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Effects of Light Rail Transit in Portland: Implications for Transit-Oriented Development Design Concepts

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Abstract

In the Portland, Oregon, region many local planners have embraced the neotraditional planning concept in the form of transit-oriented development (TOD). One of the primary components of transit-oriented development, light rail transit (LRT), has been in place in Portland long enough to provide data for analysis. Because neotraditional planners often emphasize LRT as a crucial element in decreasing auto use and in encouraging high-density development, this paper examines the effects of LRT in the Portland region including mode share, density, and property values. The empirical analysis provides evidence that light rail alone has not been sufficient to have an appreciable impact on development patterns, residential density, auto ownership, and transit modal behavior, although there has been some positive effect of rail on single-family property values. There has also been less of a decline in transit use and slower growth in two-car households in the LRT corridor as compared to a parallel bus corridor. The small positive effects of LRT may indicate the beginning of a self-selection in housing location choice wherein persons desiring rail transit choose to live where it is available.

This assessment of the evidence in terms of impacts on development trends indicates the extent to which consumer preferences have responded to LRT investments. This kind of assessment is needed to provide the basis for estimating travel mode shares and market shares for dispersed and concentrated development forms. Examination of data suggests that it may be advisable for planners to entertain more modest expectations of LRT.

Key words: Transit-oriented development, Light Rail Transit impacts

Introduction

This paper examines how light rail transit (LRT) has affected travel mode, auto ownership, residential density, and property values in Portland. The effects of the existing eastside line have been modest, whereas more developmental impacts are expected on a new second line to a faster growing westside area. This paper looks at the travel behavior and land use effects of LRT in Portland to lay a foundation to explore concepts of neotraditional design that are based on transit -- particularly rail.

Two looming questions emerge from transit-oriented design proposals. One is whether we have the ability to reshape existing development patterns and density. That is, will people be willing consumers of a new product? The second question is whether the new form will in fact produce fewer auto trips and thus more transit and nonvehicular trips. Will people really drive less and use transit more?

There is evidence that existing transit-oriented development (TOD) patterns — usually developments in older areas already well served by transit — have higher transit ridership rates than newer auto-oriented areas. This has led many to conclude that *new* transit-oriented developments will have a large impact on transit ridership. For this to happen, one or both of two things have to occur: A high percentage of people moving to new transit-oriented developments will need to be former auto-oriented residents who change their behavior. Or, the neotraditional developments will have to attract transit-oriented residents from older, traditional neighborhoods who will bring their transit-using behavior with them. In all likelihood the residents of new TODs will come from both groups. However, there is little evidence to suggest that these new residents will not be fairly auto dependent as well.

The Neotraditional Vision of Transportation

Audirac and Shermyen (1994) characterize the New Urbanism as a postmodern reconstruction of American suburbia that goes by various names: “pedestrian pockets” on the West Coast, “urban villages” in the Northeast, and “neotraditional neighborhoods” in Florida. A common element is the pedestrian-friendly street and mixed-use town center. The transit-oriented development (TOD) variation includes transit corridors and mixed-use development around transit stations. The value of transit-oriented design is predicated on the assumption that TODs generate shorter trips, less traffic, have higher transit rates, and result in a better jobs-housing balance.

Designs of neotraditional developments are conducive to walking and transit, as Bernick and Cervero (1997) describe in their formulation of the “transit village” concept.

> [T]he transit village is a compact, mixed-use community, centered around the transit station that, by design, invites residents, workers, and shoppers to drive their cars less and ride mass transit more…. Transit villages also offer alternative living and working environments that combine the suburban values and lifestyle preferences for open space, human-scale buildings, and sense of security with the more traditionally urban values of walking to neighborhood shops, meeting people on the street, and being in a culturally diverse setting (pp. 5,7).

Aware that transit-oriented design alone is not enough to change people’s behavior, Bernick and Cervero note that

> transit villages are not a panacea to today's congestion, air quality, or social equity problems... However, along with other initiatives that remove subsidies to motorists, transit villages, we believe, would make a positive contribution toward improving social and environmental conditions in our cities... [and] of demonstrating that transit-oriented development can create positive public and private benefits, and that there is a burgeoning though largely pent-up demand for transit village living... (p. 67).

Bernick and Cervero acknowledge observers skeptical about TODs, who critique them as "'boutique' design and planning concepts; underneath the physical facade, there are few transportation benefits to be found" (p. 131). However, Bernick and Cervero respond by saying these critics accept "the current settlement patterns and pricing arrangements" (p. 132). Therefore, their transit village concept is part of a larger package that includes pricing the automobile - a package whose benefits, they maintain, may not be apparent until the long term.

They identify two significant barriers to transit villages: 1) financial and 2) political. Consumer preference for low-density living make market viability of denser housing questionable in the eyes of the financial community. This, coupled with "not-in-my-backyard (NIMBY) forces, impedes multifamily housing developments" (p. 139).

Martin Wachs, as quoted in Bernick and Cervero (p. 267), points out that “ . . . a niche market is likely to exist for compact, mixed-use neighborhoods around rail stations . . . [but] all the forces pulling development to outlying areas over the past 10 years are still with us.” Is the present market for TODs large enough to warrant the emphasis it receives, particularly if not part of a package approach that includes pricing disincentives? Can costly LRT investments in low-density areas be justified on the expectations of future TOD development?

Crane (1998) finds little knowledge about how urban patterns influences travel patterns, the evidence is mixed, leading him to conclude "the potential benefits of new urbanism reflect on interesting set of hypotheses, but they remain a weak basis for ... transportation policy", p. 2.

The Role of Changing Technologies

A question that is ignored by the neotraditional proposals is the extent to which changing technologies might undermine the importance for higher densities. As both communications and transportation technologies improve, how significant might the costs of sprawl really turn out to be?

Gordon and Richardson (1995, 1997) respond to this question by arguing that the proponents of compact development have overestimated the costs of sprawl. These analysts conclude that continued improvements in transportation and communications will in fact obviate the need for concentrated settlement patterns. Tietz (1996) points to the possibilities of ever-greater global communications promised by increasing electronic interconnections. A new community is emerging — one that does not rely on front-porch interchanges with passersby, but instead on electronic connections from bedrooms and living rooms across the globe.

Genevieve Giuliano notes that there are several reasons why the relationship between land use and transportation may not be as strong as some planners want to believe. Perhaps most significant is her conclusion that "transportation is of declining importance in the locational decisions of households and firms. Transport costs make up a relatively small proportion of household expenditures, and increasingly flexible work arrangements (including telecommuting) are likely to make access to workplaces even less important in the future" (1995, 8-9). However, others such as Ewing (1997), dispute the contention that modern telecommunications have rendered geography irrelevant and emphasize the continuing importance of face-to-face contact and agglomeration economies.

The ultimate effect of telecommunications and transportation technologies on urban form will not be known for some time. But what is certain is that they provide potential for a greater population dispersion — not concentration. New forms of community have already emerged as a result of telecommunications; there is no reason to believe that electronic groups and communities will decrease in number. More and more people are choosing to telecommute, thereby enabling them to live at great distances from their place of employment. Transport technologies, including those that increase the efficiency of both automobile and transit travel, are making long-distance commuting less time consuming and more enjoyable, even in the worst conditions of congestion (Downs 1992). In short, changing technologies point to a continuation of the historic decentralization trend — not a return to compact development forms as advocated by urban planners. These planners face the conflicting challenge of facilitating, on the one hand, planning processes that respond to majority preferences for a continuation of decentralized development patterns, while at the same time advocating compact development and modes of transport thought to be more sustainable. (See Breheny (1995) for a discussion of the sustainable development rationale for increasing density and reducing auto dependency. He finds minimal energy savings and pollution reduction can be achieved by regulation of development.)

Context for the Portland Case Study

The motivation for Portland's eastside LRT line in the 1980s stemmed from an earlier freeway revolt and federal legislation allowing for the substitute of transit for highways. However, transit-oriented development was not a central part of the project, although limited transit-oriented design was undertaken in the form of station-area planning in the outer part of the LRT corridor. This took the form of densification by redevelopment of low-density areas, but due to a poor regional economy in the early 1980s and a shift of growth from the eastern part of the region to the western, this effect did not result in true transit-oriented design, as envisioned by Bernick and Cervero. With a greater amount of vacant land and a stronger development market, planning for the westside LRT line focuses more on transit-oriented development.

The New Urbanism movement and the refinement of the TOD concept coincides with the planning and construction of the westside LRT line. Like Bernick and Cerveros' "pearls on a necklace" notion, the transit station areas are being planned as points of mixed use with fairly high densities.

As a result of its history, Portland is an area where most local planners have embraced the neotraditional planning concept. Unlike the case in many metropolitan areas, decision-makers in the Portland region have achieved a remarkable amount of consensus about the connection between land use and transportation and their vision for the future. The regional planning entity, Metro, has devised a plan called Region 2040, which has been strongly influenced by a planning analysis spearheaded by 1000 Friends of Oregon, a land use watchdog organization. This analysis, known as LUTRAQ (Land Use Transportation Air Quality), has as one of its chief goals the reduction of single-occupancy vehicular (SOV) travel. At its core is growth management based on neotraditional design, supplemented with varying degrees of reliance on transportation demand management (TDM), including transportation pricing.

There is no doubt that both the LUTRAQ and Region 2040 proposals are unique and ground breaking in ambition and that the planning process in the Portland metropolitan region is fascinating to study. This area is a fertile laboratory for analysis — but are its residents informed, consenting participants in what might turn out to be a very risky experiment? What if light rail is not effective? What if developers do not seize upon planning recommendations to build at higher densities, in neotraditional form? And if they do build, what if people don't buy? And, if people do buy, what if they don't increase their use of mass transit? What if SOV use continues to increase?

Transit ridership has increased in Portland, from 130,600 average daily riders in 1981 (with a decline to 115,6000 in 1986 due to an economic recession and service cutbacks) to 198,400 in 1994. However, a comparison of 1980 and 1990 census data by the U.S. Department of Transportation (Pisarski 1992) found that during that period commuter behavior in the Portland area was "a model of the national trend.... Transit declines in the city of Portland itself were particularly marked with shares dropping from 15.9 percent to 10.9 percent. Only working at home and driving alone showed significant gains in shares. . . . Portland was one of the cities in which driving alone increased more than the increase in workers"(p. 27). Thus, while transit ridership in Portland may be increasing, shares are not necessarily increasing. Even in Portland, use of the auto continues to increase. It may be difficult to deflect, let alone reverse, the growing dependence on the auto.

The same report also shows that Seattle and Los Angeles gained transit ridership among commuters while Portland lost. This is partly attributable to faster growth rates in Seattle and Los Angeles during that period, but the loss in share carried by transit from 1980 to

1990 was higher in Portland than in Los Angeles and Seattle. Portland's share of work trips by transit fell from 8.4 percent in 1980 to 5.3 percent in 1990, while Los Angeles' share fell from 6.4 percent to 5.7 percent, and Seattle's share fell from 10.7 percent to 7.8 percent.

Interestingly, the rhetoric in Portland is to point to Los Angeles and Seattle as bad examples of sprawl and auto dominance, something Portland can avoid by becoming more transit oriented.

These are the recent trends, but future trends, as modeled in the LUTRAQ analysis, may show no real decrease in SOV share. Recent research by Giuliano (1995) questions the transportation-land use connection suggested by LUTRAQ. Her analysis of the LUTRAQ modeling projections is that "land use policies appear to have little impact on travel outcomes; most of the observed change is due to TDM [transportation demand management] policies, rather than to the land use and transit policies. Without TDM, travel impacts of the LUTRAQ alternative are minor" (1995, 8).

In other words, transit incentives and transit-oriented design may have a negligible impact on SOV use. These strategies need to be part of a larger travel demand management package that includes auto disincentives.

Purpose of this Study

This paper examines the land use and transportation impacts of the existing eastside LRT in Portland. Assessing the eastside LRT experience is instructive in determining the effects of rail-based transit on travel behavior and land use change. On the eastside line, much of the patronage was diverted from buses, and TOD efforts were small (station areas were rezoned for more intensive development) in comparison to those present in the new westside LRT corridor. The success of Portland's new westside LRT depends on TODs generating new ridership, because the existing base of bus riders is small.

Neotraditional design remains largely untested. But in Portland, one of the primary components of transit-oriented development — light rail transit (LRT) — has been in place long enough to provide data for an initial analysis. Because neotraditional planners often point to LRT as a crucial element in decreasing SOV use and in encouraging high-density development, this paper examines the extent to which eastside Portland LRT has affected location of multifamily development, residential density, housing prices, vehicle ownership, mode share, and journey-to-work.

The relationship between LRT impacts and TOD is a focus of this research due to the locational choice of residents wanting to avail themselves of LRT access. The self-selection process of choosing a residence that possesses walking access to LRT is the essence of a TOD. This research tries to assess if that is occurring.

Study Area

A treatment group, control group method is the primary mode of investigation due to the existence of a comparable parallel bus corridor. Before and after data are used in each corridor to measure travel behavior changes. Comparison of 1980 and 1990 census data span the opening date of LRT in 1986.

The primary study area (see Map 1) includes the rail corridor, the inner portion paralleling the Banfield Freeway (I-84) and the outer portion paralleling Burnside Avenue; and the bus corridor, the inner portion served by the Hawthorne and Division bus routes, and the outer portion by the Division and Powell bus routes. The rail and bus corridors are similar in land use and demography. The residential, commercial and industrial mix is shown in Table 1. The chief difference is that the rail corridor contains both LRT and an interstate freeway, I-84. The portion of Portland between the Willamette River and Interstate-205 consists of the built-out inner city area where there is very little vacant land to develop.

The multifamily housing analysis is limited to the outer portion of the two corridors. This secondary study area is defined by I-84 to the north and I-205 to the west; the eastern limits of Gresham and Troutdale (the eastern part of the Portland Metropolitan Urban Growth Boundary); and a southern boundary extending one quarter mile south of Powell Boulevard.

Findings of Rail and Bus Corridor Impact Assessment

Housing impacts are assessed by comparing the rail corridor to a parallel bus corridor in two ways: location of multi-family dwellings and density changes. In addition, single-family price effects around suburban rail stations were statistically analyzed. Travel behavior effects were assessed by comparing the two corridors in terms of changes in auto ownership, transit use, and journey-to-work differences.

Changes with Respect to Transit Level of Service

The introduction of light rail in the Banfield corridor resulted in the elimination of one of four radial bus routes operating on arterials and two express bus routes operating on the Banfield Freeway. Feeder routes to rail stations, principally the Gateway Transit Center at the boundary between the inner and outer portions of the corridor, were added. In addition, both the inner portions of the rail corridor and the parallel bus corridor were impacted equally by crosstown bus improvements in the early 1980s. The net effect was an increase in seat-miles of transit service in the rail corridor as compared to the Division bus corridor.

Results with Respect to Multifamily Housing Development

This aspect of the study is concerned with densification in the form of multifamily housing development by level of transportation access. Access is determined by use of a quarter-mile buffer around light rail stops, bus stops, and major arterials. The model employs the concept of nesting, with each individual parcel having a specific level of transportation access.[1] Levels of transportation access are defined as follows:

- **rail stations** sites within 1/4 mile of rail stops, bus stops, and major arterials
- **bus stops** sites within 1/4 mile of bus stops and major arterials
- **arterials** sites within 1/4 mile of major arterials, but not bus stops or rail stops
- **other** sites are not within 1/4 mile of major arterials, rail stops, or bus stops

[1] The nested model works remarkably well with respect to inclusiveness. The only inconsistency concerns the bus stop coverage, which contains a few fragments that do not precisely overlap with arterials. The amount of this error is approximately 3%.

The analysis utilized data from Regional Land Information System (RLIS 1996 edition), Metro, Portland, OR. ArcView was used to buffer transit stops and arterials to determine the transit locational typology of multifamily housing built during the 1986-1995 period.

Table 2 shows that about 17 percent of all multifamily development projects built in 1986 -- the year light-rail opened -- through 1995, and 12 percent of the total amount of developed multifamily area in that 10-year period has occurred around rail stations. This would seem to indicate a higher rate of developed multifamily projects relative to the percentage of area around rail stations. This higher rate should be considered, however, in light of the fact that station areas are more heavily zoned for multifamily housing development than other areas in an effort to densify rail-accessible areas. Table 3 shows the distribution of land by modal access for the study area and that 15 percent of the land zoned for multifamily housing is in rail station areas. These data are illustrated in Figure 1.

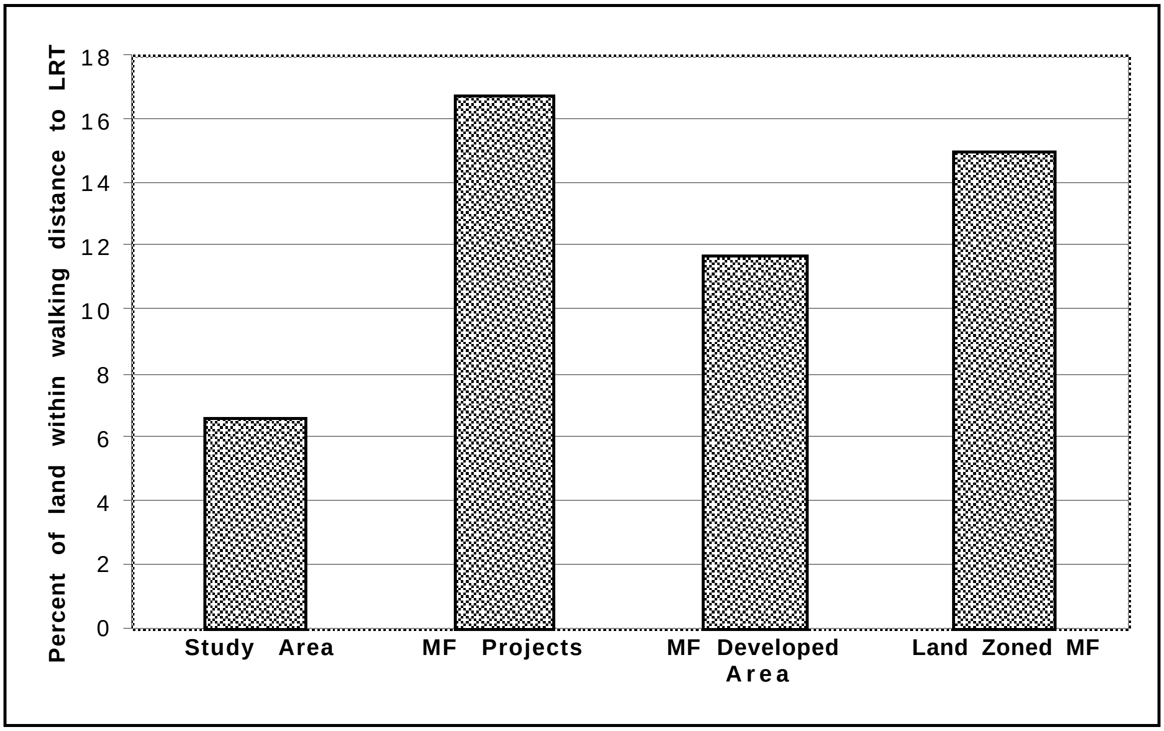
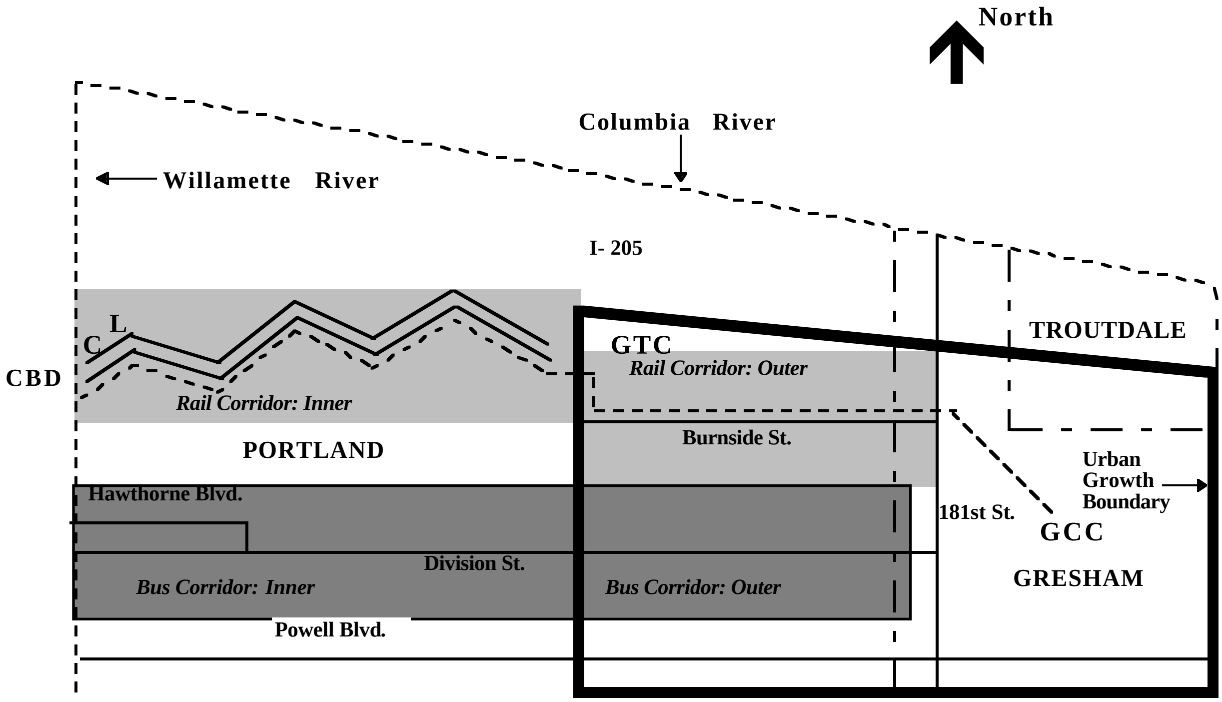
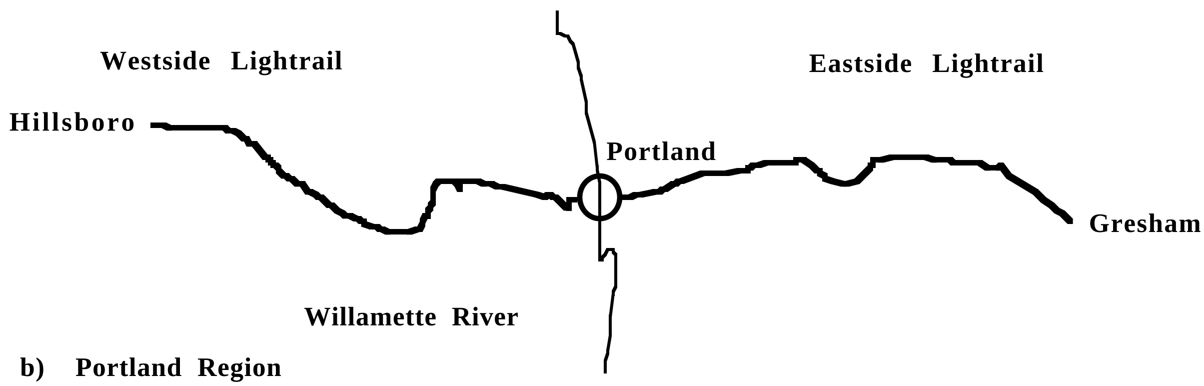


Figure 1: Rail Access. Walking distance to LRT stations (1/4 mi. buffer) includes 7 percent of study area. Seventeen percent of MF development projects since 1986 occurred within walking distance to LRT. Twelve percent of total developed MF acreage, 1986 - 1995 occurred within walking distance to LRT. Fifteen percent of land zoned for MF development is within walking distance of LRT.



a) Eastside Bus and Rail Corridors: Inner and Outer



b) Portland Region

Multifamily Housing Study Area	City Boundary	C	Convention Center
Rail Corridor	Light Rail Line	L	Lloyd Center District
Bus Corridor	I-84	GTC	Gateway Transit Center
	Major River	GCC	Gresham Civic Center

Map 1: Study Areas

Table 4 shows the number of vacant parcels and the area of vacant land zoned for multifamily housing in 1995, and the number of parcels and area of multifamily housing parcels that were developed between 1986 and 1995. Together this reflects the amount of land available for multifamily housing in 1986. The build-out rate for parcels and land area as shown in Table 5 were calculated from the values in Table 4. The results in Table 5 show that the build-out rate for parcels located in rail station areas is lower than in areas served by bus stops and arterials. Controlling for available multifamily land, the build-out rate for rail station areas is less, as shown in Figure 2.

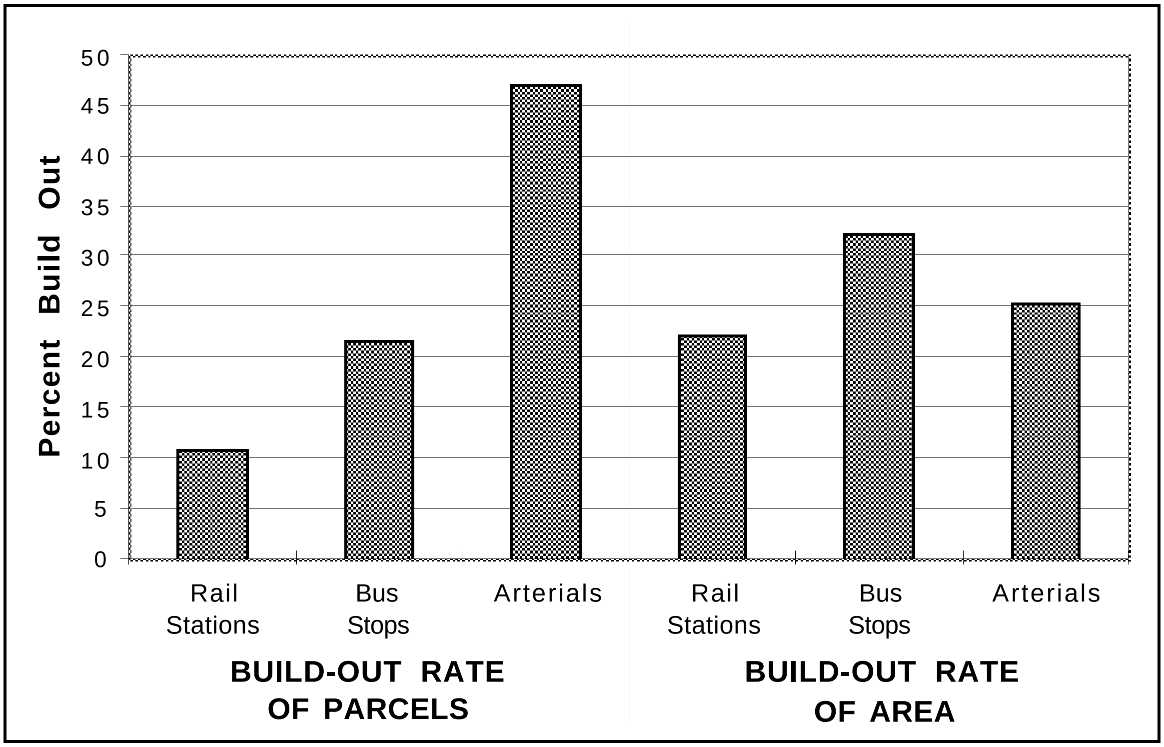


Figure 2: Build-out rate controlling for availability of MF parcels/acreage. Number of parcels/area developed for MF housing 1986 - 1995 as a percentage of parcels/area zoned MF and vacant, and zoned MF and developed for MF housing 1986 - 1995, by type of transportation access. Ten percent of the MF zoned and vacant parcels around rail stations have been developed during the 1986 - 1995 period, while 21 percent of MF zoned and vacant parcels around bus stops have been developed. Twenty-two percent of MF zoned and vacant acres around rail stations have been developed and 32 percent of MF zoned and vacant acres around bus stops have been developed.

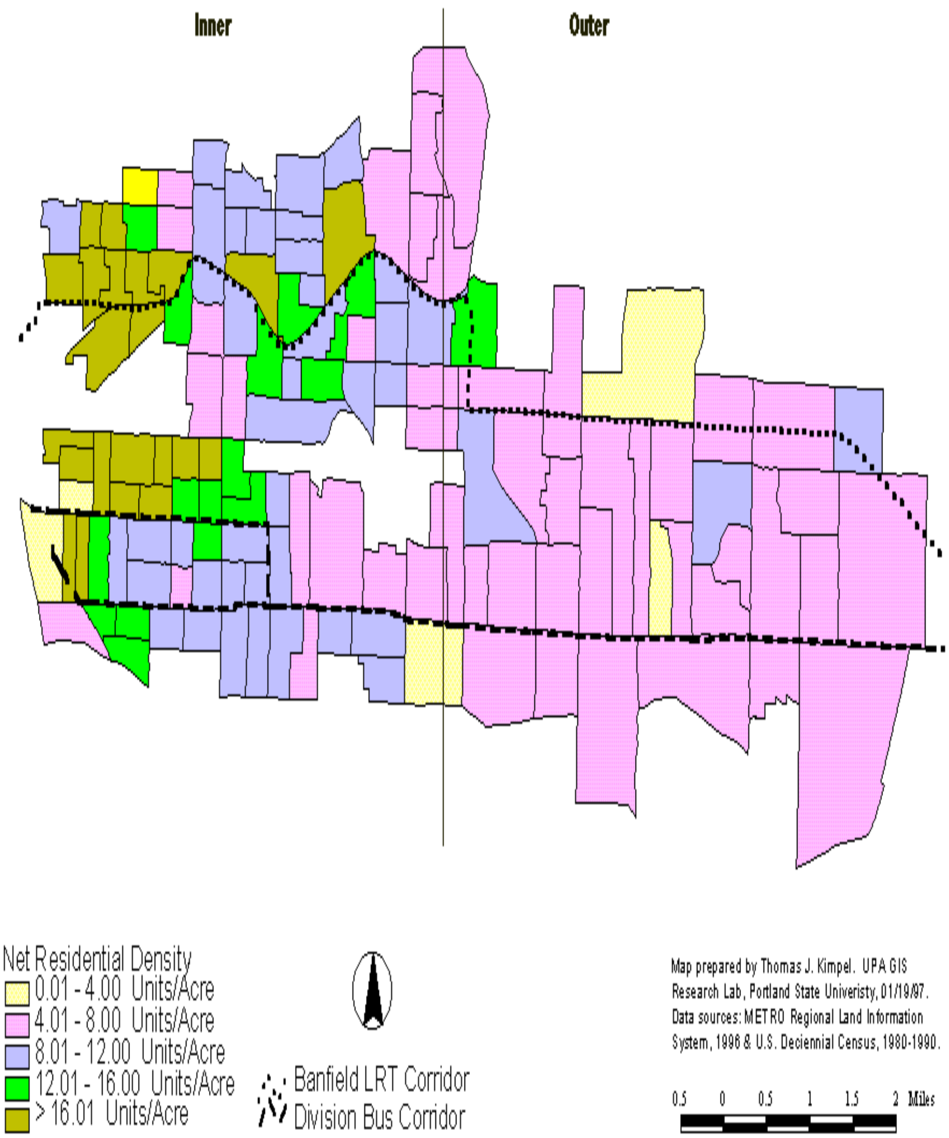
This analysis indicates that while it may appear that multifamily development is occurring more rapidly near rail station areas than elsewhere, this may be due more to an overzoning of land around stations than to the presence of LRT. Zoning land around rail stations for multifamily housing helps to concentrate multifamily housing density, but the effect of LRT alone on multifamily housing development is not strong in and of itself. On the basis of the amount of multifamily-zoned land, the development of multifamily housing is actually occurring at a faster rate near bus stops and arterials than around light rail stops.

Results with Respect to Density

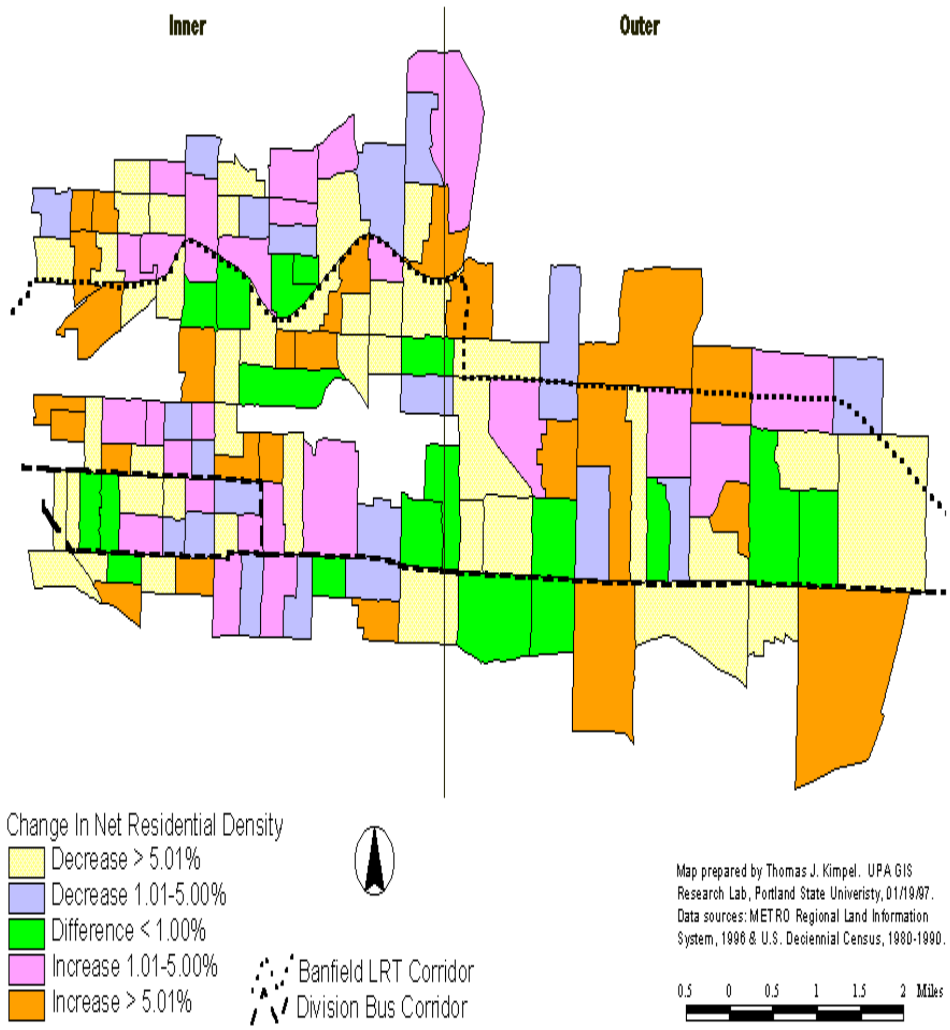
Map 2 displays the net residential density in 1990 for 1990 block groups, while Map 3 displays the percent change in net residential density from 1980 to 1990 by 1990 block groups. Gross residential density divides the number of dwelling units by the gross acreage of the block group, while net residential density divides the number of dwelling units by the area devoted to residential use in 1980 and in 1990 as determined by the year-built variable in Portland Metro's Regional Land Information System (RLIS).

Figure 3 presents the density values for the two corridors and their inner and outer portions that reflect the central city and suburban portions, and Figure 4 presents percent change from 1980 to 1990. (Figures 2 and 3 are based on data in Table 6.) This aggregation of density from the block group level to the corridor level facilitates comparison of the corridors. Interestingly, it shows that the density increase in the rail corridor is less than in the bus corridor, which may be another indication that LRT alone is not sufficient to increase residential density. The losses in residential density for both rail and for net density, bus, may be due to increasing commercial uses in the inner portion of the study area.

Map 2: Net Residential Density, 1990



Map 3: Percent Change In Net Residential Density, 1980-1990



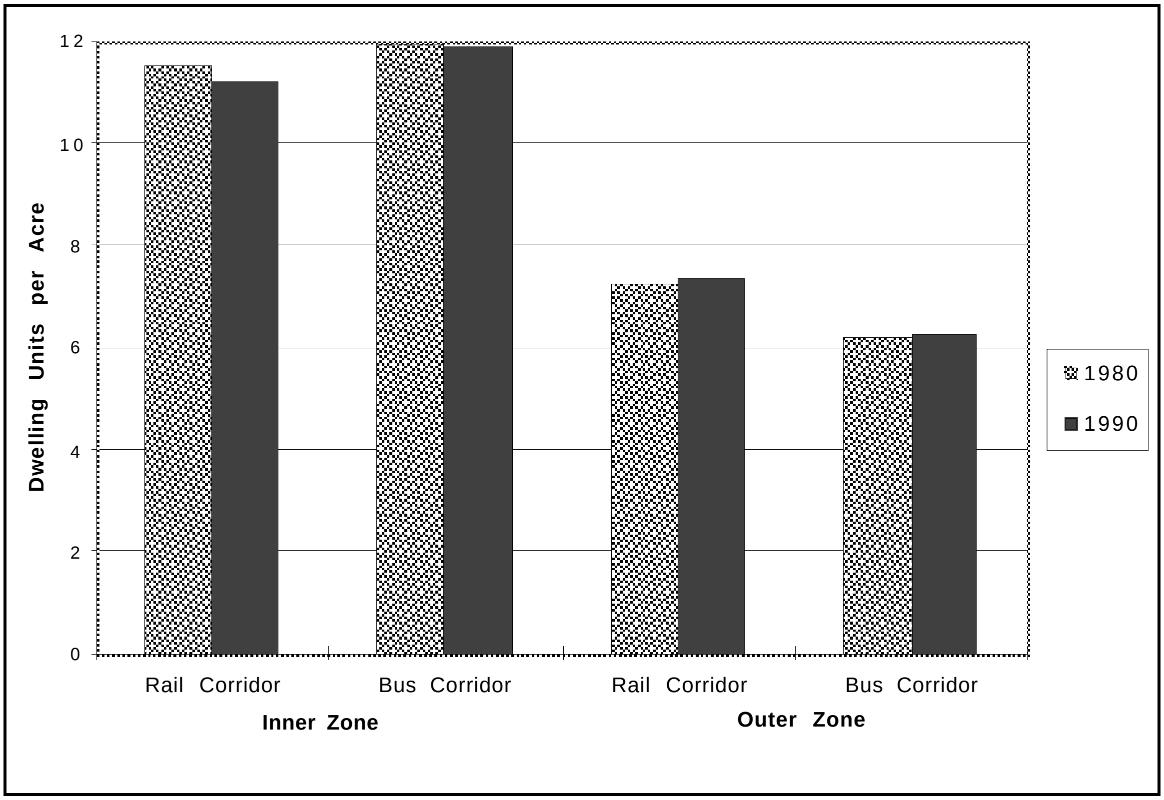


Figure 3: Net Residential Density, 1980-1990.

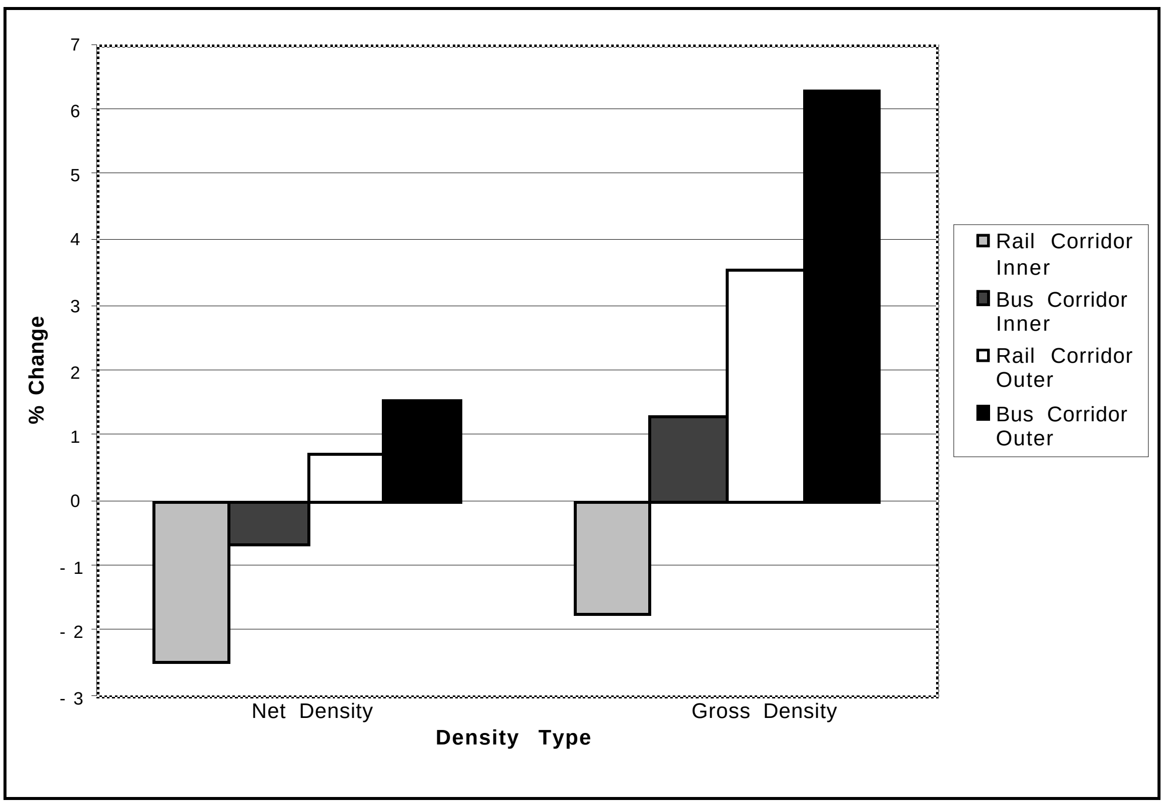


Figure 4: Percent Change in Residential Density, 1980-1990

Results with Respect to Property Values

One measure of benefit of a transportation investment is an increase in property values in areas of impact. Economic theory assumes that access to transportation services should be capitalized into property values. However, living close to an LRT station and line may also increase noise, traffic, pollution, and other nuisances, with a resulting decline in home values. Proximity to a rail line may in fact have two different effects on residential property values. On the one hand, accessibility (proximity to the LRT stations) increases property values. On the other hand, nuisance effects (proximity to the LRT line and stations) decreases property values. Chen, Rufolo, and Dueker (1997) examined the impact of light rail on single-family home values in the outer part of the eastside rail corridor, using distance to rail stations as a proxy for accessibility and distance to the line itself as a proxy for nuisance effects. The study results are robust and show that incorporating both the distance to stations and the distance to the rail line allows for separation of the accessibility effect (positive) and the nuisance effect (negative). The accessibility effect dominates the nuisance effect. The results suggest that a positive price gradient does exist with respect to station accessibility.

Thus, the real estate market has responded positively to LRT. Figure 5 illustrates that the model estimates that a house that is valued at $82,800 (median price of housing in sample) at an LRT station would be valued at $80,500 a distance of 200 feet away, $78,554 a distance of 400 feet away, $76,961 a distance of 600 feet away, $75,721 a distance of 800 away, and $74,835 (10% reduction) a distance of 1000 feet away from a rail station. This willingness to pay a premium for single-family housing having LRT access is a significant and positive land use benefit of the LRT investment.

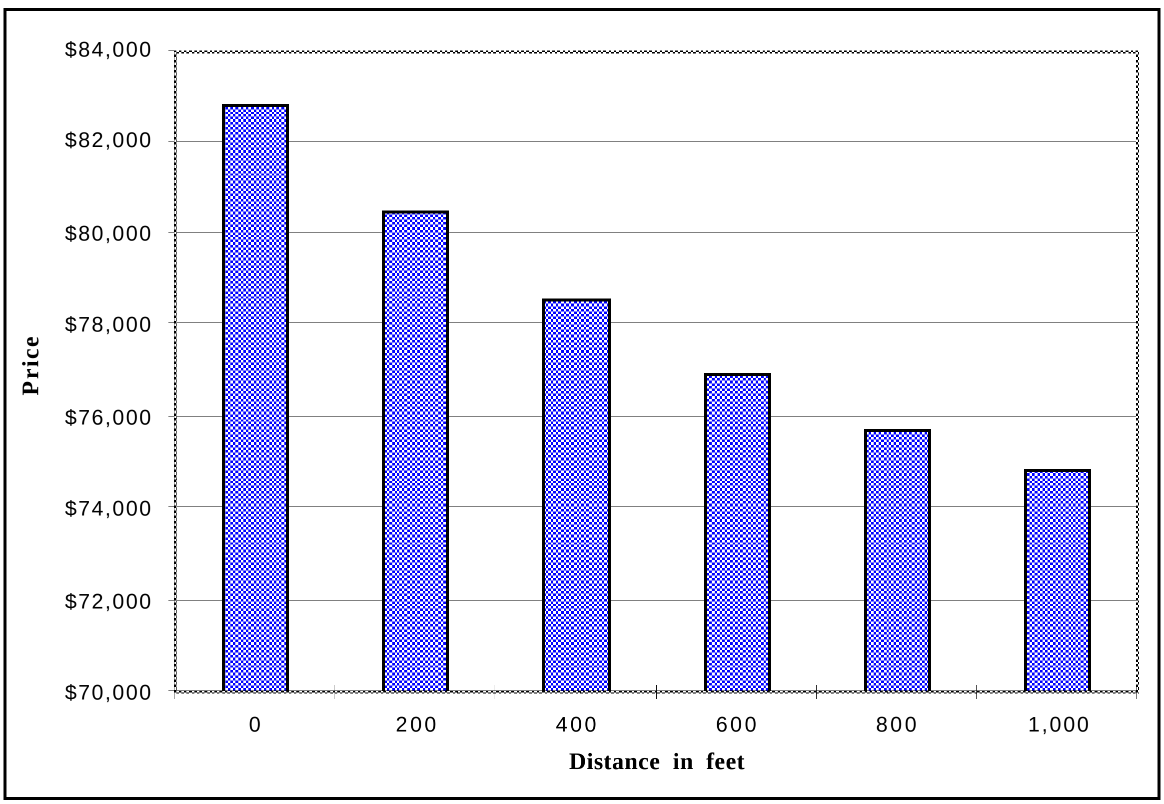


Figure 5: Price Effect of LRT on Single-family Housing

Results with Respect to Vehicle Ownership

There has been a slight effect of LRT on vehicle ownership. Figure 6 and Table 7 present the results of comparing 1980 and 1990 vehicle ownership data from the U.S. Census of Population and Housing for the rail corridor and the parallel bus corridor.

One comparison is for the inner city portion of both corridors. In the rail corridor, the zero and one vehicle ownership rate was 62.3 percent in 1980 and 56.0 percent in 1990, a 6.3-percentage point difference in share, as compared to a rate of 64.4 percent in 1980 and 59.6 percent, a 4.8-percentage point difference in share, for the parallel bus corridor. The change in zero and one vehicle ownership was less in the parallel bus corridor than in the LRT corridor. Both inner corridors saw a shift to more two-vehicle households and a loss of zero- and one-vehicle households. Both shifts are detrimental to transit ridership, and LRT is not reversing this powerful trend of increased auto availability.

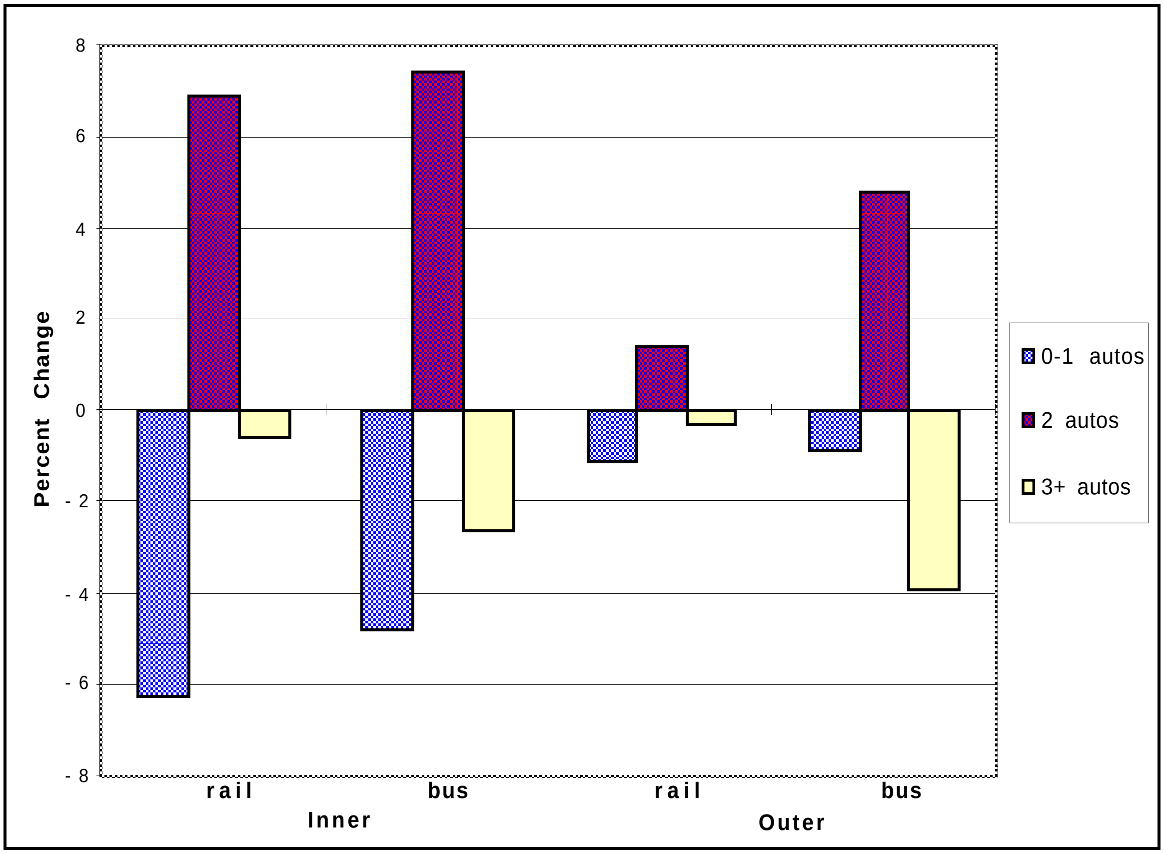


Figure 6: Percent Change in Vehicle Ownership, 1980-1990

A second comparison is for the outer portion of the corridors. In the rail corridor the zero and one auto ownership rate was 49.0 percent in 1980 and 47.9 percent in 1990, a 1.1 percentage point decrease in share, as compared to a rate of 45.4 percent in 1980 and 44.5 percent in 1990, a 0.9-percentage point decrease in share for the parallel bus corridor. However, there is an interesting difference when comparing two-vehicle households. Two-vehicle households grew by 1.4 percent in the rail corridor, while two-vehicle households grew by 4.8 percent in the bus corridor. This difference might represent the beginning of a self-selection or residential-sorting process wherein households choosing to live in the outer rail corridor are less in need of two vehicles than if they were to locate elsewhere.

Results with Respect to Transit Share

The effect of LRT on transit share has been minimal, but somewhat encouraging. Tables 8 and 9 present the results of comparing 1980 and 1990 journey-to-work data from the U.S. Census of Population and Housing for the rail corridor and the parallel bus corridor. Both corridors (shown by the shaded area in Map 1) are split into an inner city zone and an outer suburban zone.

In the inner city zone, the rail corridor lost transit share from 15 percent in 1980 to 13 percent in 1990, while the parallel corridor served by bus lost transit share by only a slightly larger amount (4 percent), from 19.7 percent to 15.6 percent. In the outer zone, the rail corridor maintained transit share, at 9.5 percent in 1980 and 9.5 percent in 1990. In the bus-only corridor, transit share fell from 9.2 percent to 7.9 percent, as shown in Figure 7.

The slightly better transit share in the outer rail corridor may be due to better transit service. Travel times, according to the LRT schedule, from the Portland CBD to Gresham is 46 minutes in the PM peak and 44 minutes in the AM peak direction. The comparable scheduled times in the parallel bus corridor, Route 9, between the Portland CBD to and from Gresham is 58 - 69 minutes in the PM outbound peak period, outbound, and 56-58 minutes in the inbound AM peak period. Off peak travel times range from 43 to 46 minutes by LRT and 53 to 61 by bus.

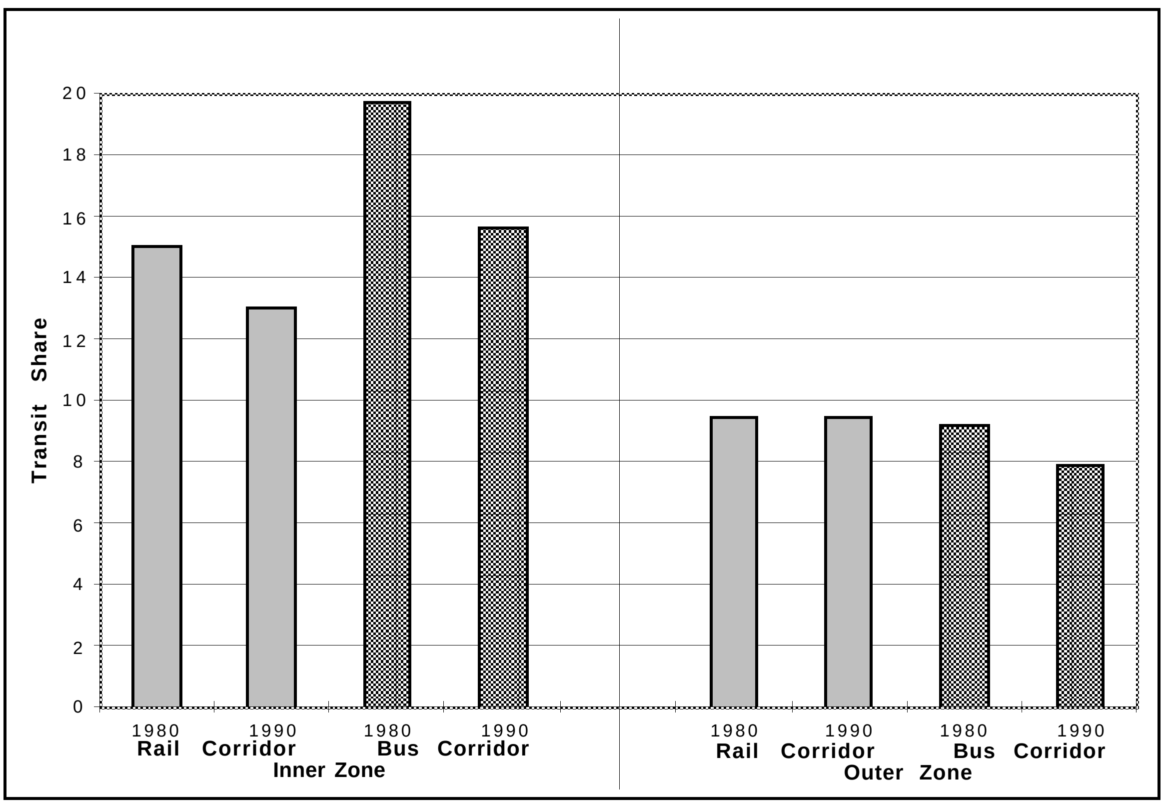


Figure 7: Transit Mode Share. In the outer rail corridor transit share remained constant, while it decreased by 14 percent in the outer bus corridor. Both inner zones lost transit share.

Figure 8 presents the percent of change from 1980 to 1990 in journey-to-work for transit and auto for each corridor (see Table 8). Comparison of the outer parts of the corridors provides another indication of an LRT impact. The outer rail corridor has not lost share of commuting to CBD by transit, while the outer bus corridor has. Auto share declined one percent in the rail corridor, while it increased in the outer bus corridor. This may indicate the outer rail corridor is attracting households more inclined to use transit than is the case in the parallel outer bus corridor, and which may help to explain the bidding up of housing prices near rail stations.

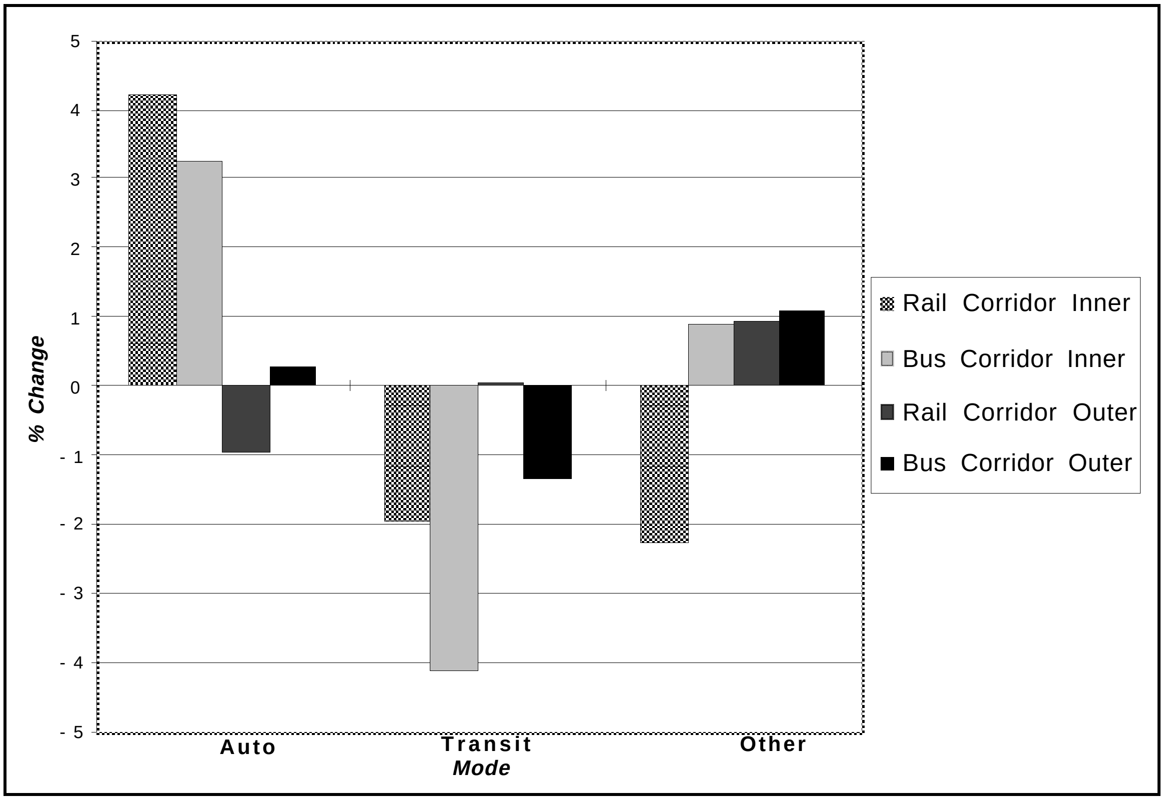


Figure 8: Percent Change in Journey-to-Work Mode Shares, 1980-1990

Transit share continues to erode, but by a smaller amount in the rail corridor. The new light rail service and the feeder bus routes have staved off some of the erosion that has occurred nationally and in Portland. However, it has not reversed the trends.

Results with Respect to Journey-to-Work by Destination, 1990

Figures 9 and 10 present the percent of journey-to-work for transit by corridor, to all destinations and to the CBD (see Table 9). The outer rail corridor is not attracting a larger proportion of CBD-destined commuters than does the outer bus corridor.

In a study of residential location choice in the Philadelphia region, Voight (1991) observed a process called “residential sorting,” which is self-selection of home location in response to employment accessibility. Voight found that census tracts with commuter rail service averaged 12 percent more of their residents working in downtown Philadelphia than were observed in surrounding tracts. However, examination of Portland commuters to the CBD by corridors in Figure 10 (see Table 9) does not support residential sorting as described by

Voight, because the proportion of trips from the outer rail corridor to the CBD it is not different from that of the outer bus corridor. But the share of CBD commuters using transit in the rail corridor is slightly higher than in the outer bus corridor, 34.9 percent as compared to 33.3 percent (see Figure 10). Consequently, residential sorting may be occurring but the numbers are barely detectable using the 1990 census data. Year 2000 census data should be able to provide more definitive results. Residential sorting is suspected by indications of differences in vehicle ownership and changes in transit share in the outer parts of the corridors.

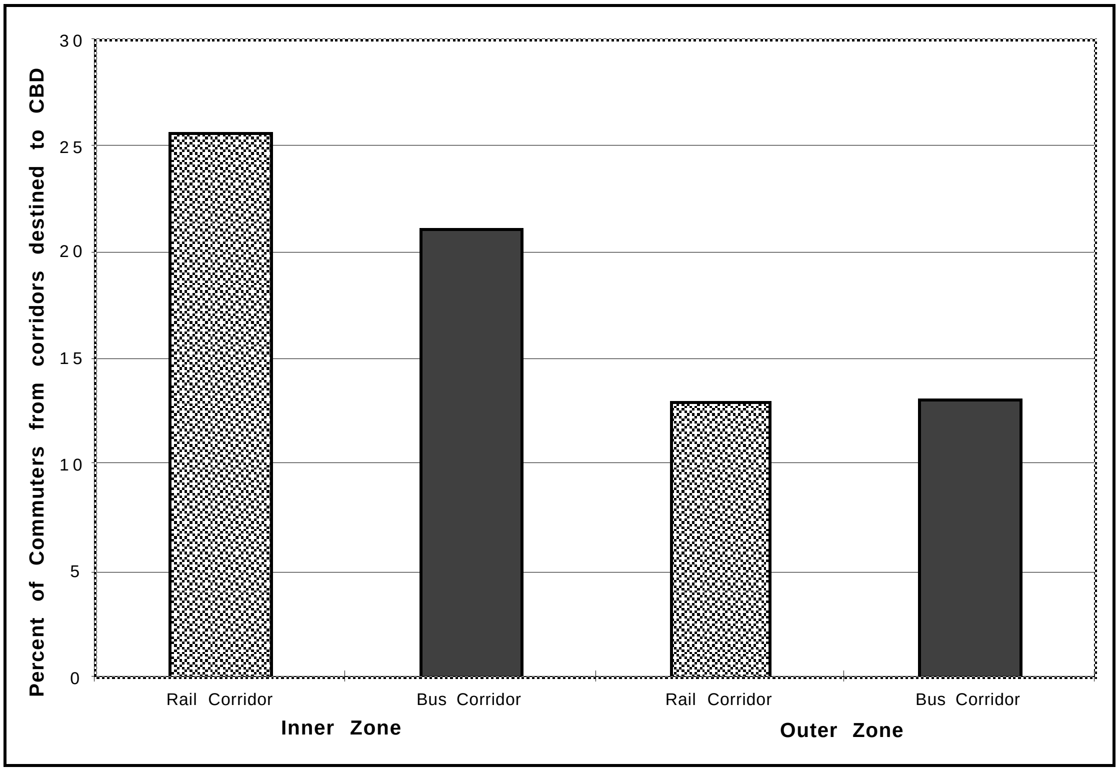


Figure 9: Commuting from Corridors to CBD

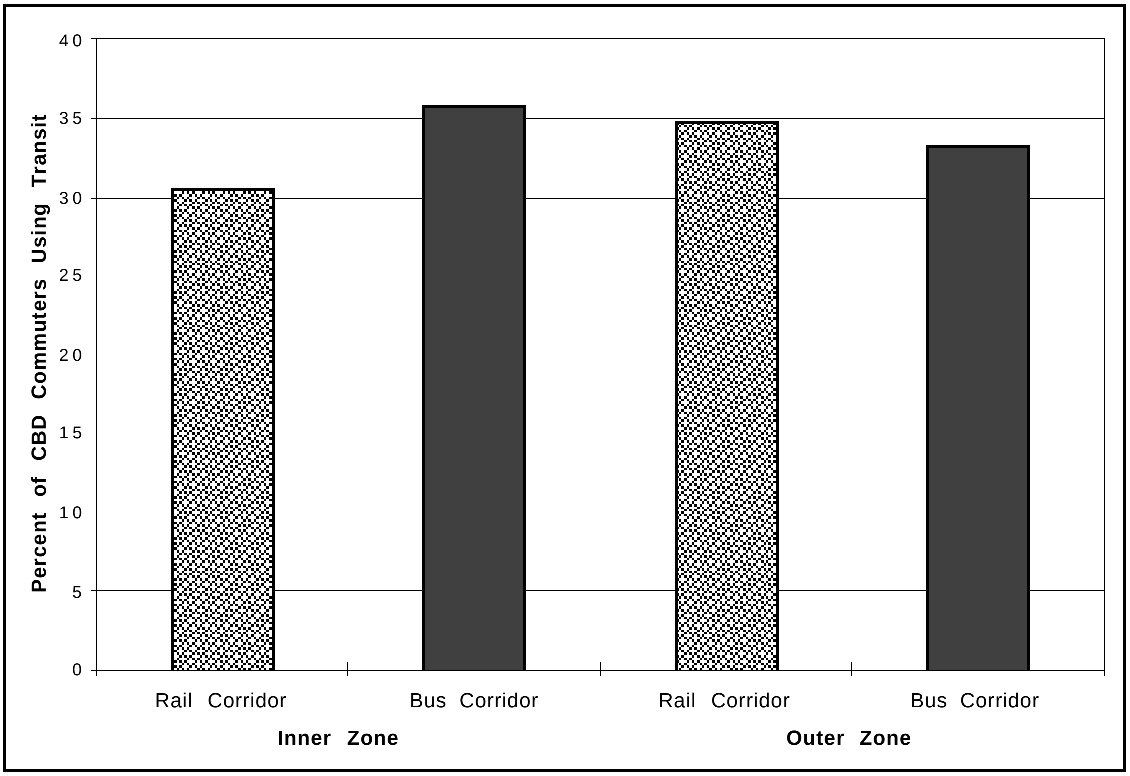


Figure 10: Share of CBD-Destined Commuters from Corridors Using Transit

Growth of Eastside LRT Ridership

LRT ridership in the rail corridor is usually reported in terms of average weekday boarding or originating rides. Average originating weekday ridership for the eastside LRT has grown from 15,600 in FY87 to 23,400 in FY97, and boardings have grown from 19,500 to 29,400 during the same period. This is a 50-percent increase from 1987 through 1997 fiscal years, or an annual rate of increase of 4.5 percent. As shown in Table 11 and Figure 10 the rate increased from an annual rate of 3.8 percent for the first five years of operation to an annual rate of increase of 4.8 percent for FY93 through FY97, the last five years.

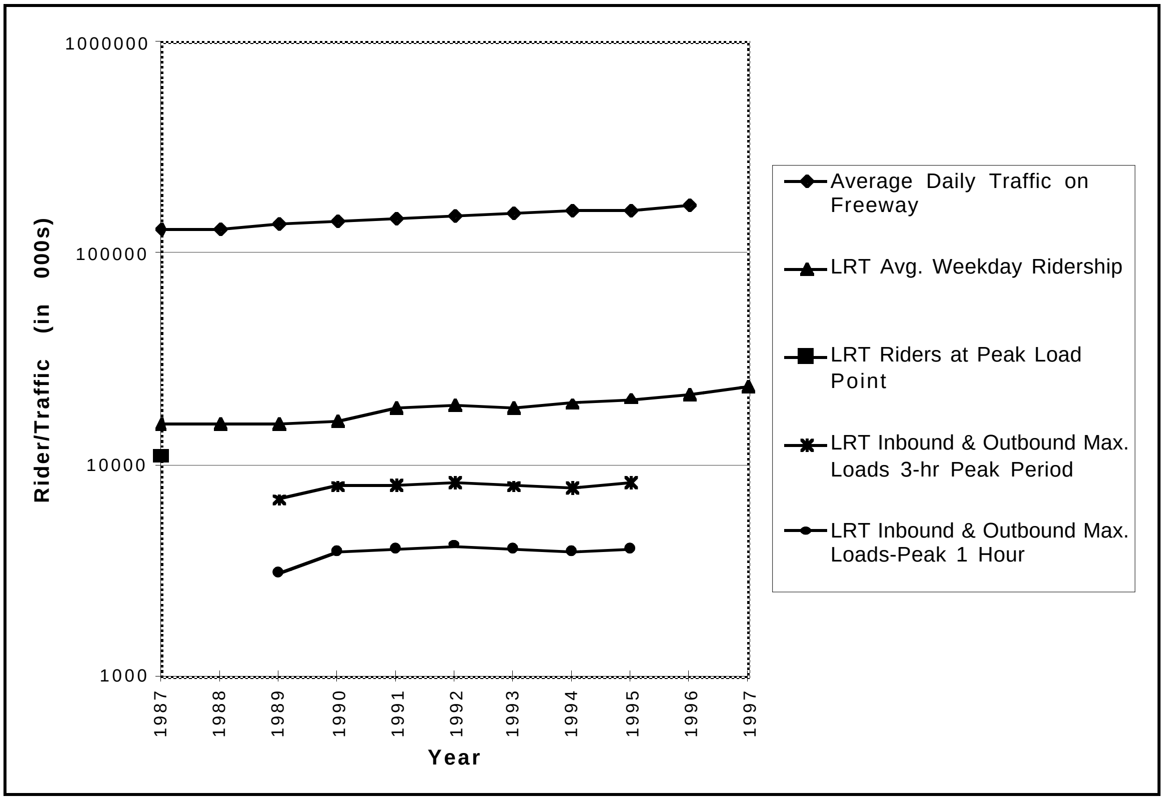


Figure 11: Banfield Corridor: Growth in Riders and Traffic

In comparing transit ridership to highway traffic it is preferable to use a measure of ridership past a point rather than total ridership. The peak loadpoint is at the Lloyd Center and the all-day maximum total loads are at the Convention Center. Only two data points are available: 11,100 at Lloyd Center in 1987 and 13,600 at the Convention Center in 1994, a 22.5-percent increase or 3.2-percent annual rate. This compares favorably to a 23.8-percent increase (3.4-percent annual rate) in highway traffic on the Banfield freeway.

This encouraging assessment of eastside LRT ridership is diminished somewhat by the flatness of peak-hour ridership despite regional growth. Peak-hour ridership is essentially flat, 2000 riders per hour for the period of FY 89 through FY95. Similarly, the ridership in the peak three-hour period is also flat at 4000 riders averaged over inbound and outbound periods. So the shoulders of the peak hour are not growing either. This does not bode well for congestion relief or air quality improvements during the peak period, during a six-year period when the region grew rapidly. There is a growth in off-peak ridership which contributes to a broader transit ridership base, a small but perhaps promising signal for transit-oriented development advocates. However, this growth may well be self-selection in terms of transit-oriented households locating into existing housing in the outer rail corridor, as opposed to conversion of auto travelers to transit.

<u>Interpretation and Discussion of Corridor Comparisons</u>

This paper has compared the rail corridor to a parallel bus corridor using several measures: the amount of multifamily housing development, residential density, housing price, mode choice, vehicle ownership, and commuting to CBD. Three kinds of positive LRT impacts were found. There has been less of a loss in transit ridership in the outer rail corridor in comparison to the outer bus corridor. Similarly, there has been a slower growth in two- and three-vehicle households in the outer rail corridor as compared to the outer bus corridor. Also, the property value of single-family housing in the outer rail corridor is impacted positively by accessibility to rail stations. These impacts may reflect an early indication of self-selection or residential sorting, wherein households appreciating transit access are locating near LRT in the outer part of the rail corridor. The real test of self-selection in the eastside rail corridor will be the Gresham Civic Center development, the first real TOD in that corridor.

Perhaps these minor impacts are an expected result given the relatively short time between the light rail opening in 1986 and the date of the post-study data, 1990 for the census data and 1995 for the multifamily housing data. Would a year 2000 comparison show a stronger light rail effect? Probably not, as apartments are being built along arterial streets in general, not just along light rail, and major projects, such as the Gresham Civic, will not be fully developed until after the year 2000. It may be that the results TOD advocates expect may not appear until 15 to 25 years after the rail investment. If this is the case, it may help explain some of the political division LRT encounters. Supporters may take a longer view, while opponents are looking for more immediate benefits.

The following section attempts to translate the impact experience of the eastside rail to implications for the westside light rail, where greater reliance on TODs ought to result in even greater self-selection or residential sorting, as well as some conversion of auto users to transit. The westside implications are quite speculative, however, but are developed to provide a context for assessing rail impacts in a new corridor.

Implications for Westside LRT

Even the supporters of LRT in Portland concede that the land use impacts, in terms of residential density, have been disappointing or at best slow and difficult and that TODs have not occurred naturally. As a result there is considerably more attention to nurturing TODs on the westside LRT line, necessarily so because the route traverses an area where existing transit ridership is low and through an area containing large tracts of undeveloped land, which creates both an opportunity and necessity for TODs. Consequently, the westside LRT line to Portland’s westside suburbs of Beaverton and Hillsboro will be a more important test of TODs than the eastside line to Gresham.

TOD development is being actively promoted, both by the regional transit agency, Tri-Met, and local jurisdictions in the westside LRT corridor. This encouragement and planning and zoning expediting, along with a strong market for multiple-family housing, is resulting in a number of new developments in the corridor, labeled as transit oriented.

Yet, even with the attention and opportunity for TODs on the west side, the actual intended impacts may be limited. The expectation is that TODs will increase land development densities, reduce vehicular trip generation, increase transit mode share, and reduce trip lengths, all of which will reduce vehicle miles of travel (VMT) per capita. At the same time, though, the additional density will increase auto trips per unit area.

The expectation that TODs will reduce auto travel and increase use of alternative modes is based on research comparing traditional and suburban neighborhoods (Friedman, Gordon and Peers 1994), but without controls for demographic and density differences in older traditional neighborhoods and suburban ones. Subsequently, Frank and Pivo (1994) controlled for density and found that trip rates and mode choice effects occur at densities higher than only 13 dwelling units per acre. Also, Cervero and Gorham (1995) compared single-family paired transit neighborhoods and auto neighborhoods, as distinguished by transit access and gridded versus random street patterns, and found that neighborhood type was a significant predictor of mode choice, when holding density and income constant. They found that 1.4 percent more work trips are likely to be by transit in a transit neighborhood than in an auto neighborhood in the Los Angeles paired neighborhoods and 5.1 percent more in the San Francisco paired neighborhoods. Even at low densities, Cervero and Gorham found a density effect: a 2- to 4-percent increase in work trips by transit for a one-dwelling-per-acre increase in density.

The results are difficult to compare for a variety of reasons. For instance Cervero and Gorham use net residential density and extrapolate the results beyond the range of the data used to estimate the model, and Frank and Pivo use gross residential density and do not control for the nonlinearity of density. Nevertheless, there does appear to be a small effect of neighborhood type and density. The question of importance here is how that small effect might translate into transit ridership and reduction of auto use in the westside LRT corridor. However, the unintended effect of increasing density is an increase in auto trips per unit area.

Conclusions

Based on the empirical analysis, three positive impacts of eastside LRT were observed. One is that households in the outer portion of the rail corridor are less auto oriented. The second is that households in the outer part of the rail corridor are also more likely to use transit. The third is a bidding up of single-family housing prices near rail stations in the outer part of the rail corridor. All three of these impacts may be linked to self-selection or residential sorting of households more prone to use transit.

The empirical analysis of multifamily housing development and density change in the eastern suburban area of the Portland region served by light rail transit and conventional bus transit provides evidence that light rail alone has not been sufficient to change development patterns, auto ownership, and transit modal behavior appreciably. Recognizing that zoning high density around station areas may not be enough to increase the impact of light rail, the Portland community of planners has embraced the neotraditional planning approach, in an effort to “make light rail work.” The New Urbanism’s higher densities and mixed-use development will soon be tested in the political arena and the economic marketplace. The extent to which these planning efforts can reverse historic decentralization or halt the future trends augured by changing improvements in transportation and communications technologies remains to be seen.

The risk that neotraditional planners take in emphasizing the costly LRT component of transit-oriented design is that they may ignore real, pressing needs. A plan that puts expensive light rail before expanded bus service, as well as highways and other mobility improvements, risks ignoring the majority who do not live near light rail transit or who, because of family and lifestyle needs, require an automobile. By the same token, an emphasis on multifamily housing risks resulting in decreasing and unaffordable options for households who, because of family and lifestyle characteristics, desire or require single-family housing (Different Drummer 1996, 60-61). Finally, most TOD planning efforts target areas of new growth, thereby continuing to neglect the serious and complex problems of the inner city, where the most transit-using and transit-dependent people reside. The emphasis becomes misplaced, chasing the elusive choice rider while underserving the captive rider.

In the Portland area, the current mode split is roughly 90 percent auto and 3 percent transit, but the regional transportation plan calls for the majority of new transportation investment to be devoted to transit. Even with reliance on an extensive LRT system and supportive TODs and auto disincentives, the expected gain is a large increase in transit ridership, but that translates to a small shift in transit mode use, from 3 percent to 4 percent of all trips in the region. This results in an unbalanced multimodal investment strategy, one which will require a larger total transportation investment than the region can afford if highway capacity and other mobility improvements are to keep pace with growth.

The challenge to planners is to assess development trends and consumer behavior. This assessment will provide the basis for estimating market shares for dispersed and concentrated development forms. There is undoubtedly a market for higher densities and mixed-use development. No doubt, there is a segment of the population that prefers multifamily living and traveling by transit. The challenge is to identify this segment and to enhance their options without ignoring the needs of other segments of the population. At the same time, planners are challenged to respond to concerns about the environment and inequitable housing through a multifaceted approach, which includes TODs, but also includes more direct measures and reforms, including pricing.

This assessment of LRT impacts in Portland is both encouraging and sobering. It identifies some emerging trends in residential location, but the overwhelming trend toward auto use and decentralization serves to caution against overly optimistic assessments of large impacts.

Acknowledgments

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Table 1: Comparison of Corridors.

Characteristic	Corridor			
	Rail		Bus	
	Acres	%	Acres	%
Zoning of Land[2]				
Commercial	1302	15.4	770	9.5
Industrial	530	6.3	884	10.9
Multi-family Resid.	1659	19.6	1351	16.7
Single-family Resid.	4151	49.1	4591	56.9
Public Open Space & Other	805	9.5	473	5.9
Total	8447	100	8069	100
	Housing Units	%	Housing Units	%
Housing				
Tenure[3]				
Owner-Occupied	16,929	51.8	17,283	51.9
Renter-Occupied	15,784	48.2	15,989	48.1
Total	32,713	100	33,272	100
	Housing Units	$	Housing Units	$
SF Resid. Mean Value[2]	18,872	$140,207	19,617	$128,855
Median Family Income[3]	32,713	$33,057	33,272	$30,462

[2] Source: Regional Land Information System (RLIS) 1998 edition.
[3] Source: American Community Survey, 1996 Multnomah County Dress Rehearsal

Table 2: Multi-family development since 1986.

Modal Access	MF Development Projects (1986-1995)	Average Parcel Size (Acres)	% MF Development Projects (1986-1995)	Acres MF Development (1986-1995)	% Area MF Development (1986-95)
1. Rail stations	24	0.93	16.8	22.4	11.7
2. Bus stops	101	1.55	70.6	156.7	82.1
3. Arterials	16	0.71	11.2	11.4	6.0
4. Other	2	0.20	1.4	0.4	0.2
Total	143	1.33	100	190.9	100.0

Table 3: Acres of vacant land zoned multi-family or land occupied by multifamily housing.

Modal Access	MF Study Acres	Acres MF/HD Zoned	% Land Zoned MF/HD
1. Rail stations	1,404.7	162.6	15.0
2. Bus stops	15,628.2	871.5	80.1
3. Arterials	3,002.6	45.2	4.2
4. Other	1,322.8	2.7	.3
Total	21,358.3	1,082.00	100.00

Table 4: Number and amount of vacant and developed multi-family parcels.

Modal Access	# Vacant MF Parcels	# Developed MF Parcels (1986-1995)	All Developed MF Parcels
1. Rail stations	202	24	259
2. Bus stops	365	101	2,068
3. Arterials	18	16	146
4. Other	1	2	13
Total	586	143	2,486

Modal Access	Acres Vacant MF (All)	Acres Developed MF (1986-1995)	All Acres Developed MF
1. Rail stations	79.1	22.4	162.6
2. Bus stops	330.1	156.7	871.5
3. Arterials	33.2	11.4	45.2
4. Other	0.0	0.4	2.7
Total	442.4	190.9	1,082.0

Table 5: Build out rate 1986 - 1995.

Modal Access	% Build Out Rate- Parcels (1986-1995)	% Build Out Rate- Acres (1986-1995)
1. Rail stations	10.6	22.1
2. Bus stops	21.7	32.2
3. Arterials	47.1	25.6
4. Other	66.7	95.1
5. Total	146.0	175

Table 6: Residential Density by Corridor, 1980 and 1990

	Dwelling Units Per Acre				*Percent Change*	
Corridor	*Net Density 1980*	*Net Density 1990*	*Gross Density 1980*	*Gross Density 1990*	*Net Density 1980-90*	*Gross Density 1980-90*
Rail	9.61	9.46	3.91	3.91	-1.60	0.05
Bus	8.73	8.71	3.98	4.11	-0.22	3.24
Rail - Inner	11.50	11.21	4.61	4.53	-2.48	-1.73
Rail - Outer	7.26	7.31	3.01	3.12	0.72	3.56
Bus - Inner	11.94	11.86	5.03	5.10	-0.68	1.29
Bus - Outer	6.16	6.25	3.01	3.19	1.55	6.29

Note: BG 0092011, 0092012, 0097023, 0098011 multiplied by .5x
Source for Tables 2-6: RLIS 1996 edition.

Table 7: Vehicle Ownership Characteristics, 1980 and 1990

1980	*Rail - Inner*	*Rail - Outer*	*Bus - Inner*	*Bus - Outer*
Population	48,424	26,747	42,786	31,810

Auto Ownership	*Value*	*%Total*	*Value*	*%Total*	*Value*	*%Total*	*Value*	*%Total*
0-1	13,122	62.29	5,178	48.95	12,038	64.41	5,444	45.41
2	5,583	26.50	3,664	34.63	4,382	23.45	3,930	32.78
3 or more	2,361	11.21	1,737	16.42	2,269	12.14	2,614	21.81
Total	21,066	100.00	10,581	100.00	18,689	100.00	11,990	100.00

1990	*Rail - Inner*	*Rail - Outer*	*Bus - Inner*	*Bus - Outer*
Population	47,051	27,391	42,595	33,360

Auto Ownership	*Value*	*%Total*	*Value*	*%Total*	*Value*	*%Total*	*Value*	*%Total*
0-1	11,321	56.03	5,284	47.85	11,270	59.61	5,689	44.55
2	6,923	33.38	3,976	36.00	5,844	30.91	4,797	37.56
3 or more	2,198	10.60	1,783	16.15	1,792	9.48	2,286	17.90
Total	20,742	100.01	11,043	100.00	18,906	100.00	12,772	100.01

Change in Ownership Rates, 1980-1990	*Rail - Inner*	*Rail - Outer*	*Bus - Inner*	*Bus - Outer*
Auto Ownership				
0-1	-6.26%	-1.10%	-4.80%	-0.86%
2	6.88%	1.37%	7.46%	4.78%
3 or more	-0.61%	-0.27%	-2.66%	-3.91%

Table 8: Journey-to-Work Mode Shares

Rail Corridor-Inner Zone

	1980		1990	
Mode	# Workers	% of Total	# Workers	% of Total
Auto	16,622	73.26	18,187	77.52
Transit	3,419	15.07	3,069	13.08
Other	2,648	11.67	2,204	9.39
Total Workers	22,690	100.00	23,460	99.99

Rail Corridor-Outer Zone

	1980		1990	
Mode	# Workers	% of Total	# Workers	% of Total
Auto	10,580	83.36	10,950	82.44
Transit	1,203	9.48	1,263	9.51
Other	909	7.16	1,069	8.05
Total Workers	12,692	100.00	13,282	100.00

Bus Corridor-Inner Zone

	1980		1990	
Mode	# Workers	% of Total	# Workers	% of Total
Auto	14,271	69.54	16,185	72.80
Transit	4,039	19.68	3,464	15.58
Other	2,212	10.78	2,584	11.62
Total Workers	20,522	100.00	22,233	100.00

Bus Corridor-Outer Zone

	1980		1990	
Mode	# Workers	% of Total	# Workers	% of Total
Auto	12,558	85.80	13,224	86.07
Transit	1,345	9.19	1,206	7.85
Other	734	5.02	935	6.09
Total Workers	14,636	100.01	15,365	100.01

Cumulative Totals

	1980		1990	
Mode	# Workers	% of Total	# Workers	% of Total
Auto	54,031	76.60	58,546	78.75
Transit	10,006	14.18	9,002	12.11
Other	6,503	9.22	6,792	9.14
Total Workers	70,540	100.00	74,340	100.00

Table 9: Destinations of Commuting by Corridors, 1990

Total Commuters to All Destinations from 4 Corridors						
Corridor	Total	SOV	HOV	Transit	Other	
Rail-Inner	21,697	14,278	2,901	2,983	1,535	
Bus-Inner	20,296	12,470	2,617	3,363	1,846	
Rail-Outer	11,532	8,197	1,614	1,254	467	
Bus-Outer	13,483	9,972	1,927	1,149	435	
Total	67,007	44,917	9,059	8,749	4,282	

% Total Commuters to All Destinations from 4 Corridors						
Corridor	Total	SOV	HOV	Transit	Other	Total
Rail-Inner	21,697	65.81	13.37	13.75	7.07	100.00
Bus-Inner	20,296	61.44	12.89	16.57	9.10	100.00
Rail-Outer	11,532	71.08	14.00	10.87	4.05	100.00
Bus-Outer	13,483	73.96	14.29	8.52	3.22	100.00
Total	67,007	67.03	13.52	13.06	6.39	100.00

Total Commuters to CBD from 4 Corridors						
Corridor	Total	SOV	HOV	Transit	Other	
Rail-Inner	5,550	2,835	862	1,694	159	
Bus-Inner	4,284	1,808	625	1,537	314	
Rail-Outer	1,499	682	246	523	49	
Bus-Outer	1,770	898	260	589	23	
Total	2,928	6,128	1,972	4,289	540	

% Total Commuters to CBD from 4 Corridors						
Corridor	Total	SOV	HOV	Transit	Other	Total
Rail-Inner	5,550	51.08	15.53	30.52	2.86	100.00
Bus-Inner	4,284	42.20	14.59	35.88	7.33	100.00
Rail-Outer	1,499	45.46	16.41	34.86	3.27	100.00
Bus-Outer	1,770	50.75	14.67	33.29	1.30	100.00
Total	12,928	47.40	15.25	33.17	4.18	100.00

Table 10: Traffic and Transit Ridership by Year

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Avg. Daily Traffic on Fwy.	130,484	130,004	139,612	141,365	146,702	151,708	157,143	161,492	162,254	169,975	N/A
LRT Avg. Weekday Ridership	15,600	15,600	15,700	16,300	18,500	19,300	18,900	19,600	20,800	21,500	23,400
LRT Riders at Peak Load Point	11,100	N/A	N/A	N/A	N/A	N/A	N/A	13,629	N/A	N/A	N/A
LRT Inbound & Outbound Max. Loads 3 hr. Peak Period	N/A	N/A	6,895	7,915	8,113	8,310	8,019	7,770	8,298	N/A	N/A
LRT Inbound & Outbound Max. Loads -Peak 1 hr.	N/A	N/A	3,135	3,868	4,042	4,156	4,021	3,886	4,068	N/A	N/A

* N/A = data not available