

The two most important elements that have limited Metro's ridership levels and its development impacts could be summarized in the following:

- The city structure. The downtown of the District of Columbia is an important high-density destination, but there is a lack of larger subcenters of activity.
- The network does not provide a good coverage of the downtown area. With the exception of Georgetown the coverage will be notably improved after the system is completed in 2001. In addition, several important subcenters of activity such as McLean and Tyssons Corner do not have direct access to Metro.
- The present socioeconomic problems in the District of Columbia have seriously reduced the attraction of living there. These are external factors to Metro, but they are curtailing Metro's capability to foster high densities and change the urban form.

### 5.3.11 Before and After Metro

After more than 20 years of operation it is possible to say that Metro has changed Washington's urban environment. Metro's radial structure has strengthened downtown Washington as a major center of economic activity. Helped by Metro, several other economic and residential subcenters have appeared in the last two decades. Arlington county has experienced a significant employment and population growth along the orange line stations. Rosslyn and Ballston station areas have become two major centers of activity. Bethesda, in Montgomery county is another major residential and economic

center that grew linked to Metro. Rockville, also in Montgomery, has also changed to become a suburban residential subcenter. Despite the existence of several economic and residential subcenters that are not served by Metro, such as McLean and Tyssons Corner; Metro has enabled a significant change in Washington's urban structure. Nowadays, Washington is a metropolitan area where it is possible to rely on transit and live in it without a car.

## 5.4 Metrorail, BART, Metro, and their Economic Development Impacts

The economy of the three metropolitan areas, should have been affected by their urban rail systems. However, we do not have data that would permit us quantify the economic benefits that have occurred as a result of their systems. Nevertheless, considering their ridership levels and the observable physical changes that these metropolises have experimented, we will estimate the level of economic impacts that these systems have had.

***Miami-Dade, Metrorail***

The low ridership levels that have been achieved by Metrorail indicate that it has not had a significant impact on metropolitan commuting patterns. In addition, little densification has occurred as a consequence of Metrorail. It has induced few changes in the urban landscape, mostly at its two southernmost stations, Dadeland South and Dadeland North. The densification and reductions in auto use that it has encouraged have been positive, but it is likely that they are not sufficiently large to compensate for the negative impacts that the system itself has, as we discussed in Chapter Four. In other words, Metrorail should encourage greater densification and achieve higher ridership to be able have a net positive economic impact on the region. To achieve this higher ridership and development, it appears to us that Metrorail's network should be expanded to serve more centers of activity. In addition, its frequencies should increase and inter-modal connections with buses and jitneys should be greatly enhanced. Finally, public investments would be

necessary to improve Miami-Dade's urban environment making it more attractive for pedestrians and transit users.

Metrorail is a recent system and is located in a fast growing metropolitan area. As space becomes scarcer, densities increase, and local policies that correct the problems that we have outlined are put in place, its economic benefits may increase and make Metrorail a net contributor to the economic development of the region.

***San Francisco Bay Area, BART***

In the San Francisco Bay area, BART carries more than 260,000 people on an average weekday. In addition to its relatively large number of riders, BART has induced changes in the urban structure of the region. It has helped San Francisco increase its residential and employment densities, and several subcenters of activity have appeared or have also been strengthened. It is likely that the negative economic impacts of BART, such as the air and noise pollution it causes and the land it uses, are more than offset by the economic benefits of removing such a large number of drivers from their cars. These benefits have been further increased by the densification that BART has encouraged, especially in downtown San Francisco. This densification seems to have had a very important impact on the financial and service sector, making of San Francisco an 'advanced city,' with a high concentration of service activities that do benefit of the greater efficiency that is enabled by BART.

Despite the apparent benefits of BART, we have to note that most of them have been limited to downtown San Francisco and a few subcenters in the Bay Area. Had there been greater development in more station areas, the ridership and densification benefits would have been larger for the region.

*Washington DC metropolitan area, Metro*

Of the three systems, Metro appears to be the one that has brought the greatest economic benefits to the region. Metro has an average weekday ridership of more than 500,000 passengers, and it has induced several important land use changes in the metropolitan area. Corridors and centers of activity have been created surrounding Metro stations, while downtown DC has increased its employment densities despite a loss of population that has been partly related to certain local problems. With half a million daily trips it can be said that auto use is being significantly reduced and this benefit is greatly enhanced by the densification benefits that have occurred not only in downtown DC, but in many other areas, like Bethesda, Rosslyn, and Ballston. This is because Metro's economic disbenefits are lower than the benefits it brings by reducing car use. In addition, it has encouraged greater densification, which has brought land and infrastructure cost savings, as well as transaction cost savings and a further expansion of the labor market. All these areas, helped by the accessibility and greater productivity that was enabled by Metro, have managed to attract large amounts of residential, commercial, and office investment. Therefore, it seems to us that Metro has had significant economic development impacts in the Washington DC metropolitan area.

## 5.5 Factors Affecting Urban Rail's Ridership and Densification Success

Based on the literature review that we have conducted and on the lessons that we have learned from the three cases that we have studied, we have identified the main factors affecting urban rail's capability to attract riders and dense development around its stations.

The principal factors affecting urban rail's success can be grouped into three different categories: that which is related to urban characteristics of the metropolis, that which relates to urban rail system design and operating variables, and that which is related to local policies. Of these factors, only the design of the system, the operating variables, and local policies can be altered in the short run. The characteristics of the metropolis cannot

be changed in the short run and the design of the system can only be changed after construction at very high cost. However, it is the characteristics of the metropolis and the alignment of the system that will have the greatest impact on the viability of an urban rail project.

**Table 5-4 Summary Data Table: Metrorail, BART, and Metro Systems**

| | Metrorail, Miami-Dade County | BART, San Francisco Bay Area | Metro, Washington Metropolitan Area |
|---|---|---|---|
| **Beginning of Operations** | 1984 | 1972 | 1976 |
| **Weekday Ridership** | 50,000 | 260,000 | 500,000 |
| **Network Size (miles)** | 21 | 80.9 | 90 |
| **Work Trip Mode Share (1990)** | 0.7% | 2.4% | 6.5% |
| **Population (million)** | 2 | 2.9 | 3.2 |
| **Downtown Population Density (people per square mile)** | 10,309 | 15,883 | 8,802 |
| **Downtown Employment Density (people per square mile)** | 6,148 | 14,723 | 11,754 |
| **Population per system mile** | 95,238 | 36,135 | 35,823 |
| **Persons per Automobile (when system began operations)** | 1.53 | 1.96 | 2.14 |
| **Alignment of the System** | Non-optimal | Adequate | Optimal |
| **Level of Service** | Non-optimal | Optimal | Optimal |
| **Inter-modal Integration** | Non-optimal | Optimal | Optimal |
| **Parking** | $70-$100 | $185-$310 | $120-$210 |
| **Zoning** | Optimal | Mixed | Optimal |
| **Community Support** | n.a. | Mixed | Adequate/Optimal |
| **Public-private Partnerships** | Mixed | Adequate | Optimal |
| **Success** | Low | Medium | Medium/High |

### 5.5.1 Urban Characteristics

#### 5.5.1.1 Population

Population is an important determinant of urban rail ridership. Of the three systems that we are examining, it is in Washington D.C. that transit modes are most frequently used in trips to work, accounting for 13.6% of all trips made, followed by the San Francisco Bay Area with 9.3%. Urban rail amounts for 6.5% and 2.4% of these total trips, respectively[182]. In Miami-Dade county, only 6.9% of total work trips are made by transit,

[182] 1990 US Census Data, Means of Transportation to Work.

of which 0.7% are by urban rail. WMATA, in Washington DC, attracts a daily workday ridership of more than 500,000 passengers, and BART, in the Bay Area, attracts more than 250,000. Both systems attract significantly more ridership and a higher percentage of total trips than Metrorail in Miami-Dade county with 47,000 daily passengers. After noting that the San Francisco Metropolitan Statistical Area (MSA) has a population of 6.2 million people, Washington MSA 3.9 million, and Dade County is home to 1.9 million, this relationship with ridership and mode share confirms the importance of population size[183].

Each of these three cases demonstrates that urban rail trip share increases with population size. However, we cannot entirely attribute the differences in mode share to differences in population. The relationship between ridership and population size is also explained by other elements such as density and the structure of the city, which we will examine with greater detail in the following pages.

#### 5.5.1.2 Densities

As we know, travel patterns will be determined by where people live and where people go to develop their daily activities, such as working and shopping. In studying the importance of densities, we have considered both population and employment densities in the different counties and/or cities that are served by the urban rail systems that we are analyzing.

[183] 1990 US Census Data, Population.

**Table 5-5 Residential and Employment Densities**

| System | | Residential Density (population per square mile) | Employment Density (jobs per square mile) |
|---|---|---|---|
| Miami Metrorail | Dade County, FL | 1,046 | 576 |
| | City of Miami, FL * | 10,309 | 6,148 |
| | City of Coral Gables, FL * | 3,476 | 2,018 |
| | City of Hialeah, FL * | 9,984 | 4,994 |
| WMATA Metro | District of Columbia | 8,802 | 11,754 |
| | Arlington, VA | 6,732 | 7,895 |
| Bay Area BART | San Francisco, CA | 15,883 | 14,723 |
| | Alameda, CA | 1,796 | 1,075 |
| | Contra Costa, CA | 1,192 | 559 |

Source: Regional Economic Information Service, Bureau of Economic Analysis. Total full and part-time jobs, 1995

BART and WMATA, the two systems with highest ridership, are those with the highest population and employment densities in the surrounding areas[184]. Yet Metrorail serves two cities, Miami and Hialeah, whose residential densities are similar to Washington's, but ridership is far lower. The fact that Metrorail does not serve an area with a high concentration of jobs suggests that a successful urban rail system should serve not only areas with high population densities but also those with dense employment centers. In other words, for a system to attain high ridership levels, it should provide a link between dense residential origins and employment destinations.

#### 5.5.1.3 Income

When urban rail systems were built in these metropolitan areas, their total population income was well above the $5 billion limit discussed in Chapter Two. By international standards, these metropolitan areas were highly developed and very wealthy, and they all, with the financial support of the U.S. federal government, had sufficient resources to pay for the construction of such a system. However, the relationship between income levels and urban rail's success is not solely related to the financial capability to pay for the project. Even if an urban rail project can be financed, it is important that a certain level of

[184] The lower densities of Alameda and Contra Costa Counties are partly explained by the existence of hills that constrain development to narrow corridors.

development be achieved for it to have a positive economic impact. This is because, as we discussed it in Chapter Two, the potential benefits of urban rail systems are positively related to the level of metropolitan development and wealth.

As we discussed in the previous chapter, these benefits are very difficult, if not impossible, to measure. Hence, it is difficult to quantify the particular economic benefits that the metropolises that we are analyzing have been achieved from the construction of their systems. However, we want to stress that because of their high level of development, these three metropolises have the potential to obtain benefits that more than offset the costs of constructing and operating the system.

Per capita income in a station area it also affects the attractiveness of particular sites for development. Stations that are situated in high income areas are more likely to attract development than those that are in low income areas, even if they are well located, as it is the case of BART's West Oakland station, or if the have good access like Metro's New Carrollton station. All things equal, the higher the income level in a station area, the more likely that private development will occur there.

#### 5.5.1.4 Economic Conditions

The increased accessibility that urban rail provides is key for attracting development and achieving greater densities and ridership. However development generally takes place in periods of economic growth. Therefore, urban rail's capability of affecting the shape of a metropolis will depend on the economic conditions of the area. In the three systems that we analyzed, developers and planning officials affirmed that development has been highly linked to the economic cycle. During the years of economic recession in the early 90's little development took place; now, as the excess of office and commercial supply is being absorbed by a growing economy, private developers' interest in station areas is growing in all three systems.

### 5.5.1.5 Car Ownership and City Structure

We can see in Table 5-6 that each system had different levels of auto ownership when urban rail operations were initiated. It was the District of Columbia, with 2.84 people per automobile and the highest transit work trip share, that showed the lowest auto ownership; and Miami-Dade county with 1.53 people per auto had the lowest transit mode share and the highest auto ownership. From this we suggest that car ownership can be used as an indicator of the potential success of an urban rail system. Nevertheless, we should not interpret this result as evidence that there is a direct causal relationship between auto ownership and urban rail modal share. As we discussed in Chapter Three, there is an interdependency between car ownership and development patterns; high car ownership encourages lower density development, and low density development encourages higher auto ownership. The more that a metropolitan area develops around the private car, the higher auto ownership will be and the less useful public transportation will be in that urban structure.

**Table 5-6 Persons per Automobile at the Time of the Opening of the System**

| System | | Year | Persons/Automobile |
|---|---|---|---|
| **Metrorail** | Dade County, FL | 1983 | 1.53 |
| **WMATA Metro** | District of Columbia* | 1976 | 2.84 |
| | Arlington, VA** | 1976 | 1.74 |
| **Bay Area BART** | San Francisco, CA*** | 1970 | 2.22 |
| | Alameda, CA*** | 1970 | 1.90 |
| | San Mateo, CA*** | 1970 | 1.66 |
| | Contra Costa, CA*** | 1970 | 1.71 |

Source:
Regional Economic Information Service, Bureau of Economic Analysis, Population, 1995
* Highway Statistics Summary To 1995, Federal Highway Administration, Office of Highway Information Management. http://www.bts.gov/site/news/fhwa/HighwayStats-Summary95/
** Virginia Department of Motor Vehicles, County/City Vehicle Registration Count.
*** Metropolitan Transportation Commission: Auto Ownership in the San Francisco Bay Area: 1930 – 2010. http://www.mtc.dst.ca.us/facts_and_figures/ao/aopaper.htm

Unlike Miami, Washington DC, and San Francisco both had important downtown centers that were not superceded by the growth of the suburbs. Urban rail, by providing enhanced accessibility helped these cities reinforce their position as regional centers of activity, especially in the case of San Francisco, where urban rail played a role in reversing the

population decline that it was experiencing[185]. As a result both city centers are a major destination for tens of thousands of daily trips. We can conclude that the structure of a city is an important determinant of urban rail's success; however, in the last decades it has been the car the one that has had the most significant role in forming urban structures. The longer a city grows in the absence of urban rail or another efficient transit system, the more likely it is to become shaped in a way conductive to automobiles. Subsequently, auto ownership will be higher, and it will be more difficult to attract high ridership levels for urban rail if constructed.

### 5.5.2 System Design

#### 5.5.2.1 Alignment and Extent of the Network

The alignment of the system is of great importance to urban rail's success, as is the extent of the urban rail network. To attract a high percentage of users, urban rail should service the major residential and employment centers. The most successful system in attracting riders is Metro, which is the one with the best system alignment. One of the reasons that can explain BART's lower modal share may be that large portions of its alignment are in highway medians.

In addition to the alignment adequacy the extent of the network is a determinant factor in urban rail's success in attracting riders. On the one hand we have Metrorail's small 21 mile network has attained low ridership levels. On the other hand we have Washington DC and the Bay Area systems. Both have a network of approximately 90 miles that provides good connections to downtown and to major sub-centers of activity such as Bethesda and the Rosslyn Corridor in Washington and to Oakland in the Bay Area. In addition, as Washington Metro network was expanded, its ridership increased significantly[186].

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[185] Washington DC's population has been declining; however this decline is related to a poor management and very particular social and economic conditions.

#### 5.5.2.2 Location of Stations

The location of a station is of great importance for its success in attracting riders and development. Depending on the exact location of the station, the number of boardings can change significantly, affecting urban rail's benefits. Among the systems that we are studying, it is those stations located within subcenters of activity that have the highest levels of ridership. Metrorail's Government Center in Miami, BART's stations in downtown San Francisco and downtown Oakland, and Metro's stations in downtown DC and Rosslyn are all good examples of stations that are closely located and well connected to major destinations. The attraction of having a good connection with urban rail is exemplified by the numerous cases in which commercial and office developers have reached agreements to have direct access to stations including Metrorail's Dadeland South station located within an office building.

Ridership is a positive indicator of the good location of a station. However, there are stations with acceptable ridership levels, such as Metro's Vienna (located in the middle of a freeway) or BART's Freemont (which stops short of Freemont's downtown center by several blocks) which does not reflect some of their location deficiencies. In other words, despite their acceptable ridership levels, these could have been higher if the location of the stations had been better selected. Several Metro and BART stations are in the same situation.

### 5.5.3 Operating Variables

#### 5.5.3.1 Station Accessibility

The location of the stations is important, but a station must be not only well located, but should also be accessible. Station accessibility is an important factor in attracting ridership and development. Station accessibility could be broken down further into accessibility to the station itself, and accessibility to the area where the station is. Accessibility to the station is very important in attracting different types of urban rail patrons. In general,

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[186] Ibid. 174

downtown stations in the three systems are easily accessible for pedestrians and transit users. However, as we move away from city centers, the quality of pedestrian access decreases in favor of auto users who require large parking lots. BART's Ashby and North Berkeley stations, Metro's New Carrollton station and Metrorail's Dadeland North station are some of many stations that have been designed with little regard for pedestrians who must traverse large parking lots before reaching the station.

The station must be accessible to other transportation modes, in particular the car. Urban rail is one among several transportation alternatives; it generally does not operate around the clock, and it does not satisfy all the transportation needs of all the population. People and firms are attracted by increased accessibility which will be the combination of the accessibility for all transportation modes including private car, bicycle, pedestrian, urban rail, and other transit modes. Accessibility is an important element that is considered by developers when selecting a development site. However, as the case of highly accessible New Carrollton station showed us, accessibility is a necessary but not sufficient condition for attracting development. Dadeland South and North Stations are also highly accessible and managed to attract development. The main differences that with respect to New Carrollton that positively affected the developers decision was the high income level of the area and the efficient negotiating role of the public authorities[187].

#### 5.5.3.2 Level of Service

The LOS provided by an urban rail system is a very important determinant of its ability to attract ridership and development around its stations. The better its service is, the more attractive that urban rail will be compared to other transportation modes, and the greater number of users it will have. For example, Metro expanded its hours of operation ridership increased.

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[187] Gianni Lodi, phone interview, Senior Planner, Metropolitan Dade County Department of Planning, Development, and Regulation; Metropolitan Planning Section, 25 February, 1998.

As it was exemplified by the Datrans office complex in Dadeland South station, of all the LOS variables that we discussed in Chapter Two, the frequency of the system and its reliability are the most important to developers. Office and retail activities will consider their proximity to urban rail as valuable if it provides them with greater accessibility to their workers and clients, but also if this enhanced accessibility can reduce their transaction costs. The higher the frequency and the reliability of the system, the shorter that total travel times will be and the more inclined that firms and general users will be to rely on it[188].

#### 5.5.3.3 Fares

Fares can have an influence on ridership; however, only large fare changes are likely to have significant impacts on ridership. On Febrary 2, 1978, BART serviced 250,000 passengers up from an average of 144,000 when the day was declared a free day. It took ten years to reach that day's ridership level in a normal operating day. Metro fares in Washington DC have remained practically constant in real terms since the system began operations; this implies that, as income per capita has increased, the price of a ticket, as a portion of the income, has decreased. Nevertheless, ridership has remained stable, after the last major extension of the Metro network took place with the blue and green line extensions. Other elements such as changes in densities and urban shape are likely to have a greater and more lasting impact on ridership than moderate fare changes.

#### 5.5.3.4 Inter-modal Integration

This analysis has been limited to what for many riders is just part of a total trip. As we know, urban rail stations are only in the walking proximity of a small percentage of the total metropolitan population. For many users, urban rail is one of the legs of an inter-modal trip involving the private car or other transportation modes. For these users, the final cost of the trip will be the summation of the cost of each of the modes used to complete the trip. The attraction of ridership to urban rail will be related to the total cost

[188] Ibid. 155

of the multi-modal trip. The faster and cheaper inter-modal connections are, the higher the ridership will be.

BART and Metro the most successful of the three systems are both well integrated with the rest of the public transport system, while Metrorail's inter-modal integration, with the exception of the busway that serves Dadeland South, is minimal.

### 5.5.4 Local Policies

#### 5.5.4.1 Parking

Monthly parking prices in downtown Miami range from 70 to 100 dollars. Meanwhile in downtown San Francisco and downtown D.C. prices range from 185 to 310 dollars and 120 to 210 dollars, respectively. The low cost of parking in Miami, especially if compared with San Francisco, indicates that parking prices also play a role in the attraction of urban rail users.

A large percentage of urban rail users drive their cars to the stations where they benefit from more than 42,000 parking spaces provided by BART, the 34,000 provided by Metro and the 8,633 spaces that Metrorail provides at 18 of its 21 stations. Assuming that all parking spaces are used by single occupant vehicles, we find that Metro provides parking for 14% of its riders, BART for 32% of its riders and 34% of Metrorail users get to the system by car. The space and the structures used for parking are costly, can limit the development potential of the stations and reduce pedestrian accessibility. However, there is a benefit in attracting riders that would have otherwise driven to their destinations. In absence of a study of the ridership and financial implications of providing car parking at stations we cannot determine whether it is a good policy of not. However, we do recognize that car users, as the users of any other transportation mode, should be provided with access to the stations.

#### 5.5.4.2 Availability of Land and Ease of Assembly

Availability of land is very important for urban rail to attract development around its stations and attain greater densities in those stations that are not located in high density, fully developed areas. However, all three systems that we are analyzing do still have large undeveloped plots of land, as it is in the cases of Metrorail's Douglas Road station, New Carrollton Metro station and BART's McArthur station. The existence of stations like Greembelt where development interest surges immediately after a large site becomes available in the proximity of the station indicates that the lack of development around the aforementioned stations may be related to the lack of supportive policies to attract development.

#### 5.5.4.3 Urban Environment

The urban environment refers to the quality and quantity of public as well as private infrastructure. Urban infrastructure attracts pedestrian activity, and generates an environment that is attractive for residential, commercial and office activities. By mixing residential with commercial and office activities transportation needs are reduced. This can be best appreciated in DC and San Francisco downtown's as well as in several of the subcenters that have been created or strengthened by their urban rail systems, such as Metro's Bethesda and BART's Oakland City Center stations. In those areas many needs can be served by walking, and the private is less necessary. In addition, because of this greater pedestrian activity, people will be more inclined to walk to the transit station. Therefore, as these two cities have shown us, this mix of uses can lead to a reduction in auto dependency. Quality urban infrastructure, including sidewalks, benches, and public spaces, should be provided to ease and encourage walking and community life, and to increase the attractiveness of the area for the location of office and commercial activities.

Of the three cases we studied, it is again Miami-Dade county the area with the least attractive urban environment and the lowest transit use.

#### 5.5.4.4 Zoning

Adequate zoning that encourages transit-oriented development and greater ridership is key for the success of urban rail in attracting riders and bringing significant economic impacts. As it has been in the case in Metrorail's Dadeland North and Dadeland South stations, or in Metro's Ballston Station, development has been attracted by zoning allowing for high densities and mixed uses. On the negative side, zoning regulations have limited the development potential in New Carrollton station[189]. Lowering parking requirements can also enhance the development viability of some station areas like BART's Frutivale station development project.

#### 5.5.4.5 Community Support

Zoning often reflects the preferences of the community. If changes in zoning ordinances are to be achieved they must be accepted and supported by the community. The attitude of the communities that surround stations is one of the key determinants of urban rail's success in changing the urban landscape and realizing its potentially positive economic impacts. The importance of zoning being supported by the community is shown, on the positive side, by the success of Metro's orange line corridor in Arlington County. On the negative side, communities on several of BART's stations enacted zoning regulations that limited the development potential of the station sites, for the same reason Georgetown in DC does not have a station. In addition, the response of the community to development projects can affect their financial viability, as public opposition can delay development projects. Finally, the role of the community is also important to sustain and enhance the development and attractiveness of the centers of activity that are created around stations.

#### 5.5.4.6 Public-private Partnerships

The organization and responsiveness of the public authorities have affected several development projects. On the positive side, Arlington county has been very pro-active in attracting development around its Metro stations. On the negative side, development

projects, like the failed development at Metrorail's Douglas Road Station because of the time consumed in dealing with the local and transit authorities, have been negatively affected by the public sector 'business style.'

The skills, experience, and responsiveness of the different public authorities that intervene in these projects are of great value. There is a need for good professionals that can understand the different social, technical, and economic issues that affect urban rail. However, even the best prepared professionals can be of little use if public institutions do not have the appropriate mechanisms, regulations, and capacity to cooperate with the communities and with the private sector to maximize the benefits of the project. The areas in which public sector officials are likely to be involved after an urban rail system has been built include:

- The drafting and enforcement of regulations including the zoning of the station areas
- Construction and improvement of access to the station
- Construction and improvement of access to the area where the station is
- Negotiation of the development of the land publicly owned
- Design and implementation of policies that affect car usage

The regulatory role of public authorities is one of the most critical areas for the success of urban rail projects. From the cases we have studied, the most important problem comes from the regulations and issues that affect the development of publicly owned land. Good projects can be negatively affected by inadequate regulations as happened with the Spanish Speaking Unity Council development project for Fruitvale station.

A very critical problem of dealing with the public sector is that it requires a lot of time, money, and energy up-front, with lots of risks and uncertainty[190]. Bill Mohr, a real estate

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[189] Ibid. 179
[190] Ibid. 155

developer, says that a project to succeed, it must be supported by politicians[191]. An additional problem concerning public partnerships is the lack of entrepreneurship of the public sector[192]. There is a fear of failure and criticism from the media and its impact on voters. Sometimes projects are not approved because public officials, fearing political risks, ask for too much; on other occasions, less sound projects are approved because of their political opportunism

The outcome and success of a negotiation between developers and the public sector can be affected by the role and negotiating power of each of the public agencies that are involved including transit, city, and county officials among others. As the role of urban rail as a transportation mode acting as an agent of change is diluted among other political agendas, it is likely that the economic benefits of the resulting projects will be lower.

Finally, little will be done if, like in Prince George's county, there is not the political will to enhance urban rail use and attract development at the station areas[193].

To summarize, we can conclude that if actions developed by the public sector are to favor the use of urban rail and its economic impacts there is a need for:

- Adequate regulations: Inadequate regulations can prevent urban rail from bringing economic benefits.
- Political will: Without political support projects with the potential to bring positive economic impacts may not be approved.
- Financial resources: Financial constraints can prevent good access to the stations from being provided, and skilled personnel from being hired.

[191] Ibid. 167
[192] Ibid.164
[193] Ibid. 179

- Professional skills: The lack of professional skills may lead to the enactment of an inappropriate zoning regulations, bad parking policies and, in general, a bad performance in all the tasks in which the public sector is involved.

### 5.5.5 Building Urban Rail to Succeed: Key Factors Affecting Urban Rail

The literature review provided us with a set of variables whose importance we have contrasted with the experiences of the three cases that we have analyzed and whose main characteristics are summarized in Table 5-4, at the beginning of Section 5.5 Our analysis has helped us trace the main explanatory variables that led to different ridership and urban impacts of each of the systems. However, the ridership and densification achieved by an urban rail system is the result of the combined effect of the different urban characteristics, the design and operation of the system, and the local policies. Therefore, we will not quantify the importance of each of the factors that we have identified as key for the success of an urban rail system.

***Urban Characteristics:*** Urban rail will not be viable in all urban areas. As we have seen in the literature and as confirmed by the analysis of the three systems, there are three main elements that determine this viability: population size, population density, and the urban structure.

Urban rail's viability is greater in those cities that have clearly defined centers between which a sufficient large number of people move to develop different activities. If centers of activity are defined it will be easier to serve a greater percentage of the trips that are done in the metropolis. However, this shape should be accompanied by high densities in those centers of activity that can provide reasonable ridership levels. The densities that are necessary to assure minimum ridership levels will vary depending on the geographical and sociological characteristics of every city. We believe that there should be a high-density center of economic activity with at least 40 jobs and 40 residents per hectare (10,000 per square mile) and several subcenters with densities above 30 people per

hectare in order for urban rail to be a viable alternative[194]. However, we are not saying that the entire alignment should serve dense employment and residential areas. Low density areas can be served, though it is advisable that they have good road and pedestrian accessibility. The successful examples of Ballston and Bethesda in Washington DC, and Dadeland South in Florida tell us that urban rail does have the capability of helping create new subcenters of activity. However, supportive policies will be necessary to help urban rail create these subcenters of activity.

***Design of the System:*** The alignment should pass through the major corridors of economic and social activity. The network should be sufficiently large to provide stops at the center of each of the major subcenters of activity. The importance of the design of the system is exemplified by Metrorail's failure, which is greatly related to its small network size of only 21 miles, and heightened by the inadequacy of the northern part of the alignment.

***Operating Variables:*** It is essential that the stations provide convenient access for all types of users: pedestrians, buses, kiss and ride passengers, and private cars. Similarly, the area where the station is should be accessible to the rest of the metropolis; urban rail is just one among many other location decisions, and it cannot alone provide the accessibility levels that are needed by firms and individuals. Major processes of development have only taken place around stations with good road access. This infrastructure should provide access to a fast and reliable urban rail system. The definition of 'fast' will vary depending on the city and the time of the day, but in general, the total travel time including waiting time and travel time should not be much greater than private car travel time. However, ridership will also be affected by the differences in comfort levels and in the monetary costs of each transportation mode.

***Local Policies:*** If the stations fulfill the previous requisites, and have sufficiently large tracts of land, they will have development potential. This development potential will

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[194] Ibid. 32

increase with ridership. To attract real estate development, zoning regulations must permit the types of mixed uses and high densities that are beneficial for developers and for the transit authority. Hence, the cooperation of the community will be necessary to support the necessary amendments. If the land that is to be developed is privately owned, construction can begin after an agreement between the developer and the land owner is reached. If the land is publicly owned, a negotiation has to be conducted until an agreement is reached between the public authority and the private developer. The negotiation process between the developers and the local and transit authorities should be fast and efficient, as it is key for the success of the project.

Real estate development and densification around the stations are long run effects. Once an urban rail system is built, the sum of the development potential of all of its stations can easily exceed the demand of real estate construction in the metropolis for many years. In addition, not all development will occur around the stations. Depending on the growth rate of the metropolis, it can take several decades before its development potential is fully realized. Therefore, the fact that not all the areas around the stations have been developed, especially in the more recent systems, should not be seen as a failure.

Ideally, all these hurdles will be passed and the urban rail system will attract increasing numbers of patrons. Simultaneously, the success of the system, as well as the attractiveness of station locations and zoning regulations will attract development. In the long run, this development will change the urban form. It will strengthen the existing centers of activity, it will create new subcenters, and will foster greater ridership of the system. Both increases in ridership and densification will bring economic benefits that will translate into a better quality of life and higher economic growth for the region.

## 5.6 Maximizing Urban Rail's Benefits

As we explained earlier, the factors that can be changed in the short run, namely, the operating variables (such as frequency and reliability of service) and the local policies

(such as zoning and parking policies) can be used as tools to maximize urban rail's benefits. In addition, an efficient system design will be key to maximize these benefits, although it will not be possible to change it after the system has been built. Based on the analysis conducted in the preceding pages, we will now outline those tools that, in our opinion, can have the greatest effect in encouraging urban rail use and densification around its stations.

As we saw in Chapter Four, urban rail economic benefits come from the ridership of the system and from the densification it promotes. Therefore the tools that are to be used should address these two needs.

### 5.6.1 System Design

#### 5.6.1.1 Alignment and Station Location

The first condition for an urban rail system to attract users is to provide a service that goes where people want to go. Urban rail stations must be centrally located, with a sufficiently large network connecting origins and destinations for which there will be demand. If this is not the case, urban rail ridership, like in Miami-Dade county, will be low and the system will be underutilized. However, not all the stations must be located in already densely developed areas. In the long-term, well selected undeveloped station sites, with the support of adequate development policies can also become important centers of activity.

### 5.6.2 Operating Variables

#### 5.6.2.1 LOS, and Inter-modal Integration

LOS should position urban rail as an attractive transportation alternative. According to developers, high frequencies and system reliability are the most important LOS variables to attract patrons and development[195]. With low ridership levels, the provision of high

[195] * Ibid 155
* Ibid. 167

frequencies may seem unjustifiable; however, low frequencies can discourage potential patrons that prefer to rely on the car. In addition, the span of time provided should cover most of the transportation needs of the population, hence, reducing auto-dependency. If these elements are not provided, development projects, such as Datrans center in Dadeland South Station, will be negatively affected[196].

Urban rail, to increase its patronage, should achieve a very good integration with other transportation modes, especially buses and other public transportation systems. These systems must also provide good frequencies, reliability, and comfort. The advantages of urban rail's high frequency and reliability would be partially lost if does not have a feeder system that provides a fast and reliable connections to its stations. In general, all transportation choices, including automobile purchase decisions, will take into account the entire public transportation network, and not only urban rail.

LOS and inter-modal integration improvements will help increase ridership.

### 5.6.3 Local Policies

#### 5.6.3.1 Zoning

Different zoning techniques can be used to influence new development and the nature of that development at station areas. The end goal of zoning policies should be to encourage high population densities, which are compatible with the social and economic structure of the metropolitan area. We will follow Jeffrey Sriver to provide a brief description of the most important zoning techniques[197].

***Comprehensive plan for station area development:*** These plans are designed considering the idiosyncrasies of the site and its neighborhoods. Their goal is to influence the nature

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[196] Ibid. 155

[197] Jeffrey Jan Sriver, Factors Influencing Land Development Around Rail Transit Stations, Master's Thesis, August 1995.

of the development and affect the social and economic interactions with the rest of the community. The efficacy of these plans can be best noticed in Metro's Bethesda station area and in Metro's orange line stations areas in Arlington county.

***Increased densities:*** Minimum density requirements are used to ensure that development is conducive to greater transit patronage. In areas of concentrated activity, higher densities are self-enforcing, since they are necessary to compensate for the high value of the land. Real estate developer George Brown built a office and hotel building in Dadeland South station because of the higher densities it was allowed[198]. On the other hand, the real estate properties owned by Gary Berman in Prince George's County did not attract residential development because permitted densities were not sufficient[199].

***Air rights development:*** When the station is located below ground the land on top of it can be developed for non-transit uses. Some good examples of air rights projects can be found at Metro's Van Ness-UDC and Friendship Height's stations and Metrorail's Dadeland South Station.

***Mix-use development:*** It can be used to encourage greater urban activity that cannot be achieved by density alone. If office, commercial, and residential uses are mixed, greater pedestrian activity and lower auto dependency will be encouraged. Bethesda's office, residential and entertainment activities probably is one of the most recent and successful examples of the attractive of mix-use development around a Metro station.

### 5.6.3.2 Parking

There is a key connection between the supply and price of parking and transit ridership[200]. Where parking is scarce, higher prices are charged, and transit ridership is higher than in

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[198] Ibid155.
[199] Ibid.179
[200] Martha Bianco, Kenneth Dueker, James Strathman, "Parking Strategies to Attract Auto Users to Transit," Presented at the 77th Annual Meeting of the Transportation Research Board, January 1998.

those places where there is no charge for parking. The cases we studied support theory. As we can see in Table 5-4, in the beginning of Section 5.5, downtown San Francisco and downtown Washington DC, have the higher parking prices and higher urban rail use than downtown Miami, where is cheaper to park. Therefore, if the price of parking is increased or its supply decreased, transit ridership will increase. As we will see, there are several price-based as well as non-price-based strategies that can be used to increase urban rail patronage.

If parking is availability and parking price is increased, it will increase the cost of driving. As the cost of driving increases, urban rail will become a more attractive alternative, and its ridership will increase.

***Price-based strategies***

*Increasing the price of parking by a tax on revenues:* This tax would be charged to parking providers that already charge for parking. This strategy would only affect CBDs where parking is priced. This strategy should be carefully implemented, because CBD firms and commuters would be at disadvantage compared to suburban locations. Hence, this strategy could stimulate decentralization.

*Increasing the price of parking by tax on parking spaces:* The tax would be on actual parking spaces rather than revenues. In the CBDs, parking providers are likely to pass a large percentage of the tax on to drivers. In other areas where there is higher possibility for drivers to park elsewhere, providers would probably pass less of the tax on to drivers. This strategy, if it is not carefully implemented, can also stimulate decentralization over the long term.

*Cashing-out employer-provided parking:* Employers would give workers the cash equivalent of the parking benefits they provide, and employees could spend that money toward paying for the parking or toward any other purpose, including transit. Because of the better transit service that is provided in the CBDs, cashing-out may encourage

centralization in the long run. However, the program may be negative for employers if it forces them to increase salaries to compensate for the loss of the tax exemption that they previously had with the free provision of parking that can be considered as a payment in kind, hence is not taxed.

*Expanding meters and accompanying residential permit programs:* Meters would be extended outside the CBD to other business districts within the central city and the suburbs. Residential permit programs would be established in the areas surrounding the metered locations to avoid spillover parking.

*Parking impact fees:* The number of parking spaces that a new development has can be taken as a proxy of the impact on the development on the transportation system. A one-time fee would be imposed on developers to cover those costs. Over the long term they may stimulate more compact development in areas of new growth.

**Table 5-7 Price-Based Parking Strategies**

| Strategy | Effectiveness | Political Feasibility | Economic Efficiency | Ease of Administration |
|---|---|---|---|---|
| **Increasing the price of parking, based on a tax on revenues** | Moderate | Moderate | Low to moderate | Moderate to high |
| **Increasing the price of parking, based on a tax on parking spaces** | High in CBD with good transit; lowest in suburbs with low transit service | Low | Low | Low |
| **Cashing out employer provided parking** | Moderate | Moderate | Moderate | Moderate |
| **Expanding meters and accompanying residential permit programs** | Low to moderate | Moderate | Moderate to high | Low to moderate |
| **Parking impact fees** | Very low in short term; somewhat greater in long term | Moderate to high | Low to moderate | Moderate |

Adapted from: Bianco et al., 1998

***Non-price based parking strategies***

*Changing zoning ordinances to restrict parking supply:* Different approaches could be followed including decreasing minimum parking requirements to satisfy non-peak parking

needs, instead of having minimum parking requirements for peak use, or imposing parking maximums to developers.

*Shared parking:* The same parking spaces could serve two uses if their demands occur at different times. It would not have a direct effect on ridership, but it would promote denser development, which would increase transit patronage.

*Transportation demand management:* It would comprise satellite parking-shuttle lots, preferential parking for carpoolers, and transit incentive programs.

**Table 5-8 Non-price Parking Based Strategies**

| Strategy | Effectiveness | Political Feasibility | Economic Efficiency | Ease of Administration |
|---|---|---|---|---|
| **Changes in zoning ordinances to restrict parking supply** | Very low in short term; somewhat greater in long term | Moderate to high | Low to moderate | Moderate |
| **Shared Parking** | Low | Moderate to high | Moderate | Low to moderate |
| **Transportation demand management** | Low to moderate | High | Moderate to high | Low to moderate |

Adapted from: Bianco et al., 1998

Policy makers must consider the peculiar characteristics of the area in choosing the appropriate parking strategies. None of these strategies performs well at every level of analysis. Combinations of policies should be implemented to achieve a system that performs better than a single strategy.

### 5.6.3.3 Good Public-private Cooperation

The success of an urban rail system depends greatly on the private sector's response to its construction. If businesses do not want to locate close to the stations and development does not occur, urban rail would fail to change the urban landscape and increase transit ridership. As we have learned from the three cases that we studied, coordination between public agencies, and their interaction with private developers is considered as expensive

and unreliable, limiting private developer's interest in developing properties in the station areas.

An improved public-private cooperation is likely to help achieve greater development around the stations. Communication must exist between public authorities, the private sector, the local communities, and the transit authority. Transit authorities should make an effort to respond to the concerns of each of the stakeholders and inform them on how urban rail is likely to benefit them. With good communication and information, it is more likely that communities, politicians, and businesses will be more supportive of urban rail and of development around its stations.

Finally, public institutions should be receptive to private sector concerns and recommendations. Clear and realistic goals that incorporate public and private interests should define a global development strategy. This strategy should be constantly updated so public officials are ready to respond timely to development proposals and other private sector projects. This readiness, combined with regulatory changes, and a de-politicization of the process should reduce the time and monetary costs, as well as the uncertainty of negotiating with the pubic sector.

#### 5.6.3.4 Public Sector Investment

There are cases, such as BART's West Oakland station, when the private sector, for a variety of reasons, will not be willing to invest in an area whose attractiveness is not clear. In those instances, the construction of public sector offices or other public services may act as an 'anchor' whose success will ultimately attract private development. One of the goals of the first phase of the public development project at BART's Fruitvale Station is precisely to attract private developers to the following phases of the project[201].

[201] Ibid. 168

### 5.6.4 Economic Benefits of the Tools

These tools, if adequately applied, will help achieve greater ridership levels and greater development at the stations. The benefits from greater ridership will be in the form of lower car use. This lower usage may help reduce imports, energy consumption, pollution, accidents, and all those benefits that we identified Chapter Four as being related to ridership. Increases in ridership will bring benefits in the short run. On the other hand, higher densities impacts will take place in the long run. This densification will help reduce transaction costs and lower land and infrastructure expenditures for firms and people located in the station areas.

Both short and long run benefits are likely to increase the productivity and investment attractiveness of the urban area. Therefore, greater economic development can occur as a result of their use.

## 5.7 Conclusion

There are many elements capable of frustrating development. If urban rail is to reduce auto dependency and influence the development of the metropolis, great attention should be given to all the factors and tools that we have described. The line that separates success from failure can be very narrow, but the final outcomes can be very different. Urban rail systems have the potential to change the urban environment and make a difference, while they may not fulfill every expectation. In most cases, urban rail's lack of success has occurred owing to inadequate use of the available tools and resources we have outlined, rather than to some deficiency of the system itself.

After the review of the literature and the analysis of these three urban rail systems that we have conducted in the first four chapters, we are ready to proceed to apply the lessons we have learned to the Tren Urbano case.

# 6 The Case of Tren Urbano

As we have discussed in the previous chapters, urban rail benefits are not immediate, and are often difficult to calculate. The fact that modern urban rail systems, like the ones we analyzed in Chapter Five, do not seem to have affected their local economies is partly due to this measurement difficulty. However, this apparent lack of effect is also explained by the failure of these systems to maximize their potential economic benefits.

Our goal is to help TU maximize its potential benefits and succeed where other systems have failed. In the following pages, we will try to ease this difficult challenge by providing a better understanding of the economies of Puerto Rico and SJMA and how they will benefit from the construction and operation of TU.

## 6.1 Puerto Rico

Puerto Rico is located within the Caribbean basin between the Atlantic Ocean and the Caribbean Sea at the eastern end of the Greater Antilles. The island is situated 1,000 miles from Miami, 1,600 miles from New York, and 4,200 miles from London, and serves as a major gateway to other Caribbean islands. The island is 100 miles long by 35 miles wide, with a central mountain range, Cerro la Punta, that reaches an altitude of 4,400 feet. Because of this mountain, most of the major urban centers and economic activities are located close to the coast. Puerto Rico has a sub-tropical climate with temperatures on the coast having an average of 81 degrees from May to October and 74 degrees during the rest of the year.

### 6.1.1 The Economy and Infrastructure

In 1991 the manufacturing sector is the most important contributor to Puerto Rico's Gross Domestic Product (GDP) followed by the service sector, government and tourism[202]. This economic structure is different from most developed nations, where the service sector is the main contributor to GDP and manufacturing is reducing its role in favor of the service sector.

***Manufacturing:*** Puerto Rico's manufacturing sector contribution to GDP is one of the highest in the world. Throughout the years, in percentage terms, this sector has experienced significant changes. In its beginnings, in the 50s, it was based on light manufacturing and a cheap labor force; then it became more specialized in heavy industries, like petrochemicals. In these last years, it has switched to more technologically oriented industries. In 1991, five industries accounted for 72.5 % of the sector with chemicals and related products (mostly pharmaceuticals) being by far the most important, followed by non-electric machinery, electric machinery, transportation equipment, and scientific and professional instruments[203].

Since 1948, Puerto Rico's industrial evolution has been influenced by U.S. government policies. As an example, Section 936 of the Internal Revenue Code of 1986 provides incentives for companies to invest in Puerto Rico in manufacturing, in the production of energy, in research laboratories, and in certain designated services. Under this section, U.S. corporations meeting certain requirements can enjoy tax credits against U.S. federal income taxes for earnings from their Puerto Rican subsidiary operations. Another U.S. policy influence can be found in the petrochemical industry that reached a peak in the 70s when the U.S. imposed petrol import quotas that did not affect Puerto Rico.

***Services:*** The main employer and contributor to GDP in the service sector is the Wholesale and Retail Trade industry followed by the Finance, Insurance and Real Estate

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[202] Puerto Rico Planning Board, 1992 Economic Data.
[203] Economic Development Administration: Office of Economic Research (as of January 1992)

industry. However, the most important growth has occurred in the Health industry. Centro Medico in SJMA is the most important medical center in the Caribbean.

***Tourism:*** The Port of San Juan, visited by more than 1 million cruise visitors in 1992, is the most popular cruise destination in the Caribbean[204]. Overall, Puerto Rico is also the main tourist destination in the area, with 3.7 million visitors in the same year, capturing approximately 22.5 % of the Caribbean travel market. The rate of growth of other competitors like the Dominican Republic and Cuba is greater. Additionally, the expansion of the number of beds for the traditional sun & beach market is limited because of physical and ecological constraints.

***Infrastructure:*** Puerto Rico has the best transportation infrastructure of the region. San Juan's port has an important container movement, through it passes most of the 85% of Puerto Rico's trade that travels by sea (EASTDIL 94). The remaining 15% is transported by air. The Luis Munioz Marin airport, that in 1991 served 8 million passengers and handled 350 million pounds of cargo, is the most important of the region.

Puerto Rico's highway system is one of the best in all of Latin America. There are over 8,500 miles of paved highway. The Las Americas Expressway permits cross-island trucking between the two largest commerce centers, San Juan and Ponce, within 90 minutes.

#### 6.1.1.1 Global Economic Vision: Challenges and Opportunities

According to Jenkings et al. Puerto Rico's economy suffers from high unemployment, low labor-force participation, and a high migration rate to the mainland[205]. The economy is dependent on a development model based on government assistance and tax credits to

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[204] EASTDIL, "Overview of Puerto Rico," 1994.
[205] Glenn Jenkins, Thomas Hexner, Helen Ladd, Russell LaMotte, "Puerto Rican Statehood: A Precondition to Sound Economic Growth," Hex Incorporated. October 1993.

attract investment, and Section 936, which provides these credits, will continue only at the will of the U.S. Congress.

Puerto Rico's economy is heavily dependent on the U.S. In the 1991 fiscal year, 87% of Puerto Rican exports went to the U.S., and 68% of imports came from the U.S., making Puerto Rico one of the most important U.S. customers (EASTDIL 94). Puerto Rico's industrial evolution has been influenced by U.S. laws, and its exports are mainly directed to the U.S. In addition, the U.S. provides an important source of income to the island, in the form of federal transfers, while the island does not pay federal taxes.

Puerto Rico must be seen in the context of a global economy that is reducing barriers and increasing global competitiveness. Puerto Rico is increasingly competing globally to attract investment and sell its products. Its competition comes not only from Mexico after the creation of NAFTA, but also from East Asia and Eastern Europe, among others.

Despite Jenkins' negative picture there is room for optimism. There still are reasons for investing in Puerto Rico. The island has a well-developed financial infrastructure, a well-trained and cheap labor force, and a good climate. In addition, it is geographically and culturally well placed as a mayor gateway to the Latin American market.

As stated in *Proyecto Puerto Rico 2005*[206], the island has to increase its technological capacity. The island's human capital must improve so as to augment its competitiveness in a world economy where knowledge is becoming the main source of wealth and physical location and resources are becoming less important. Additionally, the report recommends following a niche strategy in which Puerto Rico should acquire a dominant position in less competitive markets where it has some type of advantage, as is the case in the Caribbean region, where Puerto Rico is the most advanced economy and shares the Spanish language and a similar culture.

Finally, there are some problems that have to be considered as they might limit Puerto Rico's growth potential. The deterioration of the environment, the worsening of living conditions in an increasingly congested and polluted San Juan, and crime are some of these problems. The common denominator of all these elements is their growing importance in the determination of the location of investments. In this, as well as in other ways, Tren Urbano can play an important role.

## 6.2 San Juan Metropolitan Area

The San Juan Metropolitan Area (SJMA) is located on the north coast of the island of Puerto Rico. It contains 13 municipalities over an area of 401 square miles, of which one third is urbanized[207]. The mountainous center of the island explains the east to west concentration of development between the mountains and the sea.

According to the 1990 census, SJMA contains 1.3 million inhabitants, more than a third of the total 3.6 million people that compose the population of the entire island. This represents a population growth of more than 87% in the metropolitan area since 1964. However, SJMA's population size is well below the1.9 million people that live in Miami-Dade county. This is an element of concern, since, as we discussed in Chapter Five, insufficient population size, as in Miami-Dade county, can be one of the factors that explains low ridership levels.

One third of the metropolitan population lives in San Juan, and another third is concentrated in Bayamón, Puerto Rico's second most populous city, and in Carolina. These three municipalities account for 83% of the 410,000 jobs in the SJMA and 63% of all jobs in Puerto Rico. Over 30% of the total regional employment, nearly 150,000 jobs, will be located within a third of a mile of TU's corridor (DTOP 98).

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[206] Junta de Planificación de Puerto Rico, "Proyecto Puerto Rico 2005", November 1992.
[207] Barton Aschman Associates, Inc., "San Juan Regional Transportation Plan," March 1993.

Average population and employment densities in the SJMA are 3,410 and 1,075 persons per square mile, respectively. These figures increase to 10,200 and 3,200 persons per square mile if we take into account that only one third of the municipal area is urbanized. The population densities within one-half mile of the alignment range from 10,000 to 20,000 people per square mile.

SJMA is the economic heart of Puerto Rico, and most of the island's decision centers are located within the region. The majority of government services and financial activities, are concentrated in SJMA. In addition, San Juan is a major cruise port, and it is home to the Centro Medico, the most important medical center in the Caribbean SJMA. Finally, the port and airport of San Juan are the major gateways for Puerto Rico's imports and exports. Because of this important concentration of economic activities, an improvement in the heart of the island is very likely to benefit the rest of the island.

## 6.3 The Construction of Tren Urbano

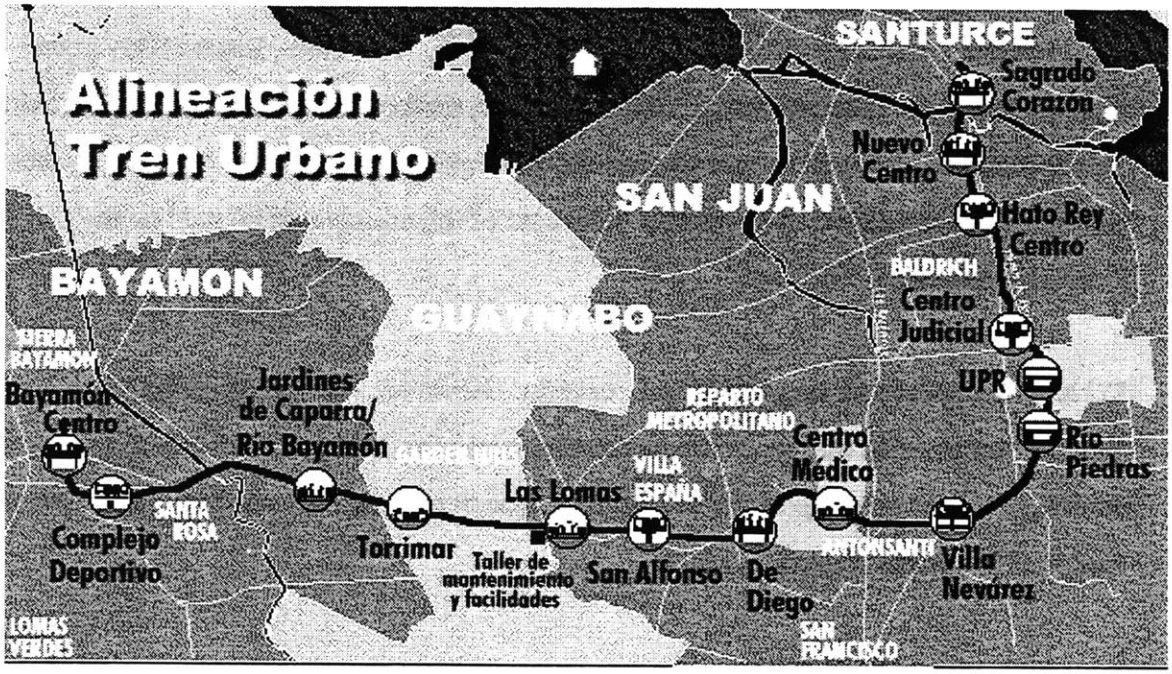
The Phase I line of Tren Urbano, a heavy rail rapid transit system, is under construction in the metropolitan area of San Juan, Puerto Rico. Carlos Pesquera, the secretary of Puerto Rico Department of Transportation and Public Works, provides the following description of the project[208]:

> *" The Phase I line of Tren Urbano will be 17.2 kilometers in length and will have 16 stations, each 138 meters in length, capable of servicing six-car trains. Ten stations will be elevated, four will be at or below grade in an open cut, and two will be underground. The system begins on elevated track in Bayamón, becomes at grade as it leaves the central business district of that municipality, continues at grade through Guaynabo and into Río Piedras, descends into a tunnel section through most of Río Piedras, and finally returns to elevated trackway through*

*Hato Rey, The project includes a maintenance and storage facility in the center of the alignment at Las Lomas, which will also be the location of the system's communications and train control system. ...Tren Urbano will offer operator-attended automated service via a double-track fixed guideway."*

Tren Urbano construction began in 1996, and the first phase of the project is expected to be completed in the year 2001. The full cost of the project has been estimated to be $1.25 billion.

**Map 6-1 Tren Urbano Phase 1 Alignment**




## 6.4 Potential Economic Benefits of TU

In the following paragraphs we will describe some of the potential economic benefits that TU is likely to have on SJMA and Puerto Rico. This analysis will complement Chapter

[208] Carlos Pesquera, Secretary, of Puerto Rico Department of Transportation and Public Works (DTOP), "The Tren Urbano Starter Line in San Juan, Puerto Rico: Project Status as of March 1998," March 22, 1998.

Four's discussion on urban rail's economic impacts and it will be limited to those impacts that will have a particular impact in SJMA and Puerto Rico.

We want to stress that these benefits are potential, because ultimately, they will depend on TU's success in attracting riders and improving SJMA's urban landscape. If after construction, TU attains low ridership levels, or if it does not lead to an increase in SJMA's residential and employment densities, most of these benefits will not occur, or will fail to reach to their full potential.

Puerto Rico, which is classified by the World Bank as an upper-middle income country, had an average per capita income of $6,590 in 1991[209]. Therefore, Puerto Rico's total population income is above the $15 billion financial minimum discussed in Chapter Two. The financial and potential economic viability of the project are further enhanced by the fact that more than $300 million of the total cost of the project will be paid by the U.S. federal government.

TU has the capacity to bring significant benefits. However, we should see TU as a 'delicate' mechanism that must receive great attention and help to be able to deliver those benefits. It is for this reason that it is of great importance that the adequate policies that support TU's success are put in place.

The following is the list of TU's potential economic impacts:

- ***Transaction Costs Benefits***

  The construction of TU is likely to benefit SJMA's service sector. As Puerto Rico develops, it is expected that its economic structure will approach that of the more developed nations, where the service sector is larger than the manufacturing sector. With San Juan being the economic heart of the island, it is likely that most of the

[209] The World Bank, "World Development Report 1994," June 1994.

service sector growth will occur in SJMA. Therefore, the efficiency gains brought by TU will further support and stimulate this service sector growth.

- ***Labor Market Benefits***

  TU, by increasing workers accessibility to jobs, will help achieve a better match between the supply and demand of jobs. This can help reduce Puerto Rico's 13.5% high unemployment rate[210].

- ***Construction & System Operation Jobs***

  The construction of TU will generate several thousand jobs. Most of these jobs will be construction related jobs, though it is expected that some jobs will be created in local firms supplying goods and services for the construction of the system. Finally, the management, operation, and maintenance of TU will require the creation of a few hundred permanent jobs.

- ***Buildup of Skills and Export of Services & Labor (from TU construction)***

  Puerto Rican firms and professionals, in collaboration with specialized international contractors, are participating in the design and construction of TU. These firms and professionals will be able to use the knowledge and exposure to advanced techniques to gain international contracts, especially in the Latin American region with which Puerto Rico has strong language and cultural ties. Construction workers will also be exposed to advanced techniques and it is likely that their skills will be upgraded. Consequently, the productivity of the Puerto Rican construction sector will be increased, not only by better infrastructure design, but also by better construction quality.

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[210] Bureau of Labor Statistics, Employment status of the civilian non-institutional population 16 years of age and over by region, division, and state, 1996-97 annual averages, http://stats.bls.gov/news.release/srgune.t01.htm.

In addition, Puerto Rican construction workers will be able to use their skills to obtain jobs in the mainland. If migration increases, unemployment and welfare expenditures would decrease, while the local economy would benefit from the expenditures and remittances of these migrant workers to the island.

- ***Densities and Land, Infrastructure, and Housing Costs***

  If TU helps increase SJMA's densities, land, and public infrastructure, such as roads, schools, and utilities, will be more efficiently used. This is especially important for Puerto Rico, where developable land is a scarce good that could be devoted to other productive uses such as agriculture production or the creation and preservation of protected spaces that would increase SJMA's and Puerto Rico's tourist attractiveness.

- ***Environment***

  As car drivers switch to TU, SJMA's environment will benefit. Environmental improvements will also benefit SJMA's tourist and investment attractiveness. It has been estimated that, compared to the no-build alternative, TU will help achieve yearly emission reductions of 12,366 tons of carbon monoxide, 643 tons of nitrogen oxides, and 1,348 tons of hydrocarbons[211]. In addition, it has been estimated that by 2010 SJMA's energy consumption will be reduced by 576,567 million BTUs.

- ***Sustainability***

- ***Congestion, and Travel Time Costs***

  It has been estimated that total travel time savings will surpass 32 million hours per year, valued at approximately $307 million[212].

[211] Ibid. 208
[212] Ibid. 208

- ***Import Substitution***

  In the case of Puerto Rico, on average, 40% of the disposable income of households is spent on the purchase, operation, and maintenance of their vehicles[213]. This is a high figure, much greater than for the U.S., where households spend an average of 18% of their income on their vehicles[214]. This big financial burden may be reduced if, with the construction or Tren Urbano, public transportation becomes a better and cheaper transportation alternative.

  If this high expenditure level is reduced, it may free up significant resources that would be devoted to buying a greater quantity of locally produced goods and services. This would help foster Puerto Rico's economic growth, while improving the wellbeing of its inhabitants.

- ***Accidents***

- ***Retail and Entertainment***

- ***Providers of Non-commercial Activities***

- ***Quality of Life***

  Quality of life improvements can have significant positive impacts in the SJMA. SJMA, its cruise port, and Puerto Rico as a whole are major tourist destinations. Competition is increasing, and it is likely to increase when Cuba's embargo is lifted. In addition, environmental constraints are limiting growth in the sun and beach sector. Hence, to grow, the tourism sector should target higher income niche markets. These markets demand higher quality and will be more critical of the environmental conditions of SJMA, which is Puerto Rico's gateway to the rest of the world.

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[213] US Department Of Transportation, "Final Environmental Impact Statement, Tren Urbano, San Juan Metropolitan Area, Puerto Rico," November 1995.
[214] Bureau of Transportation Statistics, "Transportation Statistics: Annual Report 1995."

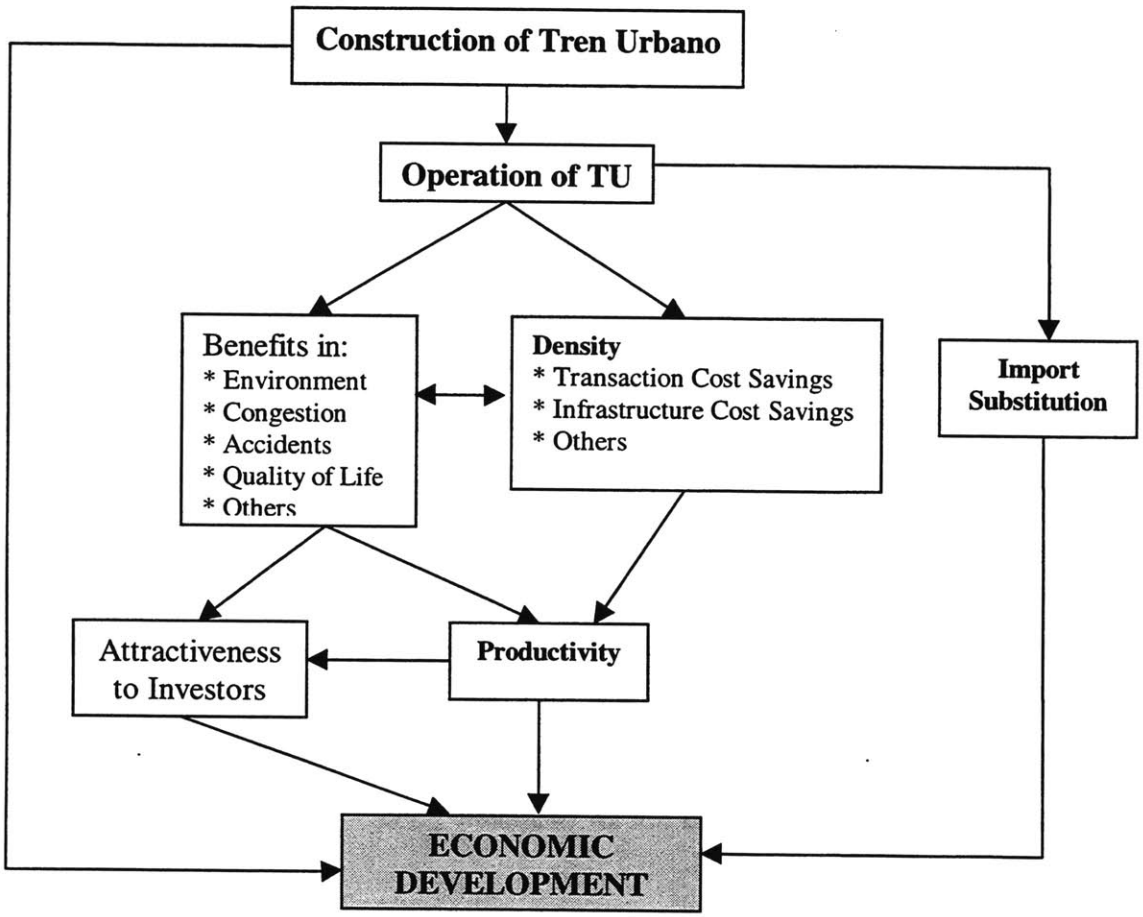
A successful TU will help decrease auto-use, while increasing pedestrian and social metropolitan activity. Greater pedestrian activity will enhance SJMA's environment and is likely to increase urban safety. In addition, lower usage of the car will improve SJMA environmental conditions. All these elements are appreciated not only by tourists, but also by investors. As TU helps increase SJMA quality of life, it will also help Puerto Rico's economy by attracting tourism, and increasing its attractiveness to foreign investors.

### 6.4.1 Final Remarks on TU's Potential Economic Impacts

Puerto Rico high economic dependency on manufacturing should decrease as its economic structure approaches that of more developed nations. In addition the important role of manufacturing is unstable, since it has been highly dependent on U.S. policies that, through the years, have favored investment in the island. The role of the service sector should increase and the natural place for the service sector growth will be SJMA which currently is the economic heart of Puerto Rico, as it concentrates 63% of the jobs in the island. Therefore, productivity improvements brought by TU will have the potential to benefit not only SJMA, but Puerto Rico as a whole.

If TU's potential benefits are realized, the entire island will achieve higher efficiency and productivity levels. These gains are likely to benefit some economic sectors more than others, but ultimately, the sum of all of these benefits will make Puerto Rico a more competitive and productive economy. As we can see in Figure 6-1, this higher productivity, with the support of the quality of life improvements and other benefits enabled by TU, will help Puerto Rico attract investment into its economy. Finally, this higher productivity and greater economic attractiveness, combined with construction and import substitution effects, will translate into a higher rate of economic growth in SJMA and in Puerto Rico.

**Figure 6-1 Economic Impacts of Tren Urbano**




## 6.5 Characterization of San Juan Metropolitan Area

In the following pages we will describe the urban characteristics of SJMA, TU design and its expected operations, SJMA's transit system, and SJMA's local policies. The importance of these factors resides in the fact that all of them will affect the potential economic benefits of TU that we have just outlined.

### 6.5.1 Car Ownership

In Puerto Rico, there are an average of 1.9 persons per automobile. This rate is lower in the five municipalities of greater San Juan, where car ownership increased by 287%

between 1964 and 1990[215]. It has been estimated that in the central SJMA there are 4,206 vehicles per square mile. In addition, the density of 100 vehicles per kilometer of paved road in the SJMA is three times higher than the U.S. average and is one of the highest of all metropolitan areas in the world[216].

### 6.5.2 City Structure

San Juan was founded by Spain more than 400 years ago, in 1521. The originally dense and centralized structure of the city can still be seen in 'Old San Juan.' However, after World War II, the entire metropolitan area of San Juan expanded, following a suburban and automobile dependent model[217].

Puerto Rico, helped by economic and technological advances, and a greater contact with the U.S., has progressively moved its preferences from the European model it inherited from Spain, towards the U.S. model. However, Puerto Rico's urban sprawl, especially in the SJMA area, has not reached U.S. levels owing partly to constraints imposed by the fact that land, unlike in the U.S., is not an 'unlimited' good.

SJMA's suburban development is denser than in the U.S.; however, this sprawl has lead to the appearance of fenced 'urbanizaciones' that are only accessible by car. After five decades of rapid growth following an auto-dependent model, street layouts and land uses are not conducive to pedestrian activity and transit use, with the exception of Old San Juan and parts of the main centers of metropolitan activity. Despite its auto-oriented development, population densities are still high, especially at the core of San Juan municipality; Old San Juan, Santurce, and Río Piedras districts.

The most important centers of economic activity in the SJMA are:

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[215] Ibid. 208

[216] Departamento de Transportación y Obras Públicas de Puerto Rico (DTOP), Tren Urbano: Equipos Rodantes y Suministros de Potencia, http://www.dtop.gov.pr/tu/equiporodante.htm, April 1998.

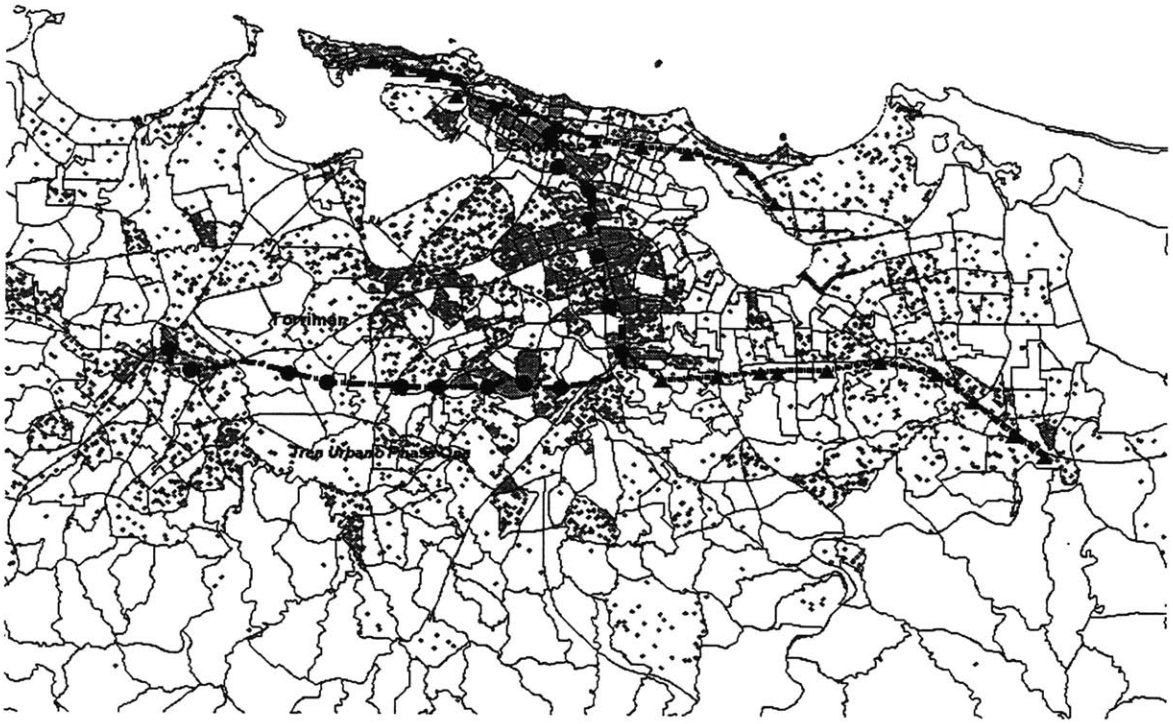
[217] Aníbal Sepúlveda, "Rio Piedras: a Town in Convalescence, The Tren Urbano as an Urban Generator," III UPR Conference on Tren Urbano, January 1997.

- Old San Juan and Santurce: centers of tourism and government activities
- Hato Rey: area with a high concentration of office activities
- University of Puerto Rico/Rio Piedras: comprised of the university, with more than 20,000 students, and the old and decaying commercial town center of Río Piedras, that owes most of its development to the presence of a público terminal (público is the local name given to a jitney.)
- Plaza Las Americas: the biggest shopping center in the Caribbean
- Centro Medico: the largest medical center in the Caribbean
- Bayamón: home to a major público terminal and to the commercial activity that gravitates around the terminal
- Carolina: area with the highest concentration of manufacturing activities in the SJMA

As we can se in, at each of these particular areas, employment densities are much greater than SJMA's average of 3,200 jobs per square mile. Hence, San Juan not only has high residential densities, but it also has defined centers of economic activity.

**Map 6-2 Residential Densities in SJMA**

**Map 6-3 Employment Densities in SJMA**



### 6.5.3 Alignment of the System

The alignment of the first phase of the system and the proposed expansions can be best analyzed by observing Map 6-1 and. The highest residential densities are found in the central areas of the municipality of San Juan, especially in Old San Juan and in most of Santurce. The Sagrado Corazón – Centro Judicial segment of the first phase of the system, is situated to the west of this high-density residential area. However, it is along this corridor and its continuation to Old San Juan that we find the highest employment densities in the SJMA. Phase I of the alignment will also serve the town centers of Río Piedras and Bayamón, areas which also have relatively high employment and residential

densities. Finally, Centro Medico and University of Puerto Rico stations will serve dense employment and service destinations.

Phase I of Tren Urbano will provide stations in several of the areas with the highest employment densities. This coverage will be significantly improved when the Old San Juan extension is completed. When the entire system is completed, the Plaza Las Americas area will be the only high-density employment center that will not be served by Tren Urbano. As we can see in Map 6-1, with the exception of the Sagrado Corazón – Centro Judicial segment, Phase I of Tren Urbano does not provide stations in the areas with the highest residential densities. However, the coverage of high-density residential areas will significantly improve when the airport and Old San Juan extensions are completed.

Some of Tren Urbano stations such as Jardines de Caparra and Las Lomas are located in low-density areas. These sites should be seen as opportunities to pursue transit-oriented development that can encourage transit ridership and bring economic benefits to the region.

### 6.5.4 Station Accessibility

Tren Urbano stations are being designed to provide good access to pedestrians, públicos, buses, taxis and private automobiles. For many decades, the automobile has been a priority in SJMA's urban development; consequently, pedestrian infrastructure, such as sidewalks and pedestrian crossings, are insufficient. It is only at Bayamón, Río Piedras, and the downtown stations where pedestrian access is sufficient, while other stations such as Las Lomas, or Jardines de Caparra are presently 'isolated' from their adjacent neighborhoods.

Road accessibility is generally good, especially at Bayamón, Complejo Deportivo, and Las Lomas stations, which have highway access to PR-5, PR-2, and PR-20, respectively.

### 6.5.5 Level of Service

Tren Urbano will be providing four minute headway during morning and evening peak hours. Regular headway will be five minutes, and 12 minutes in the evenings, weekends and holidays[218].

The system will operate 20 hours per day. This span of service is the same as that provided by BART, and longer than the 19 and 18.5 hour days of operation provided by Metrorail and Metro, respectively.

Public security has been made a high priority. The safety and security of users has been considered in the station's design. Lighting, visibility, video surveillance, and strategically placed call-boxes will help the Tren Urbano Police guarantee the security of system users.

### 6.5.6 Transit Systems in SJMA and Inter-modal Integration

There currently are two main systems that provide public transportation in the SJMA. One is the bus system, which is operated by AMA and Metrobús, and the other is the jitney system, called público. AMA service lies primarily within the municipalities of San Juan, Guaynabo and Carolina, with a few routes extending to Bayamón[219]. It connects these areas to the major centers of activity that go from Río Piedras through Hato Rey and Santurce, and ending in Old San Juan[220]. After 1997, AMA will be organized into trunk lines providing service through the most heavily used routes, and lower demand local routes with transfer centers to the trunk lines. On weekdays, the trunk and local lines will have 10 and 20 minute headways respectively. Metrobús connects Río Piedras, Hato Rey, and Santurce to Old San Juan. With a four minute headway on peak hours and operation

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[218] Ibid. 216

[219] USDOT and DTOP, "Final Environmental Impact Statement, Technical Appendices, Tren Urbano, San Juan Metropolitan Area, Puerto Rico," November 1995.

[220] Eric Randall, "An Assessment of Acuaexpreso, The Urban Ferry System in San Juan," MIT Thesis, February 1998.

on bus-only lanes, it provides a fast service. Finally, the público system covers the entire island, with 120 routes that cover the entire SJMA. In 1994, it made an estimated 143,000 trips, or 65% of daily regional transit trips, it is currently the most important transit system, although ridership is declining.

There are provisions to integrate Tren Urbano with the bus and público systems. It has been estimated that 55% of all Tren Urbano riders will arrive at the stations via bus or públicos, 40% will arrive walking and 5% by car[221]. The importance given to this inter-modal integration is reflected by the fact that four of the stations will serve as transportation centers where bus and público routes will be interconnected with the rail system.

Público's aging fleet of minivans does not provide a fixed schedule service, and there is a limited service on evenings and Sundays. AMA bus service provides a extensive coverage of the SJMA, but frequencies and schedule reliability should be improved. Metrobús frequency and reliability is higher than AMA's.

Coordinating with the público system is likely to be a hard task, because it is privately owned, and ownership is quite dispersed. On the other hand, coordination with AMA and Metrobús will be easier because they are publicly owned.

### 6.5.7 Fares

The future fare for using Tren Urbano, and its potential fare integration with buses and públicos have not yet been decided. AMA fares are currently set at $0.25 for all routes, and currently there are not provisions for reduced fare transfers. Metrobús fares are currently $0.50 per trip.

[221] Joseph Ellis Barr, "Intermodal Fare Integration: Application to the SJMA," MIT Thesis, June 1997.

### 6.5.8 Parking

Parking in downtown San Juan can cost from $40 to $60 per month[222]. If we adjust for income level differences, parking costs in San Juan are between Miami and Washington DC's prices. Hence parking prices are not high enough to produce the deterrent effects that they cause to drivers in the San Francisco Bay Area or even in Washington DC. In addition, when paying for parking, SJMA drivers are not only buying convenience and accessibility, but also the social value of having and driving a car. Therefore, it is likely that their willingness to pay for parking will be higher than that of an equivalent counterpart in the U.S. with the same income level.

### 6.5.9 Availability of Land and Ease of Assembly

There is lots of land with development potential in the proximity of most of the TU stations. It has been estimated that there will be 1,197 acres of undeveloped land within walking distance of TU stations[223]. This land has different owners, including, the TU authority, SJMA's municipalities, the Puerto Rico's Housing Department, and other public authorities, as well as private owners. The municipality of Bayamón already has plans for the development of a large plot of land in the proximity of the stations. In addition, Jardines de Caparra, Las Lomas, and Sagrado Corazón stations are close to large lots of undeveloped land. There also is potential for new real estate projects on already developed parcels at Río Piedras, Hato Rey, and at several other stations.

### 6.5.10 Urban Environment

As a result of SJMA's auto-dependent development priority, pedestrian infrastructure, such as sidewalks, benches, and plazas have received insufficient attention. With the exception of Old San Juan, the rest of the metropolitan area does not have attractive urban environments that encourage pedestrian activity and social interaction. Furthermore, San Juan's high temperatures discourage these types of activities. This problem could be

[222] Phone Survey, April 1998.
[223] Ming Zhang, "Working Paper," April 1998.

ameliorated if certain elements, such as the use of adequate urban designs and shadows provided by tree canopies, were incorporated into the urban design.

### 6.5.11 Zoning

The Planning Board is in charge of urban planning and zoning for the entire island; however, its authority is presently being de-centralized, and some municipalities, including Bayamón, have now assumed planning and zoning powers.

The municipality of Bayamón, with three TU stations, has been very proactive, and it has already designed an ambitious mixed-use development project next to Bayamón station. In the other two municipalities, the Planning Board still retains its authority. The municipality of Guaynabo will only host Torrimar station, and because of community opposition to the densification of the area, it has not expressed any interest for special zoning or development projects. Finally, the municipality of San Juan, while it does believe in the importance of achieving greater development and mixed uses around the station, has not designed specific strategies to encourage this development and have opted to rely on "market forces[224]."

### 6.5.12 Community Support

TU has, in general, strong community support, as exemplified by the fact that two additional stations have been added to the original 14 stations of the first phase of the project. This lack of major opposition to the stations can be further explained by the location, uses, and characteristics of the stations. Several of the stations, such as Centro Deportivo and Hato Rey, are situated in employment centers that will benefit from increased accessibility of the area to clients and workers. Other stations, such as Las Lomas or Jardines de Caparra, are next to large undeveloped tracts of land. Finally, Bayamón and Río Piedras are declining residential and commercial neighborhoods that see

[224] Carlos Novoa and Jorge Hernández, Municipality of San Juan, III UPR Conference on Tren Urbano, January 1997.

TU as an opportunity to, once again, attract people to their neighborhoods and businesses. TU's major community opposition has come from the high-income neighborhood of Torrimar, that does not want to be disturbed by increased activities and land use changes that the new station could sponsor.

### 6.5.13 Public-private Partnerships

There are three major players in development around stations; they are Puerto Rico's Highway and Transportation Authority (PRHTA), Puerto Ricos's Planning Board, and the Municipalities. PRHTA has control over the station sites and some properties around them; however, until present, its efforts have been concentrated on the procurement and construction of the project, and little attention has been given to development projects and even less to coordination with the municipalities and the Planning Board. Coordination between the Planning Board and municipalities is very lacking, except in the case of Bayamón station.

## 6.6 Conclusion

The previous pages have provided a description of Puerto Rico, San Juan, their economy, and the potential economic impacts that TU could have. In the following chapter, based on this description and on the experiences of the three urban rail systems that we analyzed in Chapter Five, we will provide recommendations that will help maximize these economic impacts.

# 7 Conclusions, Strategies and Recommendations

TU will serve SJMA's 1.3 million residents. This figure is lower than Miami-Dade's county of 1.9 million residents, where the system proved unsuccessful, and far from the 3 million residents in San Francisco and Washington DC metropolitan areas. Despite the fact that residential and employment densities are sufficiently high in SJMA, the form of the city, unlike downtown San Francisco and downtown DC, is not conducive to the use of transit. Finally auto ownership is higher SJMA than it was in Washington DC, and San Francisco when their urban rail systems began operations.

The bus and público systems that are intended to bring users to the stations have been losing riders, and there is a lack of coordination between the different public authorities that are involved in the transportation and development planning processes. An additional concern is the small network size of the first phase of the alignment. As the projected system is completed we expect significant increases in TU's ridership.

Finally, SJMA has not reached the development level of San Francisco and Washington, which are 'advanced cities' where the service sector plays an eminent role in their economies. The white collar activities that concentrate in those cities are time sensitive and require face-to face contact. The densification and fast movements of people that is sustained by their urban rail systems has benefited their economies by reducing transaction costs and enlarging the pool of labor from which recruitment of well-trained workers may occur.

After comparing our findings on previous urban rail experiences with the situation for TU, everything appears to suggest that the system will not achieve the expected ridership levels.

TU by itself, without public and institutional support, is likely to have a small impact on SJMA. In the following pages, we will provide recommendations and will suggest policies that can help SJMA overcome the limitations that we have identified. In addition, we will discuss SJMA's present economic structure and how TU's could be more beneficial if SJMA's economic structure moves towards a more advanced economic model, better integrated with the global economy.

## 7.1 Strategies and Recommendations

### 7.1.1 Alignment - Network Size

The first phase of the alignment, with only 11 miles, will provide a limited coverage of SJMA, as Metrorail does with its 21 mile system. If TU is to avoid the low ridership levels that Metrorail is experiencing because of its limited network size it should soon complete the following phases of the project, expanding its service to other major areas of activity, such as Old San Juan and Minillas.

### 7.1.2 SJMA's Urban Form and the Private Car

Puerto Rico's high auto-ownership and its auto-dependent urban form are likely to have a negative impact on TU's ridership. As we noted in Chapter Three, there is an interdependency between car ownership and urban development patterns; high auto-ownership encourages lower density development, and a auto-oriented urban area encourages higher auto ownership. Therefore, it will be necessary to design and implement strategies that tackle simultaneously both problems.

A successful strategy will bring not only the benefits associated with a lower use of the car and higher ridership, but it will also increase the attractive and efficiency of SJMA's urban form. An example of this greater attractive an efficiency is San Francisco, that has became an international center of economic activity.

#### 7.1.2.1 SJMA's Urban Form

Washington DC and San Francisco are two pedestrian-oriented cities boasting well-designed streets and urban spaces with social activity. In these cities, walking from the urban rail station to one's destination is a pleasant activity. On the other hand, Miami, is the most auto-oriented city of our three example cities, and in that sense, it is more similar to SJMA. SJMA, like Miami-Dade county, has also grown following an auto dependent growth model during the last few decades. The street layout, the lack of and poor quality of sidewalks, and the existence of many fenced 'urbanizaciones,' where, to increase their security, communities have isolated themselves with limited and controlled connections to the surrounding neighborhoods, are just a few of the results of this model. All these elements decrease the viability and attractiveness of pedestrian activity, and they will decrease pedestrian accessibility to TU stations.

The number of sidewalks, traffic lights, and pedestrian crossings should be increased and improved. Urban elements, such as benches, plazas, and special features that provide protection from SJMA's extreme weather conditions, should be introduced to encourage pedestrian and social activity on the streets. Increased public security will be necessary to further encourage pedestrian activity and reduce the isolation of fenced 'urbanizaciones.'

#### 7.1.2.2 Private Car Strategies

The private car is transit's main competitor; the decreasing levels of transit ridership and SJMA's rising levels of car ownership are not a coincidence. It will be difficult for TU to attract riders if the private car remains as prevalent in SJMA. Households spend, on average, 40% of their income on the purchase, operation, and maintenance of private cars; Tren Urbano can help reduce that dependence. However, the fact that people are switching from public transportation to the private car, despite its high cost, is telling us that there must be other strong forces that can explain the reasoning for making the economic 'sacrifice' to own a car. One of these strong forces that may not be captured by

an economic model is that in Puerto Rico, owning a car has become a status symbol[225]. The more that car ownership increases, the greater pressure there is for those that do not have a car to own one. Not owning a car can be a source of shame, since it can be taken as an indication of failure.

Different measures could be implemented to reduce the use of the car and improve urban rail's competitive position:

***Gas Tax Increase***

Puerto Ricos's gas taxes of 16 cents per gallon are less than half of the already low 34 cents per gallon that are charged in the U.S. and 16 times lower than the 260 cents per gallon that are charged in France[226].

A gas tax rise would increase the cost of driving and would make transit a more attractive alternative. A study should be done to assess the social and economic impacts of rising this tax. The cost price may limit the mobility of certain population segments that do not have the resources to pay for the price increase, and do not have other transportation alternatives. The price increase may also affect business activities that move freight or passengers.

It is likely that a price increase will noticeably cause short run negative economic effects, but this study should also consider the long run effects of an increase in gas prices. The economic benefits from increased TU ridership, and reductions in oil imports may turn to be more beneficial than these costs.

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[225] Alan S. Hoffman, "Toward a Positioning Strategy for Transit Services in Metropolitan San Juan," MIT Thesis, February 1997.

[226] Benjamín Colluchi, "An Overview of Rail Transit Transportation Studies in SJMA," III UPR Conference on Tren Urbano, January 1997.

**Parking**

The cases of Miami and San Francisco have shown us how parking prices can affect urban rail ridership. If parking prices are low, as in Miami or SJMA, the out of pocket cost difference of a trip made by private car and urban rail will be low, while the LOS difference will favor the car. Hence, in most of the cases, the private car will be chosen for the trip.

Despite its high level of automobile density, parking in the SJMA is relatively easy to find and is affordable. As we discussed in Chapter Five, the implementation of parking policies combining price and non-price based strategies should be studied. These parking policies should be designed to avoid decentralization processes of firms that move to areas where they do not have to pay for parking. Opposition from commercial and office activities whose clients and workers come by car would be expected. However, both San Francisco and Washington DC's downtown areas, with limited availability of parking spaces and higher parking prices, do host successful office and commercial activities.

**Marketing**

Current social attitudes towards public transit must be changed. As noted earlier, the private car is seen as a status symbol (Hoffman 1996). Públicos, buses, and especially TU should be perceived as transport for all social classes. Marketing campaigns that explain the economic and environmental advantages of using transit, combined with improvements in LOS, can help to modify these attitudes among SJMA residents and subsequently increase ridership.

The result of these policies would be a reduction in automobile purchasing and utilization, and a higher use of TU and other transit modes. As we saw in Chapter Six, economic benefits will derive from ridership increases and the densification they encourage.

### 7.1.3 Level of Service

TU's LOS will be key to determine its ridership levels and densification effects. The experience of Metrorail in Miami has taught us that low frequency service can lead to low ridership levels and lower development attraction of the station sites.

The frequencies that have been established for TU appear to be reasonable since they are higher than Metrorail's; however, it will not be until the system begins its operations that it will be possible to reassess their adequacy. In case these frequencies are found to be insufficient, TU management should be ready to rapidly increase them to avoid the cost of ridership losses and the early creation of negative attitudes towards TU.

Ensuring high reliability of the system is of extreme importance. Service disruptions, like that which BART experienced when it began its operations, must be kept to a minimum; otherwise, unreliability will result in riders allocating more time for the completion of their trips. Hence, travel times would increase and the LOS and attractiveness of TU would decrease.

A 20-hour span of service seems reasonable, and it is above the average span of service of the three systems we analyzed. This span of service, like BART's, should be flexible and be adapted to the lifestyle of the community it serves. The span of service should be set in a way that helps reduce auto dependency. Even if only a small number of trips are not serviced by TU, it may result in greater ridership losses if individuals decide to purchase cars to satisfy those trips. This is because after a car has been purchased, there is a small marginal cost of using the car for additional trips.

Present security provisions appear to be good, and they are aimed to address the security problems that are currently affecting SJMA. TU should be a secure system, and more importantly, it should be perceived as such.

### 7.1.4 Fares

Potential passengers will compare the cost of driving and its LOS with the cost and LOS of using TU or other transportation modes. In Washington DC, the relative cost of Metro has been decreasing while ridership has remained stable. These experiences tell us that, despite the importance of TU's fares, there are other elements like the extent of the network and inter-modal integration that also play an important role in attracting riders. However, careful analysis should be done to decide what the best fare level for TU is. If fares are too high, ridership may be too low, and if they are too low, losses may be too high. Fare levels should also consider the potential economic benefits of increased ridership on SJMA's and Puerto Rico's economy. From an economic growth standpoint it may be advisable to subsidize TU fares.

### 7.1.5 Station Accessibility

Access to the stations is necessary to attract both riders and development. The cases of BART and Metro tell us that automobile access to the stations is necessary but insufficient to maximize the development potential of the station areas. The most successful stations in generating ridership and attracting development have been those that are highly accessible by different modes, as it is the case of Bethesda and Rosslyn in the DC area, and of Oakland City Center in the Bay Area.

Effective road infrastructure in the SJMA will provide good access to TU stations. However, Metro's New Carrollton station demonstrates that road accessibility is insufficient to attract development. In most of TU station areas, as in the case of Metro's New Carrollton station, pedestrian infrastructure is deficient. To avoid New Carrollton's failure, efficient and 'pleasant' pedestrian access should be provided for TU's users. Road access should also be efficiently designed. After the vehicles arrive to the station, their riders should have convenient access to the station buildings. Therefore, like in the successful Bethesda station, parking lots, kiss and ride facilities, and público and bus stops

should be conveniently located. Adequate infrastructure, such as covered connections to the station entrance, could be provided in order to minimize transfer inconveniences. The size and form of the parking lots should be carefully decided, since the space used for parking will affect the station environment, its pedestrian accessibility, and the land could be devoted to alternative uses. Large surface parking lots are cheap to build, but cover large amounts of land and create an unattractive 'buffer' zone between the station and its surroundings that has to be traversed not only by pedestrians, but also by drivers that cannot park close to the station entrance. If a parking structure were built, less land would be used and the same number of parking spaces could be provided. This option is more expensive but it can be compensated by increases in the amount of land that can be devoted to development and by an improvement in pedestrian access to the station.

### 7.1.6 Inter-modal Integration

The 11 miles of TU's first phase define a small network, even smaller than the already limited 21 miles of Metrorail, and far smaller than the 90 miles of BART and Metro. This limitation will have to be compensated by efficient inter-modal integration with the private car and other public transportation systems. If this integration is not successfully completed, there is the risk of falling into the same situation as Metrorail. Metrorail, with the exception of the dedicated busway that serves its southernmost station, is not well-integrated with its bus and jitney systems.

As it stands today, it is expected that 55% of TU's riders will arrive at the stations by bus or público, 45% walking, and 5% by car (Barr 97). New bus and público routes should be introduced to feed TU with riders. Both systems should avoid duplicating services and competing with TU routes; instead, they should devote their resources to the expansion of the transit network and to LOS improvements. This has been best achieved by Metro, where the same agency operates the bus and the urban rail systems.

A key component of this inter-modal integration is fare integration. In absence of fare integration riders will pay a complete fare for each of the transportation modes that they need to make a single trip. Fare integration, as it is used by Metro and BART, should be carefully designed to avoid charging users high fares that would compel them to resort to other transportation alternatives.

Other important component of inter-modal integration is schedule coordination. TU stations will receive transfer passengers from AMA local lines. Currently, AMA local lines are planned to provide a 20 minute headway on weekday peak hours (Randall 98). AMA, like públicos, should keep to a strict schedule in order to reduce passenger waiting time.

In Miami-Dade county, financial constraints have limited the LOS of the bus service that should act as a feeder service. Most of the bus lines have low frequencies and are unreliable, which significantly increases the travel time of an inter-modal trip, while decreasing LOS. If the experience of Miami-Dade county is to be avoided, públicos and buses should provide high LOS in terms of frequency, reliability, comfort, span of service, and safety, producing a service that is compatible with TU's.

The public ownership of the bus system will ease this integration, as long as there is effective communication and cooperation between the bus and TU agencies. Integration with the público system will be harder due to their fragmented private ownership. It will be necessary to device a cooperative relationship that is profitable for públicos and at the same time provides the LOS that TU requires to successfully compete with the private car.

### 7.1.7 Zoning

Changes in zoning regulations like in Metrorail's Dadeland South station, can increase the development attractive of station sites and augment the potential benefits of urban rail. Also in the Washington metropolitan area changes in regulations, combined with other

supportive policies lead to a change of the metropolitan structure. As a consequence of these zoning changes, combined with other supportive policies, several dense subcenters of activity have grown in the last two decades around Metro's stations. These changes, as we discussed in the previous chapter, have had positive regional economic impacts.

The case of Washington and the Bay Area support the need to introduce several changes in zoning regulations if TU is to maximize its development potential, help SJMA reduce its auto-dependency, and have a net positive economic impact on SJMA. High residential and employment densities, as well as mixed uses should be allowed and encouraged at the station areas. In addition, changes in parking requirements should be introduced so that the number of parking places that is required for office and commercial developments next to TU's stations is lowered. TU has the capacity to reduce auto use, which, in turn, reduces the land and infrastructure costs of providing parking. If regulations do not take this advantage into account, part of the development potential of the station sites will be lost.

### 7.1.8 Community Support

Communities play an important role in the zoning process and in the acceptance of development projects. Development around several BART stations has been limited because of the opposition of their communities, while, helped by a supportive community, development in Arlington County has 'boomed' around Metro stations.

To avoid zoning restrictions and costly project delays caused by community opposition, special attention must be given to the communities around TU stations. Communities should be informed and educated about the potential benefits that development projects can have for the community and for the entire SJMA. Community participation must be encouraged and ideas and concerns should be considered and form part of a continuous dialogue. The goal of this dialogue is to achieve, as in Arlington county, fluid and efficient cooperation and understanding between the community, public authorities, and private

developers. With all three parties pursuing a common goal, it will be possible to reduce confrontations and expedite the identification and acceptance of good development projects, which will help attain a more attractive and productive SJMA.

### 7.1.9 Public-private Partnerships

Private development projects can be frustrated by the lengthy and expensive process of negotiation that private developers have to go through when they are interested in publicly owned properties. Developers in the three systems also complain of the difficulty of obtaining political attention and support, as it was the case of a recently frustrated development project in BART's Pleasant Hill station.

One of the priorities of TU is to attract development around the stations. Therefore, the mistakes that were made in the previous systems should be avoided, and successes should be imitated. TU needs to be prepared to act on a private sector schedule. Like BART and Metro, TU should have a department specifically dedicated to bringing development to the station sites. However, not all the public land in the station areas is owned by TU, as is the case for a large plot of land called 'finca Rosso' in the proximity of Jardines de Caparra Station, which is owned by Puerto Rico's Housing Department (Sriver 96). In addition, development at TU properties will be affected by the policies and regulations of other public agencies. For this reason, cooperation between Departamento de Transportación y Obras Públicas de Puerto Rico (DTOP), PRHTA, Puerto Rico's Planning Board, and SJMA's municipalities must be improved. Common goals, strategies, and effective procedures must be established before TU is completed. A sense of shared responsibility for TU's successes and failures should be pursued. In each of the agencies, skilled professionals and financial resources need to be devoted to identifying challenges and problems, and in orders to rapidly provide integrated solutions and improvements.

In the area of real estate development, efficient and responsive collaboration with private developers and other private sector institutions must be a priority. A broad study of the

present conditions of the SJMA real estate market and its future evolution must be completed if TU is to be prepared to have an informed dialogue with developers and be able to provide timely responses to their proposals. As part of this study, it will be necessary to estimate economic and demographic trends, as well as how much office, commercial, and residential development will take place in the SJMA. Then, an analysis must be done to define implementation strategies for the entire system. These strategies need to be constantly updated; they must establish the development model that each station should follow and how each station will relate to the system in a way that maximizes regional benefits. By implementing these recommendations, less development projects will be abandoned, as was the project for Metrorail's Douglas Road Station, that was never finalized because of time delays.

Finally, it is necessary to note that the development potential around TU stations will probably take several years before it is fully exploited. We must be patient and not accept projects that do not conform with the development strategies that have been designed, but we must be aware that encouraging development should be is one of TU's objectives.

### 7.1.10 Public Sector Investment

BART's West Oakland station is a good example of a well located and accessible station area that is very unlikely to be developed without public intervention[227]. From an economic development perspective, there is an important economic potential that will fail to be exploited without an initial public investment that makes the site attractive for private developers. Similarly, not all TU stations will be equally attractive for developers. Some stations, such as Hato Rey, are located in areas where land is valuable; these areas will probably be developed earlier. Other stations, like Las Lomas or Sagrado Corazón, are located in areas that are less attractive and developers will have less incentive to develop it. In this case, the intervention of the public sector may be necessary to overcome the problem and to cooperate with TU in the task of helping re-shape SJMA

[227] Ibid. 163

and reducing its auto dependence. This direct public intervention could be in the form of the provision of enhanced infrastructure and services, or it could take the form of direct involvement in the construction of public offices that could act as 'anchors' to attract private investors.

## 7.2 Additional strategies – The 'Advanced City' Model

As we have seen, it is the economy of 'advanced cities' like San Francisco, Washington, New York or Hong Kong, that can benefits the most from urban rail systems. This is because their economies are based on the production of services that are competing on a global scale. These economies, to sustain global competitiveness, need a large labor force from which they can recruit skilled and talented professionals. Since part of the work of many of these professionals will be to participate in face-to-face meetings with clients, suppliers, and co-workers, it will be important for them to maximize their productive time. Urban rail facilitates both purposes; first it augments the size of the labor market, by increasing the distance from which workers can commute; and second, it concentrates a large number of economic activities in a reduced area, as is the case in Manhattan in New York where meetings and face-to-face communications can occur in a fraction of time that would occur if these firms were dispersed in space. These densification benefits will be long term benefits. It will take many years until it will be possible to notice how SJMA becomes a more productive metropolitan area as it attracts investment from high value added service activities.

SJMA is far from approaching the size and importance of New York, Hong Kong, or even San Francisco. At present, SJMA lacks a strong presence of global firms or other types of firms for which reductions in transaction costs and the effective use of their highly skilled professionals can be an important source of competitiveness. However, actions can be done to facilitate a change in SJMA's economic structure. If that change is going to occur, SJMA should, on the one hand, increase its employment densities, and on the other

hand, increase the number of service activities that operate at a global scale from SJMA. TU can enable those densities, but the economic value of these densities will only be maximized if it is these activities that we have discussed locate in the SJMA. These activities will only appear if they are created within Puerto Rico, or more likely, if outside firms invest in the SJMA. We will now identify the elements most needed to favor the creation of and investment in these types of firms in SJMA.

### 7.2.1 Necessary Elements

In the following paragraphs we will discuss those elements that will help SJMA create an adequate environment for the creation or attraction of advanced, global firms for which the reductions in transaction costs, labor market accessibility, and quality of life are critical in their location decisions.

#### 7.2.1.1 Skilled Labor Force

There are two main ways by which advanced global firms can increase their presence in SJMA: fistly, if they are created by Puerto Rico residents, and secondly, if existing international firms invest in SJMA. In both cases, advanced global firms need skilled labor with technical and managerial capabilities, being able to perform in different cultural and business environment. SJMA does host several universities like the University of Puerto Rico. However, none of these universities provide nationally or internationally recognized, top ranked technical and managerial programs.

Education policies that stress this need can lead to the creation of this type of program in the areas that are selected as more suitable for the island. Then SJMA will educate men and women who will create or work for this type of firm.

#### 7.2.1.2 Good Connections to External Markets

For effective and competitive operation in the international arena the provision of good, cheap, and reliable global telecommunications is necessary. Puerto Rico's telecommunications infrastructure is presently good, but efforts should be made to constantly maintain it and upgrade it.

As a global city, there will be special need for frequent international connections for the business activities of global firms located in SJMA. SJMA's Pedro Muñoz Marín International Airport, which handled more than 8 million passengers in 1996, already has good connections with mainland U.S. Europe and Latin America, though it is mainly due to Puerto Rico's important tourist activity[228].

In addition to passenger connections, there is need for efficient and frequent air and sea cargo international service. Global and advanced firms require fast delivery and reception of goods and documents from all over the world.

#### 7.2.1.3 Attractive Environment

These global firms are generally footloose and require good air and telecommunication connections with their global clients. The most valuable asset is their workers; therefore, the location of these firms is increasingly affected by the location preferences of their highly skilled workers. SJMA has a geographical advantage; located in the Caribbean, it enjoys a nice climate and beautiful mountains and beaches. However, there are other requirements which SJMA should address to increase its attractiveness. The perceived lack of security is a major element that may negatively affect SJMA's perception. If given the choice, people like to live in beautiful and enjoyable places where they and their family will be secure. Present crime levels in SJMA can be lowered by employment creation to reduce 1997's 13.5% unemployment rate, combined with educational and social

[228] FAA Office of the Associate Administrator for Airports, Airport Activity & Development Statistics, http://www.faa.gov/arp/arphome.htm.

campaigns, as well as more efficient police activity[229]. An additional element that can help attract investment is the existence of cultural and entertainment activities. Puerto Rico's developed tourist sector already provides a number of entertainment options such as cruises, its beaches, and El Yunque national park. Cultural offerings are still limited, being Museo de Arte de Ponce the most important museum on the island. This limited offer could be easily increased with plays and concerts offered by international groups and orchestras, as well as other activities.

#### 7.2.1.4 Economic and Politic Stability

Political and economic stability is a must for a country's economy to grow. The commonwealth of Puerto Rico has achieved high levels of stability. Nevertheless, the coming election which will determine its relationship with the U.S. and the possibility of independence may affect this stability and attractiveness, given that its commonwealth status with the U.S. is one of its main investments attractions.

### 7.2.2 TU's contribution to the 'Advanced City' Model

TU, as an urban rail system, can enhance SJMA's attractive for the location of this type of activities. TU will help improve SJMA's living conditions by providing an alternative to the use of the car. Its use, combined with local policies, may help improve the urban environment pushing the type of street life and urban activities that can be found in Old San Juan to other parts of the city.

TU's construction could be used as an element of change. A coordinated action involving various SJMA and Puerto Rican authorities in cooperation with the private sector could be implemented in combination with the construction of TU. Several policies including changes in zoning ordinances, public investments to enhance SJMA's current urban infrastructure, investments in education, and the design and implementation of a Puerto Rican strategy to advance its economic structure could be combined with a national and

[229] Ibid. 210

international campaign, with TU as a centerpiece, showing SJMA's and Puerto Rico's commitment to change and modernization.

## 7.3 Conclusions

There are several elements that can limit the potential economic impacts of TU. SJMA limited population size is a constraint that we cannot affect, but there are other elements that can be changed and for which we have proposed recommendations. SJMA's urban structure, the predominance of the private car, its declining transit use, and the lack of coordination between different authorities, if correctly addressed, can help increase TU's future ridership and promote more development and higher densities for SJMA that would have occurred otherwise.

After an investment of $1.25 billion in TU, the increased economic benefits that may result from these recommendations may well justify their additional cost.

TU can reduce auto use and bring the related benefits that we outlined in Chapter Six, such as accidents reductions, better environment and health conditions, an improved labor market match, and especially the densification of the urban areas will promote increases in SJMA's productivity and in its investment attractive. However, we have noted our concern that SJMA's present economic structure may not be able to take full advantage of certain urban rail benefits such as transaction cost reductions. It is for that, that SJMA should adapt its economy to global economic trends if it is to be a significant regional or global player.

In the long run, as SJMA's size grows, and its economy evolves and becomes more competitive and involved in the global trade of goods and services, TU's improved accessibility and its densification benefits will help SJMA attain greater economic benefits that will promote greater economic development in the region. Nevertheless, we have to

be aware that, like in the three systems that we have studied, it will take a long time before TU's benefits are realized.

Through this research we have addressed some of the challenges that TU will have to overcome to maximize its benefits. However, there still is more to learn to help TU. In the following chapter we will outline several issues that should be studied to advance our understanding on the economic impacts of urban rail and how it could be applied to TU.

# 8 Summary, Findings, and Areas for Future Research

In this final chapter we will summarize the results of the research. We will also describe the most significant findings that we have made and finally, we will identify areas for future research that will help advanced the topic of the economic development impacts of urban rail, that has received little attention until now.

## 8.1 Findings

Through this research we have made several findings that will contribution to advance our understanding on the economic development opportunities that urban rail brings, and the factors that affect urban rail's final outcome.

- First of all, urban rail forms part of a broader system. The success and economic development impacts of an urban rail system are highly related to the urban characteristics of the metropolis where it is constructed. In addition, local policies implemented by different local authorities do affect urban rail's success. If the elements of this system are not considered and a clear policy defined in a way that the interest of different stakeholders are aligned into a common goal, that is the economic development of the region, urban rail is likely to fail to attract riders, densification, and economic development.

- Urban rail's failure to achieve the goals and economic benefits that were expected is not necessarily related to the failure or incapacity of this type of infrastructure to deliver these benefits. It is more the unsuitability of the urban area for an urban rail system, the inadequacy of the design, or the lack of supportive local policies such as zoning, or community support that often curtail urban rail's potential benefits.

- It is important to note that, ultimately, urban rail benefits will be highly related to their ridership levels and to the densification it helps achieve. Ridership effects will occur in the short run, and densification will take a longer period to occur, although their benefits can be even greater, since they not only provide higher ridership, but also bring reductions in transaction costs and increases in productivity that can help support highly advanced cities as it is the case of Hong Kong, New York or London.

- Public sector regulations, bureaucratic procedures, and the coordination between different public authorities can significantly affect urban rail's ridership levels and densification benefits. Public authorities should be aware that, as part of the broader system of which urban rail forms part, they play a key role in the economic development outcomes of an urban rail facility.

- An additional element is that does affect the economic development benefits of an urban rail system is the economic structure of the metropolitan area it serves. Depending on the type of activities that are performed in the metropolitan area, businesses will be more or less sensitive to economic benefits induced by urban rail such as transaction costs reductions.

## 8.2 Summary

We have studied the potential economic impacts of urban rail, factors that affect them, and how we can influence them to maximize these economic impacts. We have learned that urban rail is part of a broader system formed by the urban characteristics of the metropolis, its local policies, and the design and operation of the urban rail system whose economic impact we want to maximize. In other words, it is not possible to just build an urban rail system and expect it to fulfill the expectations that were placed on it; there are many factors that will affect it and should be addressed if these expectations are to be fulfilled.

***Economic Impacts of Urban Rail***

Urban rail's economic impacts were at their height in the first decades of the twentieth century, but after Word War II the automobile took urban rail's primary role in determining the shape of our metropolis. Despite these changes, urban rail can still play an important role in increasing the productivity of metropolises and fostering additional economic development. The most important economic benefits that can be brought by urban rail, and that can ultimately translate into economic development are the following:

- Transaction Costs
- Labor Market (Non-construction)
- Construction & System Operation Jobs
- Buildup of Skills and Export of Services & Labor
- Densities and Land, Infrastructure, and Housing Costs
- Environment
- Sustainability
- Congestion, and Travel Time Costs
- Import Substitution
- Accidents
- Retail and Entertainment
- Providers of Non-commercial Activities
- Quality of Life

***Factors Affecting Urban Rail's Economic Impacts***

The level of these benefits will be mainly related to the ridership levels that the system achieves and the densification it promotes. However, both depend on the series of factors that we are listing below:

- Urban Characteristics
  - ❖ Population
  - ❖ Income
  - ❖ Economic Conditions
  - ❖ Car Ownership
  - ❖ City Structure

- System Design & Operating Variables
    - ❖ System Design
    - ❖ Alignment of the System
    - ❖ Station Location
    - ❖ Station Accessibility
    - ❖ Level of Service (LOS)
    - ❖ Fares
    - ❖ Inter-modal Integration
- Local Policies
    - ❖ Parking
    - ❖ Zoning
    - ❖ Availability of Land and Ease of Assembly
    - ❖ Community Support
    - ❖ Public-private Cooperation

*Urban characteristics*

Urban characteristics will determine whether an urban rail system is necessary and viable in a certain metropolitan area.

*System Design and Operating Variables*

From the literature review and the three cases that we analyzed, Metrorail, BART, and Metro, we have confirmed the importance of the design of the system, that should provide with well located and accessible stations in major employment and residential areas. However, an optimal design will be insufficient if the system is not well integrated with other public transportation systems, such as buses and jitneys. Moreover, there is a need for the provision of a frequent and reliable service by urban rail and the transit systems that feed passengers to it.

*Local Policies*

It is also important to consider the role of local policies and how they can affect urban rail. Local policies have the capability for affecting urban rail's ridership levels and the densification process that it is supposed to foster. Parking policies can affect ridership. Marketing campaigns to change the social perception of

urban rail and encourage its use will be key. Ridership is likely to be affected by densities too; the denser the station area, the greater the number of riders that the system is likely to have. Local policies can also affect development and densification around stations, mainly through their zoning policies. However, zoning will be affected by the attitude of the communities toward the urban rail systems and the land use changes it can bring. Communities have affected positively and negatively development projects, and even the location of stations. Therefore, local authorities, in cooperation with urban rail authorities can help achieve a community consensus favorable to the densification of the station areas.

The final player, but not the least important, that is involved in this process is the developer. Private developers will be affected by zoning regulations and the attitude of local communities toward their projects and, if the land is publicly owned, by the negotiating process that is necessary to close a deal with transit or local authorities. The process of negotiation with public authorities can be an important factor in discouraging private development. Dealing with the public sector is described by developers as a lengthy, unreliable, and expensive process.

***The Case of Tren Urbano***

SJMA's current urban structure is not conductive for transit use and the private car has a high social acceptance and its use is relatively cheap and unconstrained. SJMA's transit systems, especially AMA's buses and públicos, do not provide an efficient service, and their ridership has been declining. Present zoning regulations do not contemplate high-density mix-use development with lower parking requirement in the proximity of TU stations. Finally, there is not coordination between the different authorities that are involved in the project or that have the power to affect it, namely TU authority, DTOP, PRHTA, and Puerto Rico's Planning Board, and SJMA municipalities. In addition, the present economic structure of SJMA is such it is likely that it will not make full use of the economic development opportunities that will be brought by TU.

With these present conditions TU may have a limited capability of having an economic development impact on SJMA and Puerto Rico's economy. However, actions can be implemented to help overcome some of the limitations that we have mentioned. Since the construction of the system and the design of the first phase of the alignment have been already decided, our study and recommendations focused more on the other factors that can be changed.

To maximize Puerto Rico's and SJMA's benefit from the potential economic benefits that we have outlined, the TU authority, in coordination with DTOP, PRHTA, Puerto Rico's Planning Board, and SJMA municipalities should implement several actions. Transit use should be encouraged, SJMA's urban structure must change providing a more pedestrian friendly environment. TU's feeder services need to be upgraded and well coordinated with TU. Zoning and development procedures should be changed to encourage densification of TU station areas. Finally, taking advantage of the boost to SJMA given by TU, efforts should be made to help SJMA's shift its economic structure toward a more advanced model, fully integrated with the major global centers of economic activity.

## 8.3 Areas for Future Research

This research has identified areas where more work is still needed. In the following paragraphs, we will describe some areas of research that, in our opinion, will bring the greatest contribution to the understanding of a complex topic: *the economic impacts of urban rail.*

***Quantification of the economic impacts of urban rail:*** This research only provided an indication of the potential economic impacts of urban rail. It would be of great value to develop a procedure that could separate urban rail effects from the effects of other economic factors. A procedure that could estimate the individual value of the different urban rail impacts would be of much greater value than one that could only estimate the aggregate impact.

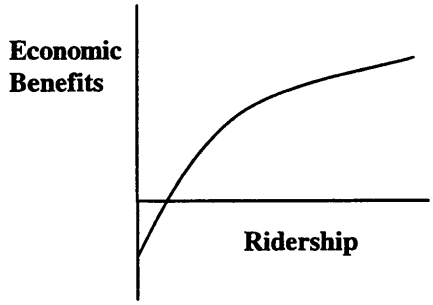
***Distribution of urban rail's economic impacts among economic activities and social sectors:*** The economic impacts of urban rail are not equally allocated. A procedure that could estimate the distribution of its benefits and costs among economic and social sectors could be used as a powerful policy tool.

***Economic strategies to enhance urban rail's economic benefits:*** After having clearly identified which are the economic activities that benefit the most from urban rail's facilities, research on the necessary actions needed to promote those economic activities would help further enhance urban rail's economic development benefits.

***Estimation of the impact of each of the factors:*** We are aware that the impact of the factors that we have described will vary depending on the specific characteristics of the system and its location. However, a more detailed and quantitative analysis of the impact of these factors would permit to identify which of them have the greatest capacity to influence urban rail.

***Ridership versus density:*** It is very unlikely that higher densities around urban rail stations will be achieved without high ridership levels. As shown by Figure 8-1, a simulation considering hypothetical cases, one with low ridership, but high density development around the stations, and another simulation with little development but high ridership levels, would allow us to know how increases in ridership or increases in density are related from an economic viewpoint.

**Figure 8-1 Urban Rail Ridership and its Economic Benefits**




Joseph Sussman, 1998

***Equity versus economic development:*** Our research has only been concerned with the maximization of urban rail's economic benefits. However, urban rail's goal can also be to reduce social inequity. There is a need for research that could answer the question of whether equity and economic development are conflicting goals. If both goals do conflict, this research could identify and quantify these tradeoffs.

***Relocation of activities:*** It is often argued that the location of retail and entertainment activities within or close to urban rail stations would have a neutral effect in economic terms. A detailed study that determined the economic value of the gains in productivity and of the net improvement in customer's level of service would permit us to determine more solidly if there is a net economic gain in the relocation of these activities to the proximity of urban rail stations.

***Provision of parking at urban rail stations:*** The provision of parking at urban rail stations is beneficial because it attracts riders that would have otherwise driven to their destinations. However, parking lots require space and are often subsidized. A study should examine the benefits of this increased ridership and compare them with the benefits that would have been reached if, instead of parking, a transit oriented development had occurred and the resources used to subsidize parking had been devoted to other purposes.

***Public Sector Cooperation and Organization:*** We have seen that the public sector role is ver important to the success of an urban rail facility and its capacity to have a positive economic impact. Helping determine adequate organizational structures of cooperation and coordination between different authorities would be very beneficial from both a transportation and economic development perspective.

## 8.4 Final Note of the Author

I hope this research has contributed to advance our knowledge on the potential economic development impacts of urban rail. Further research in this fascinating area will certainly contribute to enhance our understanding of the links between transportation and economic development, and more importantly, it will allow us to apply it to improve the living conditions of men and women through the economic development of their cities and regions.

# Appendix 1: Selected Bibliography

In the following paragraphs we will provide a brief summary of those articles and papers that have had the most valuable contribution to this thesis.

- ***Transport and Urban Development***, Edited by David Banister, 1995.

  This book contains a collection of articles written by several European authors. These articles cover a variety of transportation topics and their relationship to urban and economic development. Some of the topics that are covered are land use, urban rail, and real estate development.

- Robert W. Burchell and David Listokin, ***"Land, Infrastructure, Housing Costs and fiscal Impacts Associated with Growth: The Literature on the Impacts of Sprawl versus Managed Growth,"*** Lincoln Institute of Land Policy Research Papers, 1995.

  This paper compares the land, infrastructure, housing costs, and fiscal impacts of sprawled versus managed development. Burchell and Listokin provide theoretical and empirical evidence of the lower costs that are incurred when land is developed at higher densities than the traditional sprawl model.

- Herman Huang, "***The Land-Use Impacts of Urban Rail Transit Systems***," Journal of Planning Literature, Vol. 11, No. 1, August 1996.

  In his article, Huang revises the most important elements that affect development around stations. He gives special attention to several urban rail systems including the ones from Toronto, San Francisco, Washington DC, and Cleveland.

- Roanne Neuwirth, "***Economic impact of Transit on Cities***," Transportation Research Record, No.1274. 1990.

  This paper provides a broad review of the major economic impacts of transit on cities. This review is supported by empirical findings from three transit systems, MARTA (Metropolitan Area Regional Transit Authority) in Atlanta, MBATA (Massachusetts Bay Transportation Authority) in Boston, and DART (Dallas Area Rapid Transit) in Dallas.

- Peter Newman, Jeff Kenworthy and Felix Laube, ***"The Global City and Sustainability - Perspective from Australian Cities and a Survey of 37 Global Cities,"*** 5th International Workshop on Technological Change and Urban Form, Jakarta, Indonesia, June 1997.

  This paper discusses the factors that have historically shaped cities. It compares the economic efficiency and transportation characteristics of 37 global cities to conclude that "economic evidence suggests that there should be a reduction in car dependence."

- Rémy Prud'homme, ***"Urban Transportation and Economic Development,"*** Observatorire de l'Economie et des Institutions Locales, Working Paper 96-04. January 1996.

  According to Prud'homme, cities are the most important centers of economic development. This is because productivity increases with the size of their labor markets. However, these productivity gains may be lost without a transportation system that can efficiently move workers from their residencies to the jobs where they will be more productive.

- Allen J. Scott, ***Metropolis: From the Division of Labor to Urban Form***, University of California Press, 1988.

  This book analyzes the relationship between the economic structure of cities, their form, and their labor markets. Scott's theoretical findings and his analysis of the evolution of the economic structure of U.S. cities and of several economic activities support the growing economic importance of transaction costs which are negatively related to population densities.

# References


Alan S. Hoffman, "Toward a Positioning Strategy for Transit Services in Metropolitan San Juan," MIT Thesis, February 1997.

Alicia Munnell, "Policy Watch: Infrastructure Investment and Economic Growth," The Journal of Economic Perspectives, Vol. 6, No. 4, 1992.

Allen J. Scott, Metropolis: From the Division of Labor to Urban Form, University of California Press, 1988.

American Public Health Association, "Housing: Basic Health Principles and Recommended Ordinance," APHA, Washington D.C., 1974. As cited by Peter Newman and Trevor Hogan, 1981.

An Assessment of the BART Impact Program, BART Impact Program Advisory Committee, The National Research Council. 1980.

Anastasia Loukaitou-Sideris, Tridib Banerjee, "There is no There There," Access, No. 9, Fall 1996.

Aníbal Sepúlveda, "Rio Piedras: a Town in Convalescence, The Tren Urbano as an Urban Generator," III UPR Conference on Tren Urbano, January 1997.

Barton Aschman Associates, Inc., "San Juan Regional Transportation Plan," March 1993.

Benjamín Colluchi, "An Overview of Rail Transit Transportation Studies in SJMA," III UPR Conference on Tren Urbano, January 1997.

Bernick and Cervero, Transit Villages in the 21st Century, McGraw Hill, 1997.

Bill Cowart, "Miami's Metrorail: Lessons and Differentiation Strategies for Tren Urbano," Working Paper, April 1994.

Bill Mohr, phone interview, Catalist Investment Group, Oakland, CA, March 30, 1998.

Bureau of Labor Statistics, Employment status of the civilian non-institutional population 16 years of age and over by region, division, and state, 1996-97 annual averages, http://stats.bls.gov/news.release/srgune.t01.htm.

Bureau of Transportation Statistics, "Transportation Statistics: Annual Report 1995."

Bureau of Transportation Statistics, Highway Statistics Summary To 1995 http://www.fhwa.dot.gov/ohim/Summary95/section2.html

Carlos Castellanos, phone interview, Spanish Speaking Unity Council, Oakland, CA, March 17, 1998.

Carlos Novoa and Jorge Hernández, Municipality of San Juan, III UPR Conference on Tren Urbano, January 1997.

Carlos Pesquera, Secretary, of Puerto Rico Department of Transportation and Public Works (DTOP), "The Tren Urbano Starter Line in San Juan, Puerto Rico: Project Status as of March 1998," March 22, 1998.

Center for Urban Transportation Research, University of South Florida, "Profiles of U.S. Fixed Guideway Systems and Operators," Data Book 2, April 1997.

Clark Turner, phone Interview, Director of Planning, City of Miami, January 29, 1998.
Coase R. H., "The Nature of the Firm," Economica 4. 1937. As cited by Allen J. Scott, p. 34. 1988.

Commission Européenee, "Un résaau pour les Citoyens: Comment Tirer Parti du Potentiel des Transports Publics de Passagers en Europe, Bruxelles - Luxembourg, 1996.

Darren Timothy, "Interurban Wage Differentials and Commuting Time," Chapter 3, MIT Phd Dissertation, August 1995.

David Aschauer, "Genuine Economic Returns to Infrastructure Investment," Policy Studies Journal, Vol. 21, No. 2, 1993.

David Banister and Nathaniel Lichfiled, "The Key Issues on Transport and Urban Development," pp. 1-16. Transport and Urban Development, Edited by David Banister, 1995.

Denise Pinheiro Machado, "Urban Impacts of the Metro's Implementations and Management Process in Rio de Janeiro," Urban Transport in Developing Countries: Lessons in Innovation, PTRC 1991.

Departamento de Transportación y Obras Públicas de Puerto Rico (DTOP), Tren Urbano: Equipos Rodantes y Suministros de Potencia, http://www.dtop.gov.pr/tu/equiporodante.htm, April 1998.

EASTDIL, "Overview of Puerto Rico," 1994.

Economic Development Administration: Office of Economic Research (as of January 1992)

Edmonston, B.1975, as cited by Peter Newman and Trevor Hogan, 1981.

Emile Quinet, "Full Social Cost of Transportation in Europe," pp. 69-112. The Full Costs and Benefits of Transportation: Contributions to Theory, Method and Measurement, Edited by David L. Greene, Donald W. Jones, and Mark A. Delucchi, Springer, New York 1997.

Eric J. Miller and Amal Ibrahim, "Urban Forma and Vehicular Travel: Some Empirical Findings," prepared for the 77th Annual Meeting of the Transportation Research Board, January 1998.

Eric Randall, "An Assessment of Acuaexpreso, The Urban Ferry System in San Juan," MIT Thesis, February 1998.

FAA Office of the Associate Administrator for Airports, Airport Activity & Development Statistics, http://www.faa.gov/arp/arphome.htm.

Gary Berman, phone interview, Berman Enterprises, February 1998.

George Brown, phone interview, Manger, Green Construction Company, March 9, 1998.

Gianni Lodi, phone interview, Senior Planner, Metropolitan Dade County Department of Planning, Development, and Regulation; Metropolitan Planning Section, 25 February, 1998.

Glen Weisbrod, "Distinguishing Wide and Local Area Business Impacts of Transportation Investments," Transportation Research Record, No.1552, 1996.

Glen Weisbrod, James Beckwith, "Measuring Economic Development Benefits for Highway Decision-making: The Wisconsin Case," Transportation Quarterly, Vol. 46, No. 1, January 1992.

Glenn Jenkins, Thomas Hexner, Helen Ladd, Russell LaMotte, "Puerto Rican Statehood: A Precondition to Sound Economic Growth," Hex Incorporated. October 1993.

Herman Huang, "The Land-Use Impacts of Urban Rail Transit Systems," Journal of Planning Literature, Vol. 11, No. 1, August 1996.

International Metropolitan Railways Committee "Benefit Sharing: The Funding of Urban Transport Through Contributions from External Beneficiaries," 1987.

Iris Starr, phone interview, City of Oakland Community and Economic Development Agency, March 17, 1998.

Ishaq Nadiri, Theofanis Mamuneas, "Highway Capital and Productivity Growth," Eno Transportation Foundation, June 1996.

James Duncan et al. "The Search for Efficient Urban Growth Patterns," Tallahassee, FL, Florida Department of Community Affairs, 1989. As cited by Robert W. Burchell and David Listokin, 1995.

Jeffrey Jan Sriver, Factors Influencing Land Development Around Rail Transit Stations, Master's Thesis, August 1995.

Joe Chang, phone interview, Maryland National Park and Planning Commission, February 11, 1998.

John Funk, phone interview, Maryland National Park and Planning Commission, February 11, 1998.

John Semmens, "Is Public Transit a Good Investment," Volume 2, pp. 654-677. Proceedings of the 39th Annual Meeting of the Transportation Research Forum, Montreal, Canada, October 16-18,1997.

Jose A. Gomez-Ibañez, "Estimating Whether Transport Users Pay Their Way: The State of the Art," pp. 149-172. The Full Costs and Benefits of Transportation: Contributions to Theory, Method and Measurement, Edited by David L. Greene, Donald W. Jones, and Mark A. Delucchi, Springer, New York 1997.

Joseph Ellis Barr, "Intermodal Fare Integration: Application to the SJMA," MIT Thesis, June 1997.

Junta de Planificación de Puerto Rico, "Proyecto Puerto Rico 2005", November 1992.

King Cushman, "Exploring the land development and Transit Connection," Transit, Land Use, and Urban Form, Center for the Study of American Architecture, School of Architecture, University of Texas in Austin, 1988.

Kiyoshi Kobayashi, "The Emerging New Arena," pp. 27-44, The Future of Transportation and Communication: Visions and Perspectives from Europe, Japan, and the U.S.A., Germany, 1993.

L. Frost, The new Urban Frontier: Urbanization and City Building in Australasia and the American West. University of NSW Press, Sydney. As cited by Peter Newman, Jeff Kenworthy, Feliz Laube, 1997.

Lorenz, K. S., On Aggression, Harcourt Brace Jovanovich, New York, 1966. As cited by Peter Newman and Trevor Hogan, 1981.

Louis Berger International Inc. "Transportation Investment and Economic Expansion: Case Studies," Vol. 2, October 1995.

Manning, 1978 and Pederson, 1980; as cited by Peter Newman, Jeff Kenworthy, Felix Laube, 1997.

Margaret Heraty, "International Overviews," Urban Transport in Developing Countries: Lessons in Innovation, PTRC 1991.

Martha Bianco, Kenneth Dueker, James Strathman, "Parking Strategies to Attract Auto Users to Transit," Presented at the 77th Annual Meeting of the Transportation Research Board, January 1998.

Melvin Webber, "The BART Experience - What Have We Learned?" Institute of Urban and Regional Development, UC Berkeley, Monograph No. 26, 1976

Michael Bell, Therese McGuire, "Macroeconomic Analysis of the Linkages Between Transportation Investments and Economic Performance," National Cooperative Highway Research Program, Transportation Research Board, Report 389, 1997.

Michael Breheny, "Transport Planning, Energy and Development. Improving Our Understanding of the Basic Relationships," pp. 89-95. Transport and Urban Development, Edited by David Banister, 1995.

Ming Zhang, "Working Paper," April 1998.

Morris D. The Naked Ape. McGaw-Hill, New York, 1968. As cited by Peter Newman and Trevor Hogan, 1981.

Nancy W. Sheldon, Robert Brandwein, The Economic and Social Impact of Investments in Public Transit, Lexington Books, Lexington, MA, 1973.

New Jersey State Planning Commission. Communities of Place: the Interim State Development and Redevelopment Plan for the State of New Jersey. July, 1991. As cited by Robert W. Burchell and David Listokin, 1995.

Nigel Wilson, MacDorman & Associates, "Draft Service Evaluation Process. Design of Service Quality Measures and Service Evaluation Standards," Massachusetts Bay Transportation Authority, Conservation Law Foundation, Inc., November 25, 1995.

Oscar Figueroa and Etienne Henry, "Analysis of the Underground Systems in Latin America," Urban Transport in Developing Countries: Lessons in Innovation, PTRC, 1991.

P. R Fouracre and G. Gardner, "Mass Transit in Developing Cities," Journal of Advanced Transportation, Vol. 27 No. 3, pp.251-260, 1993.

P. R. Fouracre, R. J. Allport, and J. M. Thomson, "The Performance and Impact of Rail Mass Transit in Developing Countries," transport and Road Research Report No. 278, 1990.

Pak-Poy, P. G. and Associates, "Inner Suburban-Outer Suburban: A Comparison of Costs," No. 42, Australian Institute of Urban Studies, Canberra, 1973. As cited by Peter Newman and Trevor Hogan, 1981.

Paul Clark Greenberg, "Delivery of Tren Urbano Stations as Strategic Urban Nodes," MS CEE & MST Thesis, May 1996.

Peter Hall, "Urban Rail Development and The Measurement of Impacts," pp. 65-88. Transport and Urban Development, Edited by David Banister, 1995.

Peter Newman "Sustainability and Density: What is the Link?" UDIA Conference, Sydney, March 1994.

Peter Newman and Trevor Hogan, "A Review of Urban Density Models: Toward a Resolution on the Conflict Between Populace and Planner," Human Ecology, Vol. 9, No. 3. 1981.

Peter Newman, "From Symbolic Gesture to The Main Stream: Next Steps in Local Sustainability" Institute for Science and Technology Policy, Murdoch University.

Peter Newman, "Reducing Automobile Dependence," Environment and Urbanization, Vol. 8, No. 1, April 1996.

Peter Newman, "The Compact City: An Australian Perspective," Built Environment, Vol. 18, No. 4. 1993.

Peter Newman, "The Transport Dilemma in Developing Nation Cities," Social Dimensions of Development, Paradigm Books, 1994.

Peter Newman, Jeff Kenworthy and Felix Laube, "The Global City and Sustainability - Perspective from Australian Cities and a Survey of 37 Global Cities," 5th International Workshop on Technological Change and Urban Form, Jakarta, Indonesia, June 1997.

Peter Newman, Jeffrey Kenworthy and Peter Vintila, "Can we overcome Automobile dependence? Physical Planning in an Age of Urban Cynicism," Cities, Vol. 12. No. 1, 1995.

Peter Newman, Jeffrey Kenworthy, Paul Barter, and Chamlong Poboon "Is Increasing Automobile Dependence Inevitable in Booming Economies?: Asian Cities in an International Context," IATSS Research, Vol. 19, No. 2, 1995.

Peter Townroe, "The Coming of Supertram: The Impact of Urban Rail Development in Sheffield," pp. 162-181. Transport and Urban Development, Edited by David Banister, 1995.

Phillip Shinbeing and Jeffrey Adler, "Land Use and Rail Transit," Transportation Quarterly, Vol.49 No. 3, Summer 1995.

Public Relations Office, Metrorail Passenger Surveys. Average Weekday Passenger Boardings 1977-1997.

Puerto Rico Planning Board, 1992 Economic Data.

R. S. Tolley, B. J. Turton, Transport Systems, Policy and Planning: A Geographical Approach, Longman Scientific & Technical, Singapore, 1995.

Rémy Prud'homme, "Urban Transportation and Economic Development," Observatorire de l'Economie et des Institutions Locales, Working Paper 96-04. January 1996.

Richard L. Oram, "Transit Marketing: Successes and Failures," Transportation Research Board, September 1987.

Roanne Neuwirth, "Economic impact of Transit on Cities," p. 143. Transportation Research Record, No.1274. 1990.

Robert Cervero and John Landis, "Twenty Years of the Bay Area Rapid Transit System: Land Use and Development Impacts," Transport Research-A, Vol. 31, No. 4, 1997.

Robert Cervero, "Rail-Oriented Office Development in California: How Successful?" Transportation Quarterly, Vol. 48, No. 1, 1994.

Robert Cervero, "Urban Rail Development and The Measurement of Impacts," pp. 136-156. Transport and Urban Development, Edited by David Banister, 1995.

Robert Dunphy, Deborah Brett, Sandra Rosenbloon, Andre Bald, "Moving Beyond Gridlock: Traffic and Development," Urban Land Institute, 1997.

Robert W. Burchell and David Listokin, "Land, Infrastructure, Housing Costs and fiscal Impacts Associated with Growth: The Literature on the Impacts of Sprawl versus Managed Growth," Lincoln Institute of Land Policy Research Papers, 1995.

SACTRA, 1994; as cited by Peter Newman, Jeff Kenworthy, Feliz Laube, 1997.

Sandra Rosenbloom and Kelly Clifton, "The Puzzle of Income, Race, and Density: Preliminary Evidence on Transit Use from the 1991 American Housing Survey," Journal of Public Transportation, Fall 1996.

Schneider, K. R., On the Nature of Cities, Jossey Bass, San Francisco, 1979. As cited by Peter Newman and Trevor Hogan, 1981.

Spencer Crump, Ride the Big Red Cars, Los Angeles: Crest Publications, 1962. Ibid. 30

T.R. Lakshmanan, Peter Nijkamp. Erick Verhoef, "Full Benefits and Costs of Transportation: Review and Prospects," pp. 387-406, The Full Costs and Benefits of Transportation: Contributions to Theory, Method and Measurement, Edited by David L. Greene, Donald W. Jones, and Mark A. Delucchi, Springer, New York 1997.

Ted R. Miller, "Societal Costs of Transportation Crashes," pp. 281-314, The Full Costs and Benefits of Transportation: Contributions to Theory, Method and Measurement, Edited by David L. Greene, Donald W. Jones, and Mark A. Delucchi, Springer, New York 1997.

The Maryland National Capital Park and Planning Commission, "Greenbelt Metro Area Study (draft)," 1998.

The World Bank, "World Development Report 1994," June 1994.

Thomas C. Parker, "Community Involvement and Planning for Transit," Transit, Land Use, and Urban Form, Center for the Study of American Architecture, School of Architecture, University of Texas in Austin, 1988.

U.S. Department of Commerce, "Statistical Abstract of the United States, 1997."

US Department Of Transportation, "Final Environmental Impact Statement, Tren Urbano, San Juan Metropolitan Area, Puerto Rico," November 1995.

USDOT and DTOP, "Final Environmental Impact Statement, Technical Appendices, Tren Urbano, San Juan Metropolitan Area, Puerto Rico," November 1995.

USDOT, "The impact of BART on Economics and Finance (Interpretive Summary of the Final Report)", December 1979.

USDOT, "The Impact of BART on Land Use and Urban Development – Interpretive Summary of the Final Report," BART Impact Program, September 1979.

1990 US Census Data, Means of Transportation to Work.

1990 US Census Data, Population.