Measuring the Success of Transit-Oriented Development: Retail Market Dynamics and Other Key Determinants

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Abstract

Transit-oriented development (TOD) has become the dominant urban growth planning paradigm in the United States. Yet scant evidence has been proffered to indicate that it will produce significant environmental and social benefits commensurate with the costs of the major transportation system improvements that it requires.

Sixteen distinct planning issues will determine whether TOD significantly changes travel behavior in a metropolitan region. While some analysis exists, understanding of these issues needs improvement. In particular, more research is needed on non-work travel, retail market dynamics, and the likely constraints this $2.3 trillion area of business and human behavior imposes on TOD.

Introduction

Over the past two decades numerous metropolitan areas in the United States have embraced the concept of transit-oriented development (TOD) in an attempt to control and manage the negative environmental and social impacts of dispersed growth patterns (Porter 1997). TOD, it is suggested, will increase pedestrian and transit trip taking while reducing the number and length of auto trips, and it will contribute to the livability that some feel is lacking in modern suburban development (Calthorpe 1993).

In essence, TOD means the creation of denser, mixed use activity nodes connected by high quality public transportation. Proponents believe that a combination of design features will induce travel mode shifts that result in reduced area-wide traffic congestion and improved air quality. These features include improved street connectivity, public amenities, and a concentration of residences and jobs in proximity to transit stations and commercial businesses. As an additional benefit, the enhanced pedestrian environment will increase "casual encounters" among neighbors that can contribute to a sense of community.

These efforts typically begin implementation with major new "mass" transit investments, often light-rail systems, that are designed to link central city cores, suburban downtowns, and other major activity centers. TOD is possible without new transit, but most metro areas choose to make the transit investment. Bernick and Cervero (1996) suggest that what is needed for TOD to succeed is a "transit

metropolis," meaning a sufficient number of TODs having balanced or special uses that are connected and allow for efficient rail travel with bi-directional travel flows.

Construction of the new transit system usually precedes the land use restructuring required to effectively support the investment, i.e., the concentrations of population, employment, public amenities, and commercial activities that will attract transit riders in sufficient numbers to satisfy the transit system's fare box recovery requirements. Commercial activities, in particular, often become a consideration after the transit system alignment is finalized and station areas are identified.

A useful review of previous studies in the urban planning and transportation literature of the transportation impacts of neo-traditional development and TOD is provided by Berman (1996). This paper summarizes several more recent empirical and modeling studies of TOD, and it indicates how TOD success should be measured. Specifically, it outlines the key factors that need to be understood and weighed before significant new transit investments are made. Our aim is to enhance the regional planning process in a way that leads to cost-effective investments of scarce public dollars.

Local Benefits vs. Regional Benefits

It is important to distinguish between regional and local benefits produced by TOD, and the magnitude of benefits at both scales of measurement. Intuition suggests that station-area development involving mixed use and higher employment and residential densities will induce more pedestrian and transit trips. Several studies lend credence to this belief. However, since the ideal TOD is still a planner's vision, researchers have resorted to comparing older neighborhoods that approximate TOD with conventional suburban neighborhoods that do not. These studies suggest that the increase in non-auto trips, although small, is measurable (Bernick and Cervero 1996).

Yet local area benefits may not translate to regional benefits, especially when weighed against the costs of the transit investments needed to link individual TOD centers. Consequently, the central question for planners and decision makers is the magnitude of TOD's regional impact, namely reduced congestion and improved air quality that are the principle concerns of the traveling public. Nelson and Niles (1999), after reviewing the empirical studies to date, suggest that they provide insufficient evidence that TOD on a regional scale, even when supported by large transit investments, is likely to produce significant regional benefits.

It is important, therefore, to understand the factors that determine the regional and local success of TOD. This paper reviews the key factors and suggests where further work is needed that will expand our understanding of the strength of each and hence of TOD's potential. We focus particularly on the obstacles posed to TOD by the dynamic nature of the commercial marketplace, an important area of inquiry that has been largely overlooked in previous studies. Our purpose is not to be exhaustive, but to provide a overview which might stimulate more in-depth work.

Key Factors Determining TOD Success

A number of variables will determine the success of TOD at both the station-area and corridor or regional scale (Table 1). As indicated previously, we define success as the extent of the mode shift -- from autos to pedestrian and transit modes -- that is attributable to TOD. In economic terms, success is the benefits of this shift net the costs of building and operating new transit facilities. As thusly defined, success is measurable, and may be predictable. Other measures of success, such as sense of community and livability, although appropriate and important, do not easily lend themselves to either empirical measurement nor estimation through the use of models (Project for Public Spaces 1997).

Some factors play a major role in determining local, station-area success, while others have a significant impact at both the local and the larger, corridor/regional scale. In other words, success may be achieved

at one or several TODs if a few positive factors are present, but success will probably not be achieved at a regional scale unless a greater number of factors contribute in a positive fashion. We are not suggesting either the relative magnitude nor the sign of the impact of these factors, only that each may be significant in determining the success of TOD.

Together, these factors in Table 1 represent independent (exogenous) variables in equations that might be written to predict either the probability of success or its magnitude at both scales of interest. Several studies have attempted to dissaggregate the effect of some of these variables, while others have measured their combined effects. In the following, we cite the most recent research into these factors, and we suggest gaps in our understanding that need to be addressed.

TABLE 1. Factors determining the success of TOD

Factor	Station-area success	Regional success
Number of TODs (& station areas)		X
Transit quality		X
Transit technology		X
Street pattern	X	X
Station-area parking	X	X
Employment and housing density	X	X
Commercial mix	X	X
Retail siting criteria		X
Regional market structure		X
Consumer activity patterns		X
Travel behavior/trip chaining		X
Zoning flexibility		X
Resident reactions	X	X
Housing type preference/life style & life stage		X
Self-selection in residential choice	X	X
Government policies		X

Number of Stations/Extent of Transit Investment

Supporters of TOD envision a network of dense, mixed-use activity centers linked by high quality transit. Centers can serve a neighborhood or a larger area. The latter, or urban TOD, includes the suburban downtowns of major metro areas and major employment centers. Activities in each of these centers or nodes are origins and destinations for regional travel.

TOD land use and public transportation structure will change travel patterns and modes to the extent it offers improved access to desired activities for a significant portion of the population currently experiencing acceptable auto accessibility. Centers must be within an easy walking distance (1/4 mile) to residents, and one or more other centers must be easily accessible by transit. As the distance between a center and the traveler's origin increases, transit accessibility will tend to decrease more rapidly than auto accessibility. More transfers and hence more wait time will be a reality of the transit trip.

The proportion of the regional population that lives within close proximity to activity centers and their transit stations will obviously depend on the number of stations. And, of course, the number of centers and stations will depend on the public's willingness to build and operate the transit system. For any metro region, then, the number of people shifting to transit will be determined by the quality of the public transit system as well as the number of their daily activities that are located in TODs.

Calculating the accessibility (and mode shifts) for levels of transit quality deemed affordable to a given region is obviously a complex exercise that requires an accurate regional model. However, it is possible to estimate the scale of the transit investment that is needed to capture a sizable fraction of auto users.

Downs (1994) did this by calculating the number of TODs needed to accommodate the average population and employment growth during the 1980's of metropolitan areas with a 1990 population of one million or more. He concluded that TODs could handle the growth if their numbers were large, but that this would require a regional transit system that a city might not find financially feasible.

This leads to the inference that considerable numbers of travelers who live outside of TODs need to be attracted to transit, both for work and non-work trips. Again, this will entail investments in new transit, possibly in the form of neighborhood circulators, e.g., small vans, buses, or personal rapid transit vehicles that deliver passengers to TOD station areas and, with well-coordinated intermodal transfers, to a regional network of TODs.

A number of metro regions have modeled the transportation performance of various TOD scenarios based on assumptions concerning the portion of new growth that will be accommodated by existing and new activity centers. There is not space here to review these estimates, but it should be noted that the numbers generated, usually travel delay and air quality, will be highly dependent on the accuracy of the model and whether its design takes into account the interplay of the variables listed in Table 1. We address the status of current models and the need for decision making tools below.

Transit Technology

It is often asserted that TOD benefits from rail or other fixed-guideway transit. Commercial developers, it is believed, are attracted by its permanence. In pre-auto cities, dense development around subway and surface rail stations that dates back to the turn of the century is common. Yet it is not as easy to draw the conclusion that rail transit is both more permanent and a greater attractor of development than is bus transit.

A number of historical studies have reviewed the evolution of transit in several cities. However, none appears to have explored the question of the relative permanence of rail versus bus. A cursory and unpublished study of bus routes in Chicago found that most had remained unchanged since they were established in the early 1900's (1) Many post-auto cities have experienced the development of electric trolley systems starting in the 1890's and their removal and replacement with bus in the 1930's and 1940's. And now some of those trolley lines are coming back in the form of light rail.

Porter (1997), in a study of TOD across the United States, concludes that rail tends to stimulate concentrated development in areas such as central business districts where transit is highly accessible and auto traffic is impacted by congestion and costly parking. Another study found that rail alone is not sufficient to generate development; strong market forces and supportive public policies are also needed (PBQD 1996).

Street Patterns

TOD design would have street patterns oriented along a grid, as opposed to the cul-de-sac and curvilinear street designs of many post Word War II US suburbs. Within the grid are sidewalks and streetscapes that encourage walking, and narrow streets and other traffic calming features that

discourage driving. Crane (1996a, 1996b, 1998), Crane and Crepeau (1998), and Boarnet and Sarmiento (1996) have reviewed previous studies that suggested positive impacts of these design elements. Their more recent evaluations question the assertion that more traditional street design will reduce auto travel.

Crane (1998), based on a review of empirical studies that compare travel patterns for neighborhoods with traditional designs and modern suburbs, suggests that TOD can just as easily increase auto travel, both trip rates and vehicle miles traveled. He observes that auto travel may increase because of improved street connectivity and accessibility to neighborhood centers. Crane finds that most studies have ignored income and demographic variables that explain differences in travel behavior.

Station-Area Parking

TODs are designed to be pedestrian and transit friendly. The potential for reducing auto travel is enhanced if parking demand and supply at centers can be moderated. Some studies indicate that this may be difficult, given the current and expected continued auto dependency. Steiner (1998) found that San Francisco area shopping centers generate auto trips from outside the immediate vicinity and consequently may require more parking capacity than prescribed for by New Urbanism standards. Similarly, Thompson (1999), who modeled TOD performance in the Sacramento region, suggests that work centers must provide sufficient parking to meet the demands of the large majority of residents and employees in TODs who will continue to use autos for their travel.

Station-Area Housing and Employment Density

Studies in different metro areas have shown (Moudon et al 1997; Cervero & Kockelman 1997) that denser residential development within an easy walk of a TOD center and transit station will generate walk trips, and that these trips may substitute for vehicle trips. However, in the case of work trips, regional success is dependent on density at both trip origin and destination. At least a few concentrated employment centers served by transit are needed to attract significant numbers of commuters. The problem is that employment locations have become highly dispersed outside of the central business districts in most metro areas.

These trends appear to be continuing as central cities decline in relative, and some cases absolute, share of regional employment. For example, in 1970 39% of all jobs in the Seattle metro area (central Puget Sound region) were located in the central city. By 1994, just 29% of regional employment was inside the central city, even though it has remained a vibrant commercial center. Another 17% was situated in 16 satellite urban centers. More than half of all jobs were located in areas outside urban centers -- in commercial and industrial zones spread across four counties.

Cervero (1996), acknowledging the problem of density at both ends of the commute trip, cites the example of commuting in the San Francisco Bay area. Using 1990 Census data, he estimates that 9 % of residents in the three BART-served counties lived within a half mile of a BART station, and just 18 % of these station-area residents commuted to work by rail transit. Thus only about 2% of commute trips within these counties were taken by station-area residents using BART. Thompson (1999) suggests that transit use will grow and contribute to the success of TOD only if public policy can channel dispersing job growth to suburban transit corridors.

Station-Area Commercial Mix

Handy (1996) studied the importance of commercial establishments to the inducement of walking trips in several traditional and modern Austin neighborhoods. Although she found the total savings in auto travel by households to be small, it was statistically significant and increased with the number and variety of local stores.

A key question arises with respect to the commercial mix around stations when rail transit is retrofitted into existing urban form. There is evidence that the commercial market may not value the financial rewards of station-area location as much as planners value the regional environmental and social benefits. Porter (1997) found that development around station areas, even in the case of the first of the new rail systems, such as those in Washington, DC and San Francisco, has not occurred as rapidly as expected. He summarizes the conclusions of researchers that station-area development is more a product of market interest in specific locations than a response to transit.

Store Siting, Regional Market Structure, and Consumer Behavior

The commercial market's apparent reluctance to choose station areas reflects the criteria for preferred store sites that are determined by the needs of developers and owners to succeed financially. Nelson and Niles (1999) suggest that an understanding of key retail site selection criteria and the market forces currently shaping a metropolitan region's retail structure may help planners identify ways to improve the commercial mix at stations so that they attract more pedestrian and transit traffic.

These criteria are summarized in Table 2. Some stores, whether they offer goods or services, tend to cluster to achieve market advantage. Clustering, which is most observable in planned shopping centers, also facilitates more efficient auto access. Stores of all kinds are getting larger, both in floor and market area, taking advantage of economies of scale. Sites that offer good visibility and regional as well as local access tend to be preferred. Often, this is in a stand alone location rather than in a commercial cluster. Developers tend to avoid locations that create environmental impacts that might be objectionable to local residents.

TABLE 2. Key retail location decision criteria

Agglomeration economies
Scale economies
Visibility, access and parking
Environmental impacts
Zoning and public resistance

Retail location has shaped and is in turn shaped by consumer behavior (Table 3). Consumers express strong preferences to buy cheaply, to compare competing products, and to experience variety. And they are willing to travel often and farther than their neighborhood commercial center to find each.

TABLE 3. Consumer behavior characteristics

Bargain hunting
Comparison shopping
Preference for variety
Destination flexibility
Schedule flexibility

The modern marketplace provides consumers considerable flexibility that was not previously present. The variety and choice offered by the marketplace allows consumers to undertake a particular activity at several different locations. And by extending hours and days they are open, retail stores accommodate diverse personal schedules.

These location criteria and consumer characteristics combine and interplay in ways that have produced the pronounced retail structural trends summarized in Table 4, trends that are seen in metro regions across the United States.

TABLE 4. Major trends in retail market structure

Retail activity increasingly polycentric and dispersed
Planned shopping centers dominate market
Smaller malls cluster around major malls
"Big Boxes" market share growing
"Super" stores growing in kind and number
Many chains prefer stand alone sites
Dining out continues strong
Drive to and through convenience growing

Source: Nelson & Niles 1999

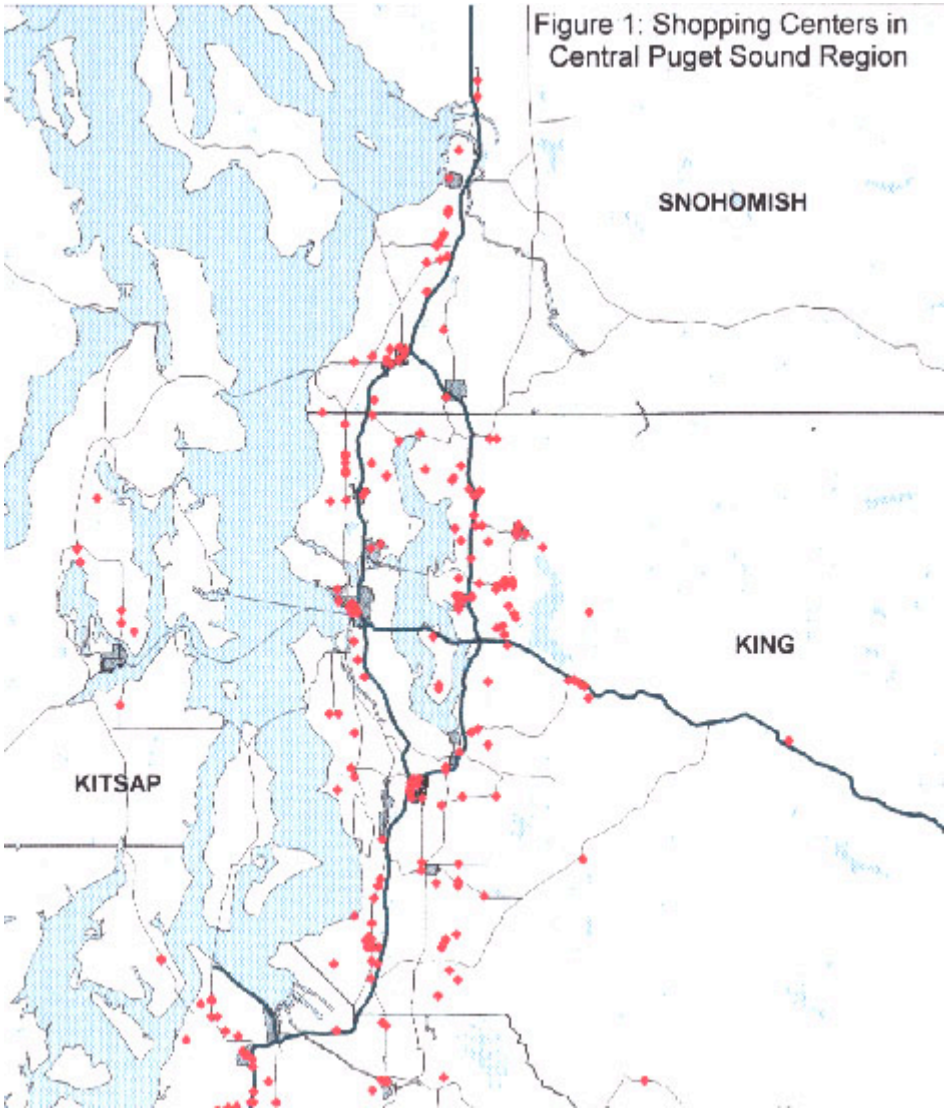


Figure 1 shows how one of these trends, the growth of planned shopping centers, has developed in the Seattle metro area. Planned shopping centers of three or more stores now number over 450 and contain about 80 million square feet of leasable area. They are spatially dispersed and are located where there is good auto access.

The modern retail structure has in turn produced profound changes in personal and household travel patterns that must be understood in order to improve TOD's chances of success.

Travel Behavior/Trip Chaining

Our focus is on "retail" activities because they directly or indirectly account for a large majority of all personal travel. By retail, we mean shopping for goods and services, eating out, and engaging in recreation, social and cultural activities outside the home. These nonwork activities generated almost three out of five person trips in 1995 (Table 5).

TABLE 5. Trip Purposes (Percent of All Person Trips)

Work	20%
Shopping	20%
Family/Personal Business	24%
Recreational/Eating Out	17%
Other	22%

Source: NPTS 1995

Nonwork trips are often chained with work trips and with other nonwork trips to maximize travel efficiency. The data in Table 6 show the importance of trip chains for the Work to Home and Home to Home tours, and the differences between genders. These data suggest that if TOD is to accomplish mode shifting, activities to be located in a TOD should be identified by pinpointing the specific purposes and locations of stops in these tours. Other tours of interest are, of course, the Work to Work and the Home to Work tours.

TABLE 6. Chaining of non-work trips (Percent of weekday tours with two or more Stops)

	Work to Home	Home to Home
Men	17.7 %	38.6 %
Women	28.2 %	43.7 %

Source: McGuckin and Murakami 1999

Zoning and Resident Reaction

Redevelopment and infill often have to contend with zoning and environmental issues. Zoning, once

established, is not easily changed, especially if the intent is to increase density, convert commercial strips to more compact nodes, and create a greater mix of uses. The authors could not find a comprehensive study of the national experience regarding proposals to change local zoning, but they are familiar with attempts to revise zoning in the context of Puget Sound area growth planning. Residents of neighborhoods where government has proposed TOD development tend to resist increased density and its impacts, whether real or perceived. Even commercial development that brings new stores and services is not always welcomed. People tend to oppose change, especially if they believe there will be impacts such as increased vehicle traffic. Attitudes toward zoning changes may differ in metro regions that have been working on this issue for some time. For example, a transportation plan for suburban Portland recommends zoning be used to guide all new retail space to TOD sites (1000 Friends of Oregon 1992).

Housing Type Preference: Life Style & Life Stage

Proponents of TOD believe that more Americans will choose "traditional" housing types -- small houses, condos, walkup apartments, accessory units -- especially when they are conveniently located near amenities. This assumption cannot yet be verified, even though the market has begun to deliver more housing of a traditional character, and buyers and renters have responded well to many of the new developments (Steuteville 1998). The number of developments, especially on urban and suburban infill sites, is still relatively small even when counted nationally.

Yet, for planning purposes, it would be instructive to know whether the current market response reflects new converts to TOD housing, or whether consumers are simply selecting housing that they would have otherwise chosen. And if there is a conversion process underway, how significant will it be in the longer term? Is it more than a small niche market? Will most home buyers and renters be attracted by the affordability of housing and on the metro fringe, as well as other attributes of suburban and exurban living?

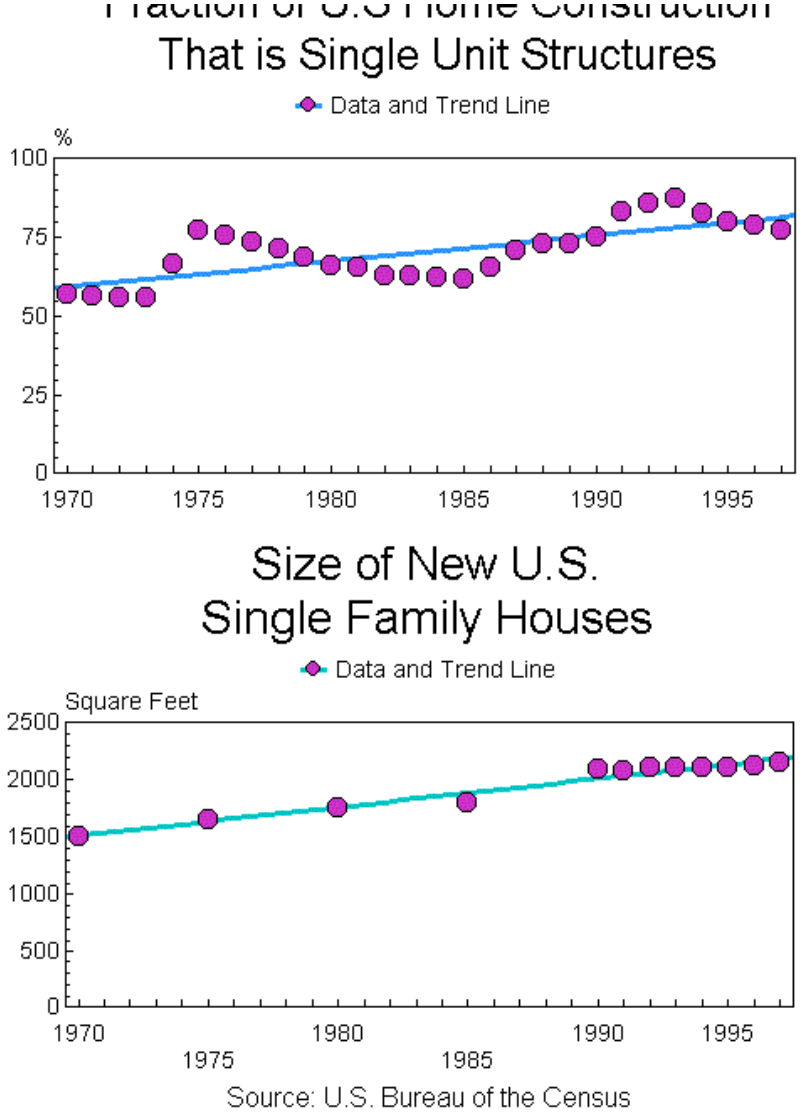
Without the revealed preference of consumers, we are forced to fall back on what people say they prefer. National surveys commissioned by Fannie Mae (Fannie Mae 1996, 1997, 1998) provide some perspective on American's housing preferences. In 1996 Fannie Mae asked adult American about their attitudes towards housing and home ownership. Of those contacted, 73 % said their ideal home is a single-family detached house with a yard on all sides. Since ownership of all types of homes, including townhouses and condos, is currently at about 64 %, if the trend follows stated preferences, it should be toward more single-family detached ownership, not less. The same survey found that Americans are willing to make significant tradeoffs for home ownership. Four of five would drive a longer distance to work if they could own rather than rent a home.

Fannie Mae's 1997 survey asked people where they would like to live. A large majority indicated they preferred either a small town or a suburb near a large city. Only 9% favored a large city.

For the past 30 years the housing market has produced a growing proportion of single family units with steadily increasing floor area (see Figure 2). New multifamily units have also been increasing in size, growing 20% in average floor area from 1988 to 1997 (US Census Bureau). The low mortgage interest rates, relaxed borrowing requirements, and strong economy of the late 1990's have pushed home ownership to record levels. Fannie Mae's most recent survey, in 1998, indicates that a majority of renters have a strong desire to move up to ownership. It will be of interest to see if the detached single-family preference and size trends continue as ownership rates increase.

FIGURE 2: Trends in New U.S. Housing

Fraction of U.S. Home Construction



Another recent private sector survey (American LIVES 1995), for the real estate industry, found that four of five consumers who bought or shopped for a home in several states, were unwilling to give up the cul-de-sacs, large yards, and privacy that comes with single-family detached homes set back from the street. A large majority didn't like the often homogenous look of conventional suburbia either. Their preference: a new suburban look with a town center as a community-gathering place, small shops, green space, and plenty of convenient parking.

The American Housing Survey sheds some light on the reasons people move and choose their neighborhood. Of the many reasons cited for leaving a previous home, the desire to establish one's own household and the need for more space rank highest in the most recent nationwide survey (Census Bureau 1997). The attributes of the house itself and its convenience to job were given most often as the top reasons for choice of neighborhood, while convenience to public transportation was eighth on the list of reasons.

A wild card that may effect housing type and size is the impending retirement of the Baby Boom generation. The US population age 55 and over will increase from 21% of the population in 1995 to over 29% in 2020. These "empty nesters" may choose to downsize their housing and opt for more

locational convenience. Fannie Mae explored the future housing preferences of Baby Boomers in its 1998 Survey. A majority, 53%, said they will remain in their current house, either as is or with renovations, while 35 % indicated that they would sell, and either buy or rent a new house. The survey did not probe whether the size of the new house had been considered in retirement plans.

Self-Selection in Residential Choice

A factor related to travel behavior and housing type preference is the propensity for self-selection in choice of residence location, i.e., people who are the most likely to use transit choose to live near transit stations. Self selection, to the extent it occurs, will mask the magnitude of transit's true impact on travel behavior. Crane (1998) points out that empirical studies that compare the travel behavior of people who live in one kind of neighborhood with people who live in another ignore this data bias. To analyze the self-selection problem, Boarnet and Sarmiento (1998), using econometric analysis, modeled both the choice of where people live and how they choose to travel to nonwork activities. They could find no influence of land use on travel in their Southern California sample when controlling for self selection. Dueker (1999) points to the possible importance of self-selection in assessing the ridership numbers for a new light rail system in Portland, but suggests that more data are required to isolate the strength of this factor.

Government Policies

Several metro areas have actively worked on TOD implementation for more than a decade. In the process, some excellent resources have been developed. For example, workbooks have been produced and workshops convened to encourage TOD in the Puget Sound region (PSRC 1998; Puget Sound Regional Council 1996; Snohomish County 1993; Energy Outreach Center 1997). These efforts have identified available policy initiatives that could encourage TOD.

Local governments have several policy tools available to leverage denser and more diverse development within TODs. These include the provision of public amenities such as parks, recreational facilities, and government services. Private development can be induced through density bonuses, tax abatement, tax increment financing, and direct grants. Joint development schemes serve to stimulate developer interest. Porter (1997) has reviewed the policies and actions taken by local government and transit agencies in a number of metro areas. He concludes that light rail is likely to attract relatively small development projects outside of central business districts (Porter 1998).

Many actions involve expenditures of some kind, so they will be subject to the financial limitations of local government budgets. They will have to compete with other demands on the public purse. Also, to the extent they are offered to a few developers, there may be pressures to provide similar benefits to others who cannot, for whatever reason, operate within the confines of a TOD. The cost of these expenditures obviously must be weighed along with transportation costs in planning TODs.

Discussion: Importance of Retail Dynamics

The potential for TOD's success will to a great degree depend on the response of the retail marketplace, including developers, store owners, and consumers, to the imperatives of density and transit accessibility. This follows from the significant fraction of all personal trips, including commute trips, that now involve nonwork activities.

Unless present long-standing trends are reversed, the marketplace will continue to evolve, producing ever greater variety and choice and, as a result, greater spatial dispersion of activity locations and more complex travel patterns. Consumer goods, services, and entertainment are converging to create new types of consumer venues where kids and parents can eat, shop, and play together or separately. At the same time, new market forces are rapidly entering the scene in ways that may gradually change the

spatial relationships of consumer to stores. Online sales tripled in 1998 over 1997. But even in the $4-5 billion range, it is minuscule compared to $2.3 trillion in retail overall.

Market richness has allowed older retail strip neighborhood centers to adapt and flourish even as they have lost traditional stores to the economies of scale and clustering. New kinds of specialty goods and services have entered the market. For example, some older neighborhood centers have become regional or sub regional destinations for consumers seeking an ethnic dining experience or antique chair. These centers, that may have otherwise been candidates for redevelopment and consolidation to a TOD had they remained underutilized, have developed a new life without the requirement that they change their form.

The large number of market variables and these dynamic changes make it difficult to predict the response of developers, store owners, and consumers to the TOD paradigm, even assuming TOD's need for major land use and transportation restructuring can be accomplished. Urban models, even new activity-based models, may not be able to predict consumer demand for new types of housing and the mix of activities that can be accommodated in TOD. The model may be capable of prediction, but the data needed to validate the model may not exist.

Planners thus face a dilemma. Local government policy makers will continue to feel public and federal government pressure for answers to the congestion and air quality problems. They will probably continue to embrace TOD and its concomitant requirements for major transit investments. But these polices will be established without clear proof that the investments will produce commensurate public benefits.

Notes

1. Personal communication from Prof. Genevieve Giuliano, University of Southern California School of Urban and Regional Planning.

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