Intrametropolitan Trends in Sunbelt and Western Cities: Transportation Implications

ROBERT CERVERO

ABSTRACT

As the nation's economic growth continues to focus on sunbelt and western metropolises, rapid changes are taking place, particularly on the peripheries of these areas, that have major mobility implications. Most notably, jobs are increasingly leaving traditional downtowns for new suburban employment complexes and sprawling office complexes. As a result of this decentralization, predominant trip patterns are becoming more and more diffuse and lateral in direction, not only in burgeoning sunbelt cities but all over the country. Congestion has seemingly lost its directional bias and can now be found in all corners of rapidly expanding metropolises like Houston, Denver, and Orange County, California. All signs suggest, moreover, that the private automobile will continue to gain dominance in commuting markets in the nation's fastest growing areas, largely because of the emerging low-density settlement patterns. From a policy standpoint, emphasis needs to be placed on substantially reorganizing traditional public transit as well as modifying radial-circumferential systems so as to better mimic scattered trip patterns. Busways and timed-transfer arrangements, such as those pioneered in several Canadian cities, are promising. Strong political resistance to radical changes in transportation service delivery practices, however, could prove difficult to overcome.

During the past two decades the nation's economic epicenter has been drifting in a southerly and westerly direction. The lower cost of doing business coupled with favorable weather and environmental conditions have lured thousands of companies, investors, and job seekers to America's sunbelt crescent. Major metropolises in Texas, Florida, and California have enjoyed particularly prosperous times. Interregional shifts in labor, capital, and investments to these states since the 1960s have produced extremely healthy and vibrant local economies, exemplified by the meteoric rise in white-collar office employment. America's political power base has likewise swung to the South and the West. The states of Florida, Texas, and California, for example, picked up nine representatives in the 1982 reapportionment of congressional seats. In total, the nation's southern and western tier states took away 16 congressional votes from the snowbelt that year.

Moreover, sunbelt cities appear to be sustaining this growth posture during the 1980s. About 90 percent of the population increase in the United States between 1980 and 1984 occurred in the South and the West. All of the 50 fastest growing metropolitan areas during this period were located in the South and the West (1). The only two metropolitan areas outside of the South and the West with populations over 1 million to grow faster than the national average during the early 1980s were Washington, D.C., and Minneapolis-St. Paul (2).

Within booming sunbelt and western regions, much of the recent population and employment growth has taken place in the suburbs and accretions beyond. New office and home building has been particularly prodigious in the suburbs. Some observers have warned, however, that unless prompt actions are taken to safeguard fast-growing metropolises and suburban corridors from the rapid influx of traffic, such areas are apt to face gridlock conditions not at all unlike those found in some of the nation's most congested central cities (3-5). To probe the implications of recent growth trends for transportation and regional mobility, in this paper are examined pertinent demographic, economic, and commuting data on the suburban versus central city spheres of 12 of the nation's fastest developing standard metropolitan statistical areas (SMSAs): Atlanta; Dallas-Ft. Worth; Denver; Houston; Los Angeles-Long Beach; Orange County, California; Phoenix; San Diego; San Francisco-Oakland; San Jose; Seattle; and Tampa-St. Petersburg. All 12 have metropolitan populations above 1 million and represent the very largest SMSAs in the South and the West. The only other southern and western SMSAs above 1 million population in 1980 not included in this list are Miami and New Orleans, both fairly mature metropolises by sunbelt standards.

Because the emphasis is on comparing trends geographically within each of these metropolises, it should be noted that there really is no clean distinction between what is and what is not a suburb in any of these 12 case areas. The Bureau of the Census simply designates parts of an SMSA either as "central city" or "not in central city"; the former designation comprises the official boundaries of the most populous municipality and, in the case of twin cities, the second largest municipality as well. This dichotomy unfortunately does not always provide an accurate portrayal of what is urban versus what is suburban. Some cities, such as Houston and Phoenix, have annexed so much surrounding territory during the past several decades that the bulk of regional jobs and residences falls into the "central city" census category, even though densities in newer annexed neighborhoods are frequently suburbialike.

Notwithstanding these definitional problems, useful insights into mobility issues can still be gained by examining assorted demographic and commuting

Department of City and Regional Planning, University of California, Berkeley, Calif. 94720.

TABLE 1 Population Changes, 1970-1980, Total SMSA and Suburban Population *(6)*

SMSA	Total Population			Percentage Living Outside Central City		
	1970	1980	Percentage Change	1970	1980	Change
Atlanta	1,390,164	2,029,710	+46.00	58.6	74.6	+16.0
Dallas	2,318,036	2,974,805	+28.33	46.6	56.7	+10.1
Denver	1,227,529	1,620,902	+32.15	58.1	64.9	+6.8
Houston	1,985,031	2,905,353	+46.42	38.0	45.1	+7.1
Los Angeles	7,037,075	7,477,503	+6.30	54.2	54.3	+0.1
Orange County	1,420,386	1,932,709	+36.12	68.3	76.5	+8.2
Phoenix	956,572	1,509,052	+56.07	35.7	45.1	+9.4
San Diego	1,357,854	1,861,846	+37.10	45.4	51.2	+5.8
San Jose	1,064,714	1,295,071	+21.64	50.3	57.2	+6.9
San Francisco	3,109,519	3,250,630	+4.57	65.4	65.7	+0.3
Seattle	1,421,869	1,607,469	+13.11	58.9	65.9	+7.0
Tampa	1,012,594	1,569,134	+58.00	51.2	67.5	+16.3
Twelve-SMSA average[a]	2,117,159	2,587,732	+32.15	52.7	60.4	+7.7
United States[b]	203,211,916	226,545,805	+11.54	42.3	44.2	+1.9

[a]Nonweighted average of 12 SMSAs.
[b]Total U.S. population and percentage of population living outside central cities.

trends taking place both in the cores and on the fringes of these 12 SMSAs. The extent to which intrametropolitan trips increasingly focus on outlying corridors, for instance, raises important questions regarding future transportation investment policies. The roles of different transit service strategies, such as timed-transfer systems and integrated busways, in serving increasingly dispersed travel patterns are probed. General policy inferences of emerging commuting trends are also drawn in the concluding section.

DEMOGRAPHIC TRENDS IN SUNBELT AND WESTERN METROPOLISES

The explosive population growth experienced by many southern and western metropolises during the past several decades has been well documented and needs no particular elaboration here. For the 12 case areas of interest, Table 1 gives population growth trends during the 1970s. On average, total population increased three times faster in these metropolitan areas between 1970 and 1980 than in the nation as a whole. Tampa and Phoenix had the greatest percentage of growth, and Houston outgained all others in absolute terms (nearly 1 million new residents).

With the exceptions of Los Angeles and San Francisco, moreover, all of these areas decentralized more rapidly during the 1970s than did the nation at large. When the relatively large suburban population base that already existed in 1970 in these areas is considered, recent gains are all the more impressive. The most dramatic suburban growth occurred in Tampa, Atlanta, and Dallas. On average, more than 60 percent of the total SMSA population currently lives outside of the central city in all 12 case areas compared with a national figure of 44.

This suburbanization wave has continued unabated into the 1980s. The five fastest growing large metropolitan areas in the country between 1980 and 1984 were Houston, Dallas, Tampa, Phoenix, and Denver, all with annual growth rates of more than 2.7 percent and all exploding on their urban perimeters. Suburbanization, moreover, appears to have picked up momentum in most sections of the country during the 1980s. In the 36 U.S. metropolitan areas with over 1 million population, the suburbs grew at an annual rate of 1.25 percent from 1980 to 1984; in comparison, the major central cities grew at a much slower, 0.42 percent, pace (1,2).

In terms of several other demographic characteristics--population density, household size, and family income levels--the 12 metropolises appear quite similar to other urbanized areas around the country. The data in Table 2 indicate that these case areas are slightly denser than their urbanized counterparts in the North and the East, partly because most have comparatively large average household sizes and partly because, as do most big cities, they have sizable numbers of apartment dwellers. Median family incomes of these 12 areas generally also exceed the national average, although a fair amount of variation exists even among sunbelt cities. At the lower end of the earnings scale is Tampa-St. Petersburg where median yearly annual household income falls nearly $5,000 below the national average. The high proportion of retirees living on Florida's Gulf Coast heavily skews this figure, however.

Table 2 also gives 1980 vehicle ownership rates for these 12 SMSAs. All but 2 of the 12 metropolises exceed the national average of vehicles per household; the exceptions are Tampa and San Francisco. Tampa's relatively low ownership rate again reflects the area's large retirement population, and the Bay Area's low figure can be attributed to public transit's relatively strong presence in the region, particularly within the city of San Francisco. Among the 12 selected SMSAs, Denver holds the highest rate

TABLE 2 Summary of 1980 Demographic Characteristics for Urbanized Areas of SMSAs *(7)*

SMSA	Population Density[a]	Vehicles per Household[b]	Persons per Household	Median Income ($)
Atlanta	1,783	1.6	2.8	21,509
Dallas	1,915	1.8	2.7	24,463
Denver	3,080	1.8	2.6	18,622
Houston	2,300	1.9	2.8	24,463
Los Angeles and Orange County	5,188	1.7	2.8	22,049
Phoenix	2,198	1.8	2.7	20,545
San Diego	2,790	1.7	2.7	20,095
San Francisco	4,009	1.5	2.5	24,599
San Jose	3,816	1.9	2.8	26,695
Seattle	2,874	1.7	2.6	24,930
Tampa	2,621	1.5	2.5	16,543
Eleven-SMSA average[c]	2,961	1.7	2.7	22,228
U.S. average	2,676	1.5	2.8	21,243

Note: An urbanized area consists of a central city or cities and surrounding closely settled territory ("urban fringe"), as defined by the Census Bureau.
[a]Total population per square mile of urbanized land.
[b]Total vehicles, including automobiles, trucks, vans, and motorcycles.
[c]Nonweighted average for 11 SMSAs.

TABLE 3 Employment Totals and Concentrations Outside Central Cities, 1970-1980 *(6)*

SMSA	Total Employment 1970	1980	Percentage Change	Percentage of Employment Outside Central City 1970	1980	Change
Atlanta	587,708	966,935	64.53	64.4	81.9	+17.5
Dallas	976,077	1,488,947	52.54	45.2	56.7	+11.5
Denver	492,961	819,770	66.30	51.3	65.1	+13.8
Houston	797,421	1,448,657	81.67	35.3	42.9	+7.6
Los Angeles	2,826,565	3,471,764	22.83	54.3	55.1	+0.8
Orange County	544,313	974,845	79.10	67.8	72.1	+4.3
Phoenix	362,156	663,624	83.24	36.4	44.7	+8.3
San Diego	430,495	756,400	75.70	41.2	52.6	+5.4
San Francisco	1,267,643	1,592,892	25.66	63.9	69.5	+5.6
San Jose	409,077	661,063	61.60	60.5	53.4	-7.1
Seattle	556,755	791,049	42.08	55.7	65.4	+9.7
Tampa	346,353	613,308	77.08	50.1	66.4	+16.3
Twelve-SMSA average[a]	841,016	1,239,631	59.57	52.2	60.5	+8.3
United States	76,852,389	96,617,296	25.73	35.6	47.7	+12.1

[a]Nonweighted average of 12 SMSAs.

of vehicles per person (0.70) and Atlanta has the lowest (0.57).

EMPLOYMENT IN SUNBELT AND WESTERN METROPOLISES

Employment growth in the 12 case SMSAs has been just as impressive as population gains (Table 3). Overall, the number of jobs grew about twice as fast during the 1970s in the 12 areas as it did in the nation as a whole. Phoenix, Houston, and Orange County enjoyed the healthiest gains. Moreover, the share of total regional jobs outside the central city rose in all but one of the 12 SMSAs; the exception was San Jose where the shrinkage in the suburban share of jobs can be attributed to the ongoing high technology employment boom of the renowned Silicon Valley, much of which has occurred within San Jose's northern city limits. The vast majority of San Jose's growth since the early 1970s, however, could nonetheless be characterized by sprawling, low-rise office development.

The data given in Table 4 further highlight the ascendancy of suburbia as the preferred employment location in most of the 12 SMSAs. Particularly in Tampa-St. Petersburg, Atlanta, Denver, Houston, and Phoenix, suburban employment flourished throughout the 1970s at the expense of the respective downtowns.

Most of the gains in both regional and suburban employment, not only in these 12 areas but throughout the United States, have been registered in the tertiary (i.e., service), quaternary (i.e., information-based), and advanced technology sectors. The rapid growth of these sectors has reflected the largest postindustrialization of America's economy--the change from a heavy "smokestack" manufacturing base to one devoted more to the production of ideas and information. Nationally, the share of jobs in manufacturing has fallen from 32 percent right after World War II to 24 percent in the early 1980s (8). Combined, the nation's nonmanufacturing and nonagricultural sectors, including jobs in offices, retail, government, education, and entertainment, grew from 49 to 66 percent of total employment during this same period.

TABLE 4 Changes in Office-Related Employment Within and Outside Central City *(6)*

SMSA	Change in Office-Related[a] Employment, 1970-1980 (%) Inside Central City	Outside Central City
Atlanta	-16.4	109.2
Dallas	20.5	91.3
Denver	19.4	110.8
Houston	60.4	120.6
Los Angeles	20.7	24.6
Orange County	55.7	90.5
Phoenix	59.5	124.7
San Diego	57.8	95.7
San Francisco	6.1	36.7
San Jose	90.7	42.6
Seattle	10.9	66.9
Tampa	19.2	134.8
Twelve-SMSA average[b]	33.7	87.8
United States[c]	15.0	115.9

[a]Office-related is defined as those Standard Industrial Classification (SIC) codes in services, retail, light manufacturing, and associated industries.
[b]Nonweighted average of 12 SMSAs.
[c]All U.S. SMSAs.

It has been this "white-collarization" of employment that has prompted many businesses to relocate their offices in suburbia. No longer are most firms tied to rail spurs and ports; they have become footloose, able to make locational decisions on the basis of factors other than proximity to raw materials and goods. Particularly in the case of high technology industries, the miniaturization of product lines has drastically reduced the cost of shipping goods to the point where firms are virtually free to move wherever they can maximize their net advantage. In most cases this has been the suburbs because of a combination of factors including lower rents and land costs; the presence of large labor pools, especially married women who are often available for clerical jobs; better access and visibility; and a perceived higher quality working environment attractive to highly skilled labor (9). In addition, the rapid acceleration of telecommunications technologies has enabled many businesses to spin off portions of their back-office operations (e.g., computer functions) to less expensive suburban environs.

A few additional statistics underscore the full scope of recent suburban office development in the nation's fastest growing southern and western metropolises. In Houston, only 39 percent of all office construction was outside downtown in 1970; by 1982 the share had catapulted to 87 percent (10). In the Rocky Mountain states, although Denver has emerged as the undisputed regional hub, most office building activities have actually taken place outside its downtown. The suburbs' share of annual office construction erupted from just 15 percent in 1970 to 73 percent in 1981 (10). Along Denver's southeast I-25 corridor, a stretch dotted with business-executive parks, more office space has already been produced than in all of downtown Denver. Phoenix's suburban employment growth has been

even more staggering. Of the Phoenix SMSA's 21 million square feet of privately owned, multitenant office space, only 2 million square feet have been built downtown. Although the city of Phoenix has actively pursued downtown redevelopment, no new office buildings were constructed during the late 1970s or early 1980s. In contrast, Phoenix's northern suburban corridor witnessed the addition of four new office towers that total 1.3 million square feet during 1982 and 1983 (11).

Although such statistics bode favorably for the economic future of suburbia in the 12 case metropolises, it should be noted that office employment grew even more precipitously in other nondowntown settings across the country. New white-collar jobs were particularly plentiful on the fringes of a number of smaller metropolitan areas in the 250,000 to 1 million population range. For example, employment in the suburbs of Des Moines, Norfolk-Virginia Beach, Memphis, and Tulsa rose by 112, 126, 154, and 166 percent, respectively, during the 1970s. Among the 36 U.S. metropolitan areas of 1 million or more population, however, the suburban work force of the 12 case areas grew head and shoulders above the rest. In addition, it should be noted that the averages given in Table 4 are suppressed by the inclusion of California cities, in particular Los Angeles and San Francisco, both of which have reached fairly mature stages of their growth cycles compared with the other case areas. Excluding West Coast cities from Table 4, the average change in suburban office-related employment during the 1970s was 125 percent, above the national average.

TABLE 5 1980 Work Trip Patterns Within SMSAs for Different Regions of the United States *(12)*

Region	Percentage of Total Work Trips Within SMSA			
	Central City to Central City	Central City to Suburbs[a]	Suburbs to Central City	Suburbs to Suburbs[a]
Northeast	32.2	4.7	15.3	47.8
North Central	30.7	7.0	20.3	49.0
South	36.1	6.1	23.7	40.1
West	32.4	9.3	19.9	38.4
Total United States	33.1	6.7	20.1	40.1

[a]Suburbs represents all areas in an SMSA outside the central city.

GEOGRAPHY OF COMMUTING

Contrary to popular belief, the largest share of work trips made in the SMSAs of the United States is not radial ones from the suburbs to central cities but lateral ones, both beginning and ending in the suburbs. The data given in Table 5 indicate that this preeminence in suburb-to-suburb commuting holds for all four regions of the country. Intrasuburban travel is actually most prominent in the Northeast, largely because of the enormous amount of crosstown and interstate travel throughout the greater New York metropolitan area. The South has the highest share of the traditional suburb-to-central city radial commuting, and the highest incidences of reverse commuting can be found in the Pacific states.

The data in Table 6 disclose 1970-1980 trends in intrametropolitan as well as suprametropolitan travel for the 12 case areas, broken down by place of residence within each SMSA. The table reveals that the shares of trips destined to suburbs--reverse commutes and suburb-to-suburb journeys--rose in nearly all of the 12 case areas. Long-haul trips from suburbia to places outside of SMSAs likewise jumped during the 1970s in most places. Correspondingly, the role of inner-city trip making dropped sharply in almost all of the study areas. Only in the cases of Atlanta and Tampa did commuting shares within central cities rise.

Several areas recorded particularly significant increases in reverse commuting, notably Dallas, Orange County, and San Jose. Orange County also sustained high rates of intermetropolitan commuting during the 1970s. In 1980 nearly one-quarter of Orange County's employed residents commuted to surrounding counties, and 18 percent went to neighboring Los Angeles County. Atlanta, Dallas, and San Jose experienced the greatest gains in suburb-to-suburb commuting during the decade. The Atlanta region also stands out for its increasingly insular pattern of commuting--residents within Atlanta's city limits are making relatively more intraurban journeys whereas those living outside the city proper have

TABLE 6 Changes in Commuting Patterns Within and Between Central City and Other Locations, 1970-1980 *(6)*

SMSA	Percentage of Central City Residents Commuting						Percentage of Residents Living Outside Central City Commuting					
	Inside Central City		To Outside of Central City[a]		To Outside of SMSA		To Central City		Outside Central City[a]		To Outside of SMSA	
	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980
Atlanta	69.2	73.3	18.4	14.6	12.4	12.1	36.2	26.9	62.7	68.3	1.1	4.8
Dallas	81.2	74.9	11.1	18.7	7.7	6.4	41.7	30.9	54.7	60.1	3.6	9.0
Denver	78.3	75.5	14.9	16.4	6.8	8.1	41.2	38.6	58.7	61.0	0.1	0.4
Houston	78.4	77.5	7.4	8.2	14.2	14.3	40.4	43.8	59.5	54.0	0.1	2.2
Los Angeles	63.5	63.8	22.9	24.2	13.6	12.0	16.3	19.4	76.0	79.8	7.7	0.8
Orange County	44.5	40.9	29.0	34.8	26.5	24.3	19.9	19.2	65.0	69.3	15.1	11.5
Phoenix	78.6	74.5	13.0	14.9	8.4	10.6	26.8	26.4	73.2	72.9	.0	0.7
San Diego	78.2	73.1	14.0	12.7	7.8	14.2	29.5	30.2	70.4	69.4	0.1	0.4
San Francisco	75.6	73.4	11.1	13.2	13.3	13.4	25.8	28.7	67.6	66.0	6.6	5.3
San Jose	46.5	42.6	36.2	41.5	17.3	15.9	15.7	8.2	84.2	91.5	0.1	8.5
Seattle	80.8	77.4	12.6	15.3	6.6	7.3	41.4	36.1	58.2	60.8	0.4	3.1
Tampa	73.3	75.2	16.3	18.9	10.4	5.9	32.3	29.6	67.4	66.9	0.3	3.5
Twelve-SMSA average[b]	70.7	68.5	17.2	19.5	12.1	12.0	30.4	27.3	66.4	68.5	3.2	4.2
United States[c]	80.7	71.8	15.2	14.5	4.1	13.7	32.8	28.0	59.4	55.8	7.8	16.2

[a]Outside the central city but within the SMSA.
[b]Nonweighted average of the 12 SMSAs.
[c]All U.S. SMSAs.

stepped up their intersuburban travels. Dallas, moreover, witnessed the largest increases in commuting between its suburbs and exurbs (i.e., areas outside the SMSA), and Los Angeles registered equally dramatic declines in suprametropolitan travel (i.e., to and from different SMSAs).

Combined, these trends suggest that trip patterns in the most prosperous regions of the United States are becoming more convoluted. Symmetric, star-shaped commute paths, long a hallmark of U.S. cities, have been replaced by a patchwork quilt of intrametropolitan travel. No longer does commuting follow a distinct directional orientation; heavy rush-hour traffic, once the dubious privilege of downtown motorists, now impinges on everyone to some degree (3). For many, the days of a leisurely contra-flow commute are fast coming to a close. Along the Katy (I-10W) and Gulf (I-45S) Freeways in Houston, for instance, inbound and outbound traffic volumes are today virtually identical during both the morning and the evening peaks (13). With more than 400 new automobiles being added to the streets of Houston each day, clogged arteries and congested freeways are virtually assured during rush hours in almost any part of the SMSA.

Not only are Houstonians plagued with "ubiquitous congestion," they, along with Dallas commuters, are chalking up more miles to get to and from work daily than people anywhere else in the country. The per capita miles of daily vehicular travel in Houston and Dallas were 20.7 and 21.6, respectively, in 1980. This compares with a per capita average of 16.5 mi for all 12 case areas and 14.2 mi for all 366 U.S. urbanized areas.

URBAN VERSUS SUBURBAN COMMUTING: WHICH IS FASTER?

Accompanying the sprawl of U.S. cities during the past several decades has been a lengthening of average commuter travel times. Between 1970 and 1980, for instance, the mean time to get to work increased from 23 to 26 min (14 percent) in Atlanta and from 21 to 26 min in the San Francisco Bay Area (24 percent). Nationwide, average commuting times rose from 22 to 24 min (9 percent) during the 1970s.

Although suburbanites generally commute longer distances than their central city coworkers, they often do so at faster average speeds such that the total time both groups spend behind the wheel is nearly equal. In 1979, for the nation as a whole, the data in Table 7 indicate that the typical suburban motorist traveled more than 3 mi farther to get to work than the average city dweller; however, suburban motorists traveled at speeds more than 5 mph faster. On average, urban commuters beat their suburban counterparts to work by only 1 min. (Within any single modal category, however, central city residents generally got to work at least 3 min faster than suburbanites; the comparability of travel time for all modes combined largely reflects the fact that urban commuters patronize slower bus transit modes far more frequently than do suburbanites.) The longest commuting times were experienced by those suburbanites who opted for public transportation, which reflects the lengthy waits associated with scheduled bus services in low-density areas.

On the whole, the regional dispersal of trips has been a mixed blessing to the average commuter. He tends to travel farther; however, a smaller share of his time is generally spent in frustrating, slow-moving traffic. The disadvantage of traditional downtown-focused radial commuting is that it results in "trip convergence"--motorists from the outskirts are funneled into the same geographically limited space, which produces traffic standstills. With dispersal, trips tend to be more circuitous; however, the multidestinational commuting patterns help to free downtown traffic snarls. As employment activities continue to intensify along the urban fringes, many new confluence points will emerge, and the speed advantages of intrasuburban commuting could quickly become a relic of the past. In time, new traffic equilibriums are likely to be reached, and the shorter commute distances afforded by the relocation of jobs to close-by suburban residences will be offset by slower home-to-office travel speeds.

MODAL COMMUTING TRENDS

With the steady decentralization of jobs and housing, it is no surprise that the private automobile is, by a wide margin, the preferred mode of passenger travel in the nation's most rapidly growing metropolises (Table 8). Unlike most other areas of the country, however, the share of total trips has actually been shifting slightly from the automobile to public transportation modes in Los Angeles, Orange County, San Jose, and Seattle. In contrast, every SMSA in the North Central region of the country except Minneapolis-St. Paul lost transit patrons during the 1970s. This is not to suggest that diesel buses have won the affections of southerners and westerners, however. Slight gains in transit's modal share, although against the grain of national trends, are fairly inconsequential in real terms because ridership levels have historically been low in the South and the West. Among the 12 case areas, only San Francisco and Atlanta (both of which have modern rapid rail systems), along with Seattle, presently have transit usage rates appreciably above the national average.

At the other end of the modal spectrum are Houston, Dallas, and Tampa, each with more than 90 percent of all commuter trips made by private automobile and rapidly dwindling transit ridership levels. Annual bus patronage declined by more than 15 million riders in these three areas during the 1970s. Houston does, however, enjoy comparatively high rates of carpooling; 22 percent of its daily vehicular work trips involve one or more passengers (compared with a national average of 18 percent for urbanized

TABLE 7 1979 Journey-to-Work Distance, Travel Time, and Speed Statistics for the United States by Place of Residence Within SMSAs *(14)*

	Average Distance (mi)		Average Travel Time (min)		Average Travel Speed (mph)	
	Central City	Non-Central City	Central City	Non-Central City	Central City	Non-Central City
Automobile or truck	9.4	12.7	20.5	23.4	27.5	32.6
Drive alone	8.8	11.8	24.7	29.0	21.4	24.4
Carpool	11.7	16.4	19.5	22.0	36.0	44.7
Public transportation	9.0	20.0	39.9	48.7	13.5	24.6
All modes[a]	8.8	12.6	23.1	24.2	22.9	31.2

[a]In addition to automobile or truck and public transportation modes, this category includes cycling, motorcycling, walking, and other means of travel.

TABLE 8 Modal Distribution of Commuter Trips in 12 SMSAs, 1970-1980 *(15)*

	Percentage of Total Commuter Trips Made by								
	Private Vehicle			Public Transportation[a]			Other[b]		
SMSA	1970	1980	Change (%)	1970	1980	Change (%)	1970	1980	Change (%)
Atlanta	84.6	88.3	+3.7	9.4	7.6	-1.8	6.0	4.1	-1.9
Dallas	88.0	91.8	+3.8	5.2	3.4	-1.8	6.8	4.8	-2.0
Denver	85.2	85.5	+0.3	4.4	6.1	+1.7	10.4	8.4	-2.0
Houston	86.9	91.9	+5.0	5.4	3.0	-2.4	7.7	5.1	-2.4
Los Angeles	85.9	85.5	-0.4	5.5	7.0	+1.5	8.6	7.5	-1.1
Orange County	92.5	90.9	-1.6	0.3	2.1	+1.8	7.2	7.0	-0.2
Phoenix	88.9	89.1	+0.2	1.2	2.0	+0.8	9.9	8.9	-1.0
San Diego	75.8	81.2	+5.4	4.2	3.3	-0.9	20.0	15.5	-4.5
San Francisco	73.5	73.7	+0.2	15.2	16.4	+1.2	11.3	9.9	-1.4
San Jose	88.7	89.0	-0.3	2.3	3.1	+0.8	9.0	7.9	-1.1
Seattle	83.5	82.1	-1.4	7.1	9.6	+2.5	9.4	8.3	-1.1
Tampa	87.6	90.4	+2.8	3.1	1.8	-1.3	9.3	7.8	-1.5
Twelve-SMSA average[c]	84.8	86.2	+1.4	5.5	5.8	+0.3	9.7	7.9	-1.8
United States[d]	77.7	84.1	+6.4	8.9	6.4	-2.5	9.4	7.9	-1.2

[a]Includes bus, rail transit, railroads, and taxicab modes.
[b]Includes bicycle, walk, and other modes as well as residents who work at home.
[c]Nonweighted average of 12 SMSAs.
[d]All U.S. SMSAs.

areas). Still, carpooling rates appear to be either declining or stabilizing in almost all of the 12 case areas. On average, peak-hour vehicle occupancy levels dropped from 1.14 to 1.13 (-0.2 percent) during the 1970s in these 12 areas compared with a decline in all of the nation's SMSAs from 1.18 to 1.15 (-2.5 percent).

The data in Table 8 also reveal that cycling and walking to work consistently declined in all 12 areas during the 1970s. The largest drop-off was in San Diego. Still, more than 15 percent of all journeys to work there are made by nonmotorized modes. The popularity of walking and cycling among San Diegans can be partly attributed to the area's large concentration of enlisted personnel, many of whom live either on a military base or close by.

Finally, changes in the geographic distribution of different commuter modes within SMSAs are also worth noting. In most places, both automobile and transit usage have risen in the suburbs and remain fairly stagnant (or declined) elsewhere (16). Nationwide, the percentage of transit users who live in the suburbs rose from 25 to 30 percent during the 1970s. Every large SMSA in the South and the West, with the exceptions of San Antonio, Ft. Lauderdale, and New Orleans, experienced a drop in central city ridership and a corresponding increase in suburban usage during the 1970s (16). This flip-flop largely reflects the redeployment of bus services from central cities to outlying areas by many regional transit authorities during the 1970s, a maneuver used to gain the tax support of wealthier suburban communities.

The shifting of transit's market to the South and the West provides new, untapped frontiers for industrywide innovation. Traditionally, transit bosses in the United States have viewed suburbia as forbidden territory. A vast majority of bus operators in this country continue to offer fixed-route, radial services focusing on downtown hubs with an occasional foray to an outlying shopping mall. Yet the congregation of employment and retail activities along the urban fringes of many booming metropolises presents a unique opportunity for the transit industry to carve out a new niche for itself. In particular, employment subcenters offer natural intercept points for building coordinated networks of converging transit routes. Clearly, if the nation's public transit industry is to reinvigorate itself, burgeoning suburban work centers are the place to begin focusing its dwindling resources.

POLICY INFERENCES

Census trends during the 1970s offer graphic evidence of the explosive growth in sunbelt and western conurbations, particularly in suburban and fringe settings. The mobility implications of rapid interregional and intrametropolitan shifts in population and economic activities are substantial. A labyrinth of commute patterns now characterizes cityscapes, casting serious doubts over the future of conventional bus transit and other shared-ride modes of transportation. Despite some recent gains in transit usage in the western United States, all signs point to greater reliance on automobiles in the future. Only a ubiquitous transportation system that emulates the interconnectivity of a telephone network, some argue, can thrive in an environment of scattered trip ends (17).

Unfortunately, these trends do not square well with the current transportation networks of many U.S. cities, irrespective of the region of the country. Most metropolitan highway systems were built to funnel commuters from the outskirts to downtown. Many radial thoroughfares are simply incapable of handling large volumes of lateral and peripherally oriented trips. Yet money is drying up for new road building, and priority is usually given to the maintenance and restoration of facilities already in place. Even if there was available funding, it is questionable whether politically potent suburban constituencies would allow their idyllic neighborhoods to be disrupted by new highway construction (3). For example, in Walnut Creek, a booming suburb east of San Francisco and Oakland, local residents recently approved a strict growth control ordinance as a means of containing traffic instead of supporting a $400 million bond referendum for new road construction. Increasingly, suburbanites are opting to halt growth altogether rather than risk future traffic snarls brought on by new road improvements.

Transit Choices

Conventional fixed-route, set-schedule bus transportation is in dire need of a radical overhaul if it

is to become a viable mode in the nation's fastest growing metropolises. Serious consideration needs to be given to the replacement of radial systems by grids offering high degrees of route interconnectivity to better serve the continuing dispersion of regional commuting patterns. Only this kind of network eases the burden of making transfers. Outlying office centers, shopping malls, and other activity centers form natural building blocks for multifocal, timed-transfer networks. Recent experiences in two Canadian cities, Edmonton and Ottawa, provide useful precedents for designing such multidestinational networks.

In the mid-1970s Edmonton Transit reconfigured its bus routes to feed, in synchrony, into 19 dispersed transit centers. At present, anywhere from five to ten bus routes converge simultaneously on one of Edmonton's transit centers precisely 5 and 35 min after the hour during the off-peak period and at 15- to 20-min intervals during the peak period. Those patrons continuing their trip scramble to another bus to make their connections, and, like clockwork, buses depart 3 to 5 min later. Pulse scheduling and timed transfers have enabled Edmonton Transit to adapt its service to best mimic the area's dominant crosstown commuting pattern. As a result, Edmontonians can today reach nearly 90 percent of a 130-mi² service area within 50 min or less during the midday via public transit (18).

Insightful lessons about how transit can be made to work in low-density settings are also offered by Ottawa's recent experiences. In the early 1980s Ottawa introduced a timed-transfer network similar to Edmonton's, with the notable exception that a mostly grade-separated, dedicated busway serves as the main-line connector between outlying transit centers and downtown. The transitway operates just like any other rapid transit facility, with vehicles, in Ottawa's case buses, stopping at every station. Special ramp access from criss-crossing surface streets is provided at most stations so that feeder buses can connect directly into the main line without any transfers having to be made.

What makes Ottawa so unusual is that, after completing a detailed alternatives analysis, it opted for busways over the eminently more popular light rail transit (LRT) technology. Ottawa's primary reason for choosing busways over LRT is compelling: by best estimates, the busway would cost 50 percent less to construct and 20 percent less to operate and would provide roughly the same capacity (19). Because buses can also feed into Ottawa's sprawling residential neighborhoods whereas LRT would rely on transfers, the busway was also deemed superior in terms of overall service quality. By all accounts, Ottawa's busway, coupled with other supportive programs such as restricted downtown parking and a central city transit mall, has been an unqualified success. More than 30 percent of all vehicle trips in the region and 60 percent of downtown-destined peak-hour journeys are currently made via public transit, a phenomenal achievement for a bus-only community. Judging by experiences in both Ottawa and Edmonton, it is evident that a suburban environment and viable public transit are indeed compatible if planned in tandem.

Calls for major reform within the urban transit industry in the wake of major population shifts and suburbanization, it might be noted, are nothing new (20,p.486):

> Can we not pause long enough in this headlong decentralization process to see where we are going. The mass transportation industry is caught in a strong tide which is sweeping this and many other businesses toward disaster. [The] situation calls for strong expression and vigorous leadership.

Delivered at the 1940 annual meeting of the American Transit Association, this forewarning indeed holds as much relevance today as it did nearly one-half century ago.

Automobile-Highway Choices

Given the low-density settlement pattern of many rapidly growing metropolises, equally important questions can be raised about the abilities of the automobile-highway system to adequately meet emerging trip patterns. As the nation's political power base shifts more to the South and the West, larger sums of federal transportation dollars can be expected to flow in these directions as well. Some southern and western cities, however, appear to be more inclined to sink billions of dollars into building new fixed-guideway systems rather than reforming roadway networks; perhaps the perceived environmental benefits of rail transit sway these investment choices the most. Private-sector contributions to road financing perhaps represent a more promising avenue for constructing new roadways in growth areas. Already, more than $300 million in private-sector contributions has been spent on or pledged to roadway improvements in a dozen rapidly growing communities; most activities have been recorded in California, Texas, and Colorado (21). The most generous contribution to date has come from developers of the Hacienda Business Park in Pleasanton, California, some 35 mi east of downtown San Francisco. There, more than $80 million has been committed to major freeway and arterial investments as well as the construction of areawide pedestrian and cycling trails, residential sound barriers, and flood control canals (3,21). Although adequate funding programs might be designed along specific corridors in fast-growing regions, building a suburban constituency that is supportive of new road building is apt to be a far more difficult challenge.

Future Challenges

The suburban corridors of rapidly expanding communities, many of which are concentrated in the nation's southern and western states, represent a new frontier for the transportation planning profession. These settings offer unprecedented opportunities not only for technological and policy innovations but also for reinvigorating more established modes of transportation, such as bus transit.

In light of recent demographic and commuting trends, the logic of sinking billions of dollars into building new rail transit systems in fast-growing sunbelt metropolises should be reassessed. the sprawling, fragmented profiles of many of these areas were indelibly shaped by the automobile-freeway system, and nothing suggests that these settlement patterns will be reversed by building new rail systems. Rail advocates and critics continue to argue about the long-term costs of rail versus nonrail systems, but, in terms of the demand side of the equation, every trend suggests that carefully integrated timed-transfer networks and busways would be wiser investments for the nation's fastest growing communities.

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REFERENCES

1. Patterns of Metropolitan Area and County Population Growth: 1980 to 1984. Series P-25, No. 976. Bureau of the Census, U.S. Department of Commerce, 1985.
2. R.L. Forstall and D.E. Starsinic. The Largest U.S. Metropolitan Areas. Urban Land, Vol. 43, No. 9, 1984, pp. 32-33.
3. C.K. Orski. Suburban Mobility: The Coming Transportation Crisis? Transportation Quarterly, Vol. 39, No. 2, 1985, pp. 283-296.
4. C. Conte. The Explosive Growth of Suburbia Leads to Bumper-to-Bumper Blues. Wall Street Journal, April 16, 1985, p. 37.
5. J.S. Lublin. The Suburban Life: Trees, Grass Plus Noise, Traffic and Pollution. Wall Street Journal, June 20, 1985, p. 29.
6. Census of Population: General Population Characteristics, United States Summary. Bureau of the Census, U.S. Department of Commerce, 1973 and 1983.
7. C.G. Rodriguez, J.J. McDonnell, R.W. Draper, and E. McGarry. Transportation Planning Data for Urbanized Areas. FHWA, U.S. Department of Transportation, 1985.
8. R.S. Phillips and A.C. Vidal. The Growth and Restructuring of Metropolitan Economics. Journal of the American Planning Association, Vol. 49, No. 3, 1983, pp. 291-304.
9. Location of High Technology Firms and Regional Economics. Joint Economic Committee of the U.S. Congress, 1982.
10. Office Buildings: Income/Expense Analysis, Downtown and Suburban. Institute of Real Estate Management, Chicago, Ill., 1984.
11. R. Cervero. Managing the Traffic Impacts of Suburban Office Growth. Transportation Quarterly, Vol. 38, No. 4, 1984, pp. 533-550.
12. Census of Population: Journey to Work--Metropolitan Commuting Flows. Bureau of the Census, U.S. Department of Commerce, 1984.
13. Mobility and Congestion: Office Location Issues in Houston. Research Brief, Vol. 1, No. 4. Rice Center, Houston, Tex., 1979.
14. 1980 Census of Population: Journey to Work--Characteristics of Workers in Metropolitan Areas. Bureau of the Census, U.S. Department of Commerce, 1984.
15. Census of Population: Journey to Work--Characteristics of Workers in Metropolitan Areas. Bureau of the Census, U.S. Department of Commerce, 1973 and 1974.
16. P.N. Fulton. Are We Solving the Commuting Problem? American Demographics, Vol. 5, No. 11, 1983, pp. 17-19, 46-48.
17. M. Webber. Trends and Trepidations. Presented at the Conference on Mobility of Major Metropolitan Areas, UMTA, U.S. Department of Transportation, Los Angeles, Calif., Nov. 1984.
18. J.J. Bakker. Advantages and Experiences with Timed Transfers. Presented at the 60th Annual Meeting of the Transportation Research Board, Washington, D.C., Jan. 1981.
19. J. Bonsall. A Bus for All Seasons. Presented at the seminar on The Canadian Experience: Making Transit Work in the Golden Gate Corridor, cosponsored by the Golden Gate Bridge, Highway and Transportation District and the Canadian Consulate General, San Rafael, Calif., Oct. 3, 1985.
20. H. Bartholomew. Effects of Urban Decentralization Upon Transit Operation and Policies. Proc., American Transit Association Fifty-Ninth Annual Convention, New York, 1940.
21. R. Cervero. Suburban Gridlock. Center for Urban Policy Research, Rutgers University, New Brunswick, N.J., 1985.

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