Title
Land Uses and Travel at Suburban Activity Centers

Author
Cervero, Robert

Publication Date
1991-10-01

Land Uses and Travel at Suburban Activity Centers

Robert Cervero

UCTC
No. 91

The University of California Transportation Center

University of California
Berkeley, CA 94720

The University of California Transportation Center

The University of California Transportation Center (UCTC) is one of ten regional units mandated by Congress and established in Fall 1988 to support research, education, and training in surface transportation. The UC Center serves federal Region IX and is supported by matching grants from the U.S. Department of Transportation, the California Department of Transportation (Caltrans), and the University.

Based on the Berkeley Campus, UCTC draws upon existing capabilities and resources of the Institutes of Transportation Studies at Berkeley, Davis, Irvine, and Los Angeles; the Institute of Urban and Regional Development at Berkeley; and several academic departments at the Berkeley, Davis, Irvine, and Los Angeles campuses. Faculty and students on other University of California campuses may participate in Center activities. Researchers at other universities within the region also have opportunities to collaborate with UC faculty on selected studies.

UCTC's educational and research programs are focused on strategic planning for improving metropolitan accessibility, with emphasis on the special conditions in Region IX. Particular attention is directed to strategies for using transportation as an instrument of economic development, while also accommodating to the region's persistent expansion and while maintaining and enhancing the quality of life there.

The Center distributes reports on its research in working papers, monographs, and in reprints of published articles. It also publishes *Access*, a magazine presenting summaries of selected studies. For a list of publications in print, write to the address below.

University of California
Transportation Center

108 Naval Architecture Building
Berkeley, California 94720
Tel: 510/643-7378
FAX: 510/643-5456

DISCLAIMER

Land Uses and Travel at Suburban Activity Centers

Robert Cervero

Department of City and Regional Planning
University of California at Berkeley

Reprint, No. 91

Transportation Quarterly
Vol. 45, No. 4, October 1991, pp. 479-491

The University of California Transportation Center
University of California at Berkeley

Land Uses and Travel at Suburban Activity Centers

ROBERT CERVERO

Prof. Cervero is the author of two books on suburban mobility, Suburban Gridlock *(1986) and* America's Suburban Centers *(1989). Over the past year he has been working in Indonesia on regional development financing for the Harvard Institute for International Development.*

SEVERAL recent studies have focused on how land-use characteristics of suburban activity centers affect travel demand.[1] Research indicates that low densities, single uses, small scales, and plentiful parking tend to induce drive-alone automobile usage in the suburbs for employment, residential, commercial, and institutional land uses alike. Much of this past work, however, has been fairly aggregate in scope, relying on comparisons of travel behavior between different activity centers among different cities. Usually, transportation demand, such as average vehicle occupancy levels or trip-generation rates, is gauged in terms of "averages." Few, if any, analyses have been done at a property site level (i.e., relating travel demand of workers within a building to that site's density, degree of land-use mixture, tenancy characteristics, and so on).

This article aims to build upon past research by studying the relationship between land use and various indicators of travel demand for a number of office buildings at six different suburban activity centers across the United States. The data source used in this analysis was the report on *Travel Characteristics at Large-Scale Suburban Activity Centers,* recently made available through the National Cooperative Highway Research Program (NCHRP).[2] The NCHRP report is a

1. R. Cervero, *Suburban Gridlock* (New Brunswick, NJ: Center for Urban Policy Research, Rutgers University, 1986); Cervero, "Land-Use Mixing and Suburban Mobility," *Transportation Quarterly* 42 no. 3 (1988): 429–446; Cervero, *America's Suburban Centers: The Land Use-Transportation Link* (Boston: Unwin-Hyman, 1989); Rice Center, *Houston's Major Activity Centers and Worker Travel Behavior* Joint Center for Urban Mobility Research, (Houston: 1987); Rice Center (1989) *Suburban Activity Centers: Private Sector Participation* (Washington, DC: U.S. Department of Transportation, Urban Mass Transportation Administration, 1989); and T. Hartshorn and P. Muller, *Suburban Business Centers: Employment Implications* (Washington, DC: U.S. Department of Commerce, Economic Development Administration, 1986).

2. K. Hooper *Travel Characteristics at Large-Scale Suburban Activity Centers, Report 323* (Washington, DC: Cooperative Highway Research Program, 1989).

TRANSPORTATION QUARTERLY, Vol. 45, No. 4, October 1991 (479–491)

rich source of information on a range of site and travel-demand characteristics of individual buildings—housing such functions as offices, retail, hotels, and residences—within six of the largest suburban activity centers in the country.

The analysis that follows examines the influence of project size, density, land-use mixing, and parking facilities on three measures of transportation demand: trip generation rates, work-trip mode splits, and automobile occupancy levels. The analyses are summarized by presenting a table of land-use elasticities—indices of how sensitive various measures of travel demand are to various indicators of site land-use characteristics. The article concludes with discussions on how land use and transportation can be more closely integrated in U.S. suburbs.

The term "land use" is used rather loosely in this article, and is meant to convey more than how land is simply put to use. Here, land use refers to the overall built environment—size and density of suburban work sites, degree to which uses are segregated or commingled, tenant mixes, and site design features, such as the amount and availability of parking. In that all of these attributes of the built environment influence travel behavior, this broader definition of land use is more compelling. Indeed, it is how land is used and organized that shapes how and along what corridors we travel.

HYPOTHESES AND RESEARCH APPROACH

This research tests two basic propositions.

1. High levels of automobile commuting to large-scale suburban activity centers are associated with built environments that have low densities, single land uses, and high supplies of parking. Conversely, transit and walking trips are more common in the exact opposite kinds of suburban settings—ones with high densities, multiple land uses, and limited parking.

2. Mixed-use suburban work environments result in relatively low vehicle-trip generation rates since employees at such places are more likely to rideshare, walk, and cycle to work. Average automobile occupancy rates are thus also likely to be higher. While to some degree the answers to these hypotheses should be obvious, the emphasis of this analysis is less on proving or disproving hypotheses and more on empirically measuring the strength and magnitude of relationships between suburban land uses and various indicators of travel demand.

Using the NCHRP report, land-use and transportation data were compiled for 83 randomly sampled individual buildings in the following suburban activity centers: Bellevue, Washington (near Seattle), 10 buildings; South Coast Metro (Orange County, California), 11 buildings; Parkway Center (in northern Dallas), 12 buildings; Perimeter Center (north of Atlanta), 15 buildings; Tysons Corner (outside of Washington, D.C.), 16 buildings; and Southdale (near Minneapolis), 19 buildings. These are among the largest suburban employment centers in the country, each containing over 10,000 office employees and over 3.5 million square feet of office floorspace. All of the centers have a significant retail component as well, ranging in size from 2 million square feet of retail floorspace at the Perimeter Center to over 7 million square feet at Parkway Center. The 83 surveyed buildings were devoted either solely to office functions or else had a mixture of office, retail, and other tenant-support functions. Thus, cases could be easily coded as either single-use office or mixed-office/retail sites. Source data were gathered from a combination of questionnaire responses (generally on travel choices and household characteristics of office workers), field counts, and site inspections.[3]

For the analyses that follow, data on the 83 sites were pooled and stepwise regression analyses were used to identify land-use factors that were the strongest predictors of different measures of travel demand. The chief purpose of the analysis was not to produce the best predictor models of travel demand, however. Such models would need to be far more robust than the ones presented here, incorporating variables that measured service and price characteristics of various modes. Unfortunately, such data were not available from the NCHRP source. Rather, the intent here is more basic: to associate and gauge the general strength of relationships between various land-use characteristics of suburban office buildings and travel demand (using, admittedly, a less than fully specified model). The analyses should provide at least some initial insights into the relative importance of the built environment on travel behavior at some of America's largest suburban activity centers.

CHARACTERIZING THE ACTIVITY CENTERS

Employees at the 83 office buildings that were surveyed can be characterized as follows. Around 62 percent of employees were in

3. The interested reader is referred to the NCHRP report (see Hooper, *Travel Characteristics*) for a discussion of the data collection procedures.

professional or managerial positions and over 85 percent worked in desk jobs. Nearly 60 percent of employees interviewed were women. On average, employees were from households with 2.16 vehicles available, close to the national average.

The surveyed office buildings were, on average, around 260,000 gross square feet in size, containing businesses involved with financial management, real estate brokering, engineering consulting, insurance services, and legal counseling. Both built-to-suit company buildings and multi-tenant spec buildings were surveyed. Individual buildings ranged from a single tenant to over 100 occupants, with the average tenancy being 20 firms. On average, buildings were 86 percent occupied, reflecting the general healthy office leasing markets in the six metropolitan areas sampled. In general, surveyed buildings were dense, averaging 10 stories in height and around 3.3 employees per 1,000 gross square feet of floorspace. Overall, the structures could be characterized as fairly dense, modern spec office buildings housing a predominantly professional workforce.

FACTORS AFFECTING OFFICE WORK-TRIP GENERATION RATES

Since transportation is a "derived demand" (i.e., it is derived from the activities at a particular place), trip rates generated by individual office buildings should be strongly associated with various land-use characteristics of the sites. Table 1 presents the best-fitting model for predicting vehicle work trips per employee (TRIPRATE). In general, plentiful parking and multi-tenancy appear to induce vehicle work trips to suburban job sites, while on-site retail components tend to lower trip rates. That parking induces vehicle trips seems obvious. More interesting are the influences of the other two variables. Single-tenancy and mixed-use buildings are associated with low vehicle-trip generation rates since both encourage employees to vanpool and carpool to work. Past research has shown that ridesharing generally increases in single tenant environments since ridematching and other promotional programs are easier to implement.[4] Adding retail components in and near a building likewise induces ridesharing since the inclusion of restaurants, shops, banks, and

4. R. Cervero and B. Griesenbeck, "Commuting Choices in Suburban Labor Markets: A Case Analysis of Pleasanton, California," *Transportation Research* 22A (1988):151–161; and K. Bhatt and T. Higgins, *An Assessment of Travel Demand Approaches at Suburban Activity Centers* (Washington, DC: Urban Mass Transportation Administration, U.S. Department of Transportation, 1989).

TABLE I—STEPWISE REGRESSION RESULTS ON FACTORS INFLUENCING VEHICLE WORK TRIPS PER EMPLOYEE

	Dependent Variable: TRIPRATE			
Variable	*Beta Coefficient*	*Standard Error*	*t Statistic*	*Probability*
PARK/EMP	0.063	0.029	2.19	.038
MIXEDUSE	−0.078	0.047	−1.66	.110
TENANCY	0.155	0.094	1.66	.111
Constant	0.311	0.085	3.66	.001

Summary Statistics:

Number of observations = 57
R-Squared = .357
F Statistic = 4.25
Probability = .016

Variable Definitions:

TRIPRATE	= Vehicle work trips per employee.
PARK/EMP	= Available parking spaces per employee.
MIXEDUSE	= Degree of mixed uses: 1 = mixed office and retail uses, 0 = office or office-related uses only.
TENANCY	= Type of tenant: 1 = multi-tenant, 0 = single tenant.

other consumer outlets reduces the need to have a car on site.[5] The relationship between mixed uses and vehicle work-trip rates was not terribly strong—*ceteris paribus,* the model suggests that the existence of a retail component within a suburban office building can cut vehicle-trip rates per employee by about 8 percent. Over time, however, the relationship between suburban land-use mixes and trip rates could be expected to strengthen as more suburban office workers grow accustomed to ridesharing and traveling by some mode other than the drive-alone automobile.

FACTORS AFFECTING WORK-TRIP MODAL SPLITS

The next set of analyses concentrated on how land-use characteristics affect modal splits. Table II presents the regression results for predicting variation in the dependent variable AUTO—the percentage of work trips made by automobiles. Auto travel comprises over 90 percent of all work trips made to each of the 6 suburban activity centers. The best-fitting model indicates that the share of work trips by the private automobile declines by a little over 3 percent if an

5. Cevero, "Land-Use Mixing."

TABLE II—STEPWISE REGRESSION RESULTS ON FACTORS INFLUENCING PERCENTAGE OF WORK TRIPS MADE BY PRIVATE AUTOMOBILE

	Dependent Variable: AUTO			
Variable	*Beta Coefficient*	*Standard Error*	*t Statistic*	*Probability*
PARK/EMP	5.005	1.964	2.55	.020
MIXEDUSE	−3.207	2.128	−1.51	.148
Constant	90.687	2.662	34.07	.000

Summary Statistics:

Number of observations = 52
R-Squared = .277
F Statistic = 3.52
Probability = .050

Variable Definitions:

AUTO = Percent of work trips made by private automobile.
PARK/EMP = Available parking spaces per employee.
MIXEDUSE = Degree of mixed uses: 1 = mixed office and retail uses, 0 = office or office-related uses only.

office building has a mixed-use component. The mixed-use variable, however, is only significant at the 15 percent probability level and, overall, the model has only modest explanatory powers. More significant is the influence of on-site parking—the model suggests that the auto share of work trips increases by 5 percent for an office building with 1.5 versus 0.5 parking spaces per employee.

All remaining modes make up small slices of the "commuting pie" at the 6 suburban activity centers. With the exception of Bellevue, which has a transit mode share of 8.8 percent, none of the other surveyed activity centers has a transit mode share over 1 percent.[6] Still, at 10 of the 83 buildings surveyed, transit's mode share exceeded 4 percent, providing enough variation in the data to allow the influence of land-use factors on transit usage to be modeled. Overall, a much better fit was obtained relative to the prior model. Table III shows that transit's share increases by over 3 percent if a building has a mixed-use retail component.

Density also seems to matter. All else being equal, the model suggests that a 10-story suburban office tower will average around 4 percent more transit usage than a 1-story building. And whereas available parking appears to encourage auto commuting, at the same time it appears to work against transit usage in suburbia. Finally, the

6. Hooper, *Travel Characteristics*.

TABLE III—STEPWISE REGRESSION RESULTS ON FACTORS INFLUENCING PERCENTAGE OF WORK TRIPS MADE BY MASS TRANSIT

	Dependent Variable: TRANSIT			
Variable	*Beta Coefficient*	*Standard Error*	*t Statistic*	*Probability*
PARKSPACE	−0.005	0.001	−2.84	.013
MIXEDUSE	3.236	1.989	2.77	.015
BLDGHEIGHT	0.403	0.124	3.26	.006
AUTOCCUP	13.895	5.022	2.77	.015
Constant	−13.167	5.870	−2.24	.042

Summary Statistics:

Number of observations = 39
R-Squared = .668
F Statistic = 7.06
Probability = .003

Variable Definitions:

TRANSIT = Percent of work trips made by mass transit mode.
PARKSPACE = Number of parking spaces.
MIXEDUSE = Degree of mixed uses: 1 = mixed office and retail uses, 0 = office or office-related uses only.
BLDGHEIGHT = Number of stories of office building.
AUTOCCUP = Auto occupancy level, number of persons per vehicle during AM peak period.

model indicates that transit usage also increases when average auto occupancy levels rise (representing greater carpooling and vanpooling activities). This no doubt reflects an associative relationship between relatively high levels of ridesharing and transit usage, both of which gain popularity as densities rise and parking supplies fall.

A final modal split analysis was performed on walk trips to work. While no one makes walk trips to work at 42 of the 83 surveyed suburban sites, at 15 others foot travel made up over 0.5 percent of work trips and at 2 sites in Bellevue it made up over 1.5 percent of commute trips. Fortunately, there was enough variation in the data to allow the affects of land-use factors on pedestrian work trips to be modeled. Table IV presents the stepwise results. Mixed-use activities appear to have a relatively important positive influence on walking to work in suburbia—an office building housing some mixed-use activities will, all other things being equal, average 0.3 percent more pedestrian work trips, a sizeable amount given that the overall average was only 0.4 percent. The remaining two variables in the equation pick up associative relationships. Specifically, higher rates of transit usage are associated with higher levels of walking to work

TABLE IV—STEPWISE REGRESSION RESULTS ON FACTORS INFLUENCING PERCENTAGE OF WORK TRIPS MADE BY WALKING

	Dependent Variable: WALK			
Variable	*Beta Coefficient*	*Standard Error*	*t Statistic*	*Probability*
MIXEDUSE	0.292	0.174	1.69	.101
TRANSIT	0.089	0.022	4.00	.001
AUTOCCUP	−1.073	0.629	−1.71	.087
Constant	1.433	0.706	2.03	.050

Summary Statistics:

Number of observations = 39
R-Squared = .324
F Statistic = 5.58
Probability = .003

Variable Definitions:

WALK	= Percent of work trips made by walking.
MIXEDUSE	= Degree of mixed uses: 1 = mixed office and retail uses, 0 = office or office-related uses only.
TRANSIT	= Percent of work trips made by mass transit mode.
AUTOCCUP	= Auto occupancy level, number of persons per vehicle during AM peak period.

whereas the relationship between automobile occupancy and walking appears to be the opposite. This finding likely reflects the existence of a distance threshold of choosing transit vis-á-vis ridesharing as the work-trip mode in suburban employment settings. Where workers reside near their work sites, say within two miles, both transit and walking tend to be viable commute alternatives in suburbia and perhaps are sometimes substituted for one another. Over longer commuting distances, however, ridesharing becomes a more attractive option since the benefits of having someone else drive and picking up others en route are only appreciable over relatively lengthy journeys. Thus, ridesharing and walking are not likely to be practical substitutes for one another in most suburban employment settings; while both seem to be induced by mixed-use work settings, quite likely, in places where ridesharing tends to more common, walk trips probably tend to be rare.

FACTORS AFFECTING VEHICLE OCCUPANCY LEVELS

High vehicle occupancy levels, reflecting greater ridesharing activities, are thought to be influenced by both the scale and level of mixing of a project. The stepwise results, summarized in Table V, confirm this. Bigger suburban projects induce ridesharing since they

TABLE V—STEPWISE REGRESSION RESULTS ON FACTORS INFLUENCING VEHICLE OCCUPANCY LEVELS

	Dependent Variable: AUTOCCUP			
Variable	*Beta Coefficient*	*Standard Error*	*t Statistic*	*Probability*
TOTALSQFT	0.0008	0.0002	4.056	.000
MIXEDUSE	0.0865	0.0415	2.082	.046
PARKSPACE	−0.0002	0.0001	−3.639	.001
Constant	1.0901	0.0388	28.124	.000

Summary Statistics:

Number of observations = 53
R-Squared = .389
F Statistic = 6.17
Probability = .002

Variable Definitions:

AUTOCCUP = Auto occupancy level, number of persons per vehicle during AM peak period.
TOTALSQFT = Total gross square feet of floorspace, in thousands.
MIXEDUSE = Degree of mixed uses: 1 = mixed office and retail uses, 0 = office or office-related uses only.
PARKSPACE = Number of parking spaces.

provide more of a critical mass from which to match workers into carpools and vanpools. Large-scale developments are also more likely to be able to support a rideshare coordinator and launch successful rideshare promotional efforts. The model suggests that, all other things held constant, a 1 million square foot suburban building will average 0.84 more passengers per automobile work trip made to the site each morning than a 500,000 square foot project. Clearly, size counts. Moreover, the model indicates that plentiful parking works against ridesharing, inviting suburban office workers to commute alone. In general, the results suggest that a suburban office building with 4,000 parking spaces could be expected to average 0.46 fewer passengers per car than an otherwise comparable building with only 2,000 parking stalls.

LAND-USE ELASTICITIES

To gain some sense of the relative importance of various land use and site factors in influencing travel demand, it is useful to present the regression results in elasticity form. As used here, elasticities gauge how sensitive various travel demand variables are to changes in land-use variables by taking out the influence of measurement units. An absolute value over one indicates an elastic transportation/

land-use relationship, suggesting policy initiatives like zoning reforms can have potentially high mobility pay-offs.

Table VI summarizes the findings of this research by presenting midpoint elasticities. These figures were calculated by multiplying the partial regression coefficients of the land-use variables by the ratio of the mean value of the land-use (independent) variables to the mean value of the travel-demand (dependent) variables. Thus, they measure elasticities at the midpoint of the demand curves for each of the transportation variables and thus are most valid for "typical" large-scale suburban activity centers.

From the table, all of the land-use variables have signs that match *a priori* expectations, thus confirming the hypotheses that were posited. The strongest association appears to be between density, reflected by number of stories of the surveyed building, and transit modal share. The remaining relationships, however, are fairly inelastic. In general, adding retail and other mixed-use components into a suburban office building appears to affect work-trip behavior only modestly, apparently having the strongest influence on the amount of walking and transit trip-making, especially for those workers who reside relatively close by. Size, density, and tenancy characteristics of projects appear to have relatively greater influence than land-use mixing on trip-making in suburban employment settings. Again,

TABLE VI—SUMMARY OF MIDPOINT ELASTICITIES BETWEEN TRAVEL DEMAND AND LAND-USE FACTORS (Names for specific land-use variables shown in brackets)

	Travel-demand Measures				
	Percent of Work Trips Made by:				
Land-Use Measures	*Automobile*	*Transit*	*Walking*	*Automobile Occupancy*	*Vehicle Trips/Employee*
Mixed use	−.015 (MIXEDUSE)	.269 (MIXEDUSE)	.326 (MIXEDUSE)	.029 (MIXEDUSE)	−.061 (MIXEDUSE)
Size/ Density/ Tenancy		1.207 (BLDGHEIGHT)		.201 (TOTALSQFT)	.272 (TENANCY)
Parking supply	.069 (PARK/EMP)	−.103 (PARKSPACE)		−.169 (PARKSPACE)	.197 (PARK/EMP)

Variable Definitions:

MIXEDUSE	= Degree of mixed uses: 1 = mixed office and retail uses, 0 = office or office-related uses only.
BLDGHEIGHT	= Number of stories of office building.
TOTALSQFT	= Total gross square feet of floorspace, in thousands.
TENANCY	= Type of tenant: 1 = multi-tenant, 0 = single tenant.
PARK/EMP	= Available parking spaces per employee.
PARKSPACE	= Number of parking spaces.

massing (in the form of tall buildings) appears to be an important precursor to relatively high levels of transit useage. Lastly, supplies of parking appear to have a relatively modest influence on commuting choices. The fairly low elasticities, however, are thought to be partly a reflection of the fact that nearly all of the office buildings studied had generous parking supplies, at least in comparison to their downtown counterparts. Including more buildings with fairly low parking levels in the survey probably would have provided greater variation from which to measure the influence of parking. Additionally, the inclusion of a variable measuring whether parking is charged, and by how much, would probably have strengthened the collective influences on parking policies on the various travel-demand variables studied.

Perhaps simple building comparisons offer the best lesson into what is achievable when the supply and price of parking are controlled in suburbia. Pacific Northwest Bell (PNB), a major employer in central Bellevue, provides its 1,150 workers with 402 parking spaces, over half of which are reserved for carpools and vanpools. The company charges $3 per day to park, or $60 per month for single drivers, $45 per month for two-person poolers, and free parking for vehicles with three or more occupants. Presently, one-half of PNB workers solo commute, 37 percent pool (in part because of the company's strong ridershare promotion effort), and 12 percent arrive via bus transit. A block away lies another office tower that is surrounded by 730 spaces, none of which are reserved for carpools, available free-of-charge to the 650 workers. The commuting habits of workers in this building are quite different—85 percent drive alone and only 8 percent carpool or vanpool. Thus, within the Bellevue activity center, tight parking and market prices have encouraged ridesharing and transit usage; where parking is plentiful and free, however, solo commuting reigns supreme.

While collectively these results suggest that commuting behavior tends to be fairly insensitive to land-use characteristics of large-scale suburban office settings, it should be kept in mind that the elasticities presented are near-term ones. Since many suburban employment centers across America are relatively new, perhaps this finding is not surprising. Over the long term, once commuting habits of workers begin to set in and other reinforcing factors take hold (e.g., improvements in transit services to dense work settings), the relationship between land-use variables and commuting choices could be expected to strengthen. Clearly, an important research challenge in coming years is to monitor the changing relationship between the built environment of suburban workplaces and the travel choices of their workers and clients.

CONCLUSION

The land-use environments of contemporary suburban workplaces appear to have a modest to moderate influence on commuting behavior. The absence of strong statistical relationships perhaps reflect the absence of truly dense, mixed-use work settings in America's suburbs more than anything. Given enough variation from which to measure how land-use mixing, density, and levels of parking affect mode choice and occupancy levels, better fitting models could have possibly been produced.

Perhaps the best evidence on the relationship between suburban workplaces and transit usage comes from abroad. Europe offers numerous examples where suburban workers are opting for mass transit. Satellite centers like Farsta and Vallingby outside of Stockholm, Albertslund outside of Copenhagen, and Scarborough and North York outside of Toronto stand as testaments to the ability of clustered, mixed-use suburban workplaces to attract well over one-half of their workforces into transit vehicles for the journey to work.[7] Of course, these satellite workcenters are fed by comfortable rail cars that are linked to clustered residential development and that operate on frequent headways. Moreover, motorists are charged considerably more for motor fuel, vehicle registrations, and parking in these places than in the United States.[8]

One actually does not have to look beyond the United States to find cases where respectable shares of workers in suburban office buildings are arriving and leaving each day via transit. A recent study found that 25 percent of those working in office buildings within 2,000 feet of the Silver Spring Metrorail station, situated some 10 miles from the core of Washington, D.C., arrived to work each day by

7. P. Holgren, "Traffic and Urban Development in Stockholm," *Traffic Digest and Review* 14 no. 8 (1966): 3–12; P. Goldsack, "Stockholm: How to Fight Traffic with First-Class Transit," *Mass Transit 1* (1982): 10–16; and J. Pill, Emerging Suburban Activity Centers in Metropolitan Toronto, *Journal of Advanced Transportation* 17 no 3 (1983): 301–315.

8. J. Pucher, "Urban Travel Behavior as the Outcome of Public Policy: the Example of Modal-split in Western Europe and North America," *Journal of the American Planning Association* 54 no. 3 (1988): 509–520; and P. Newman and J. Kenworthy, "Gasoline Consumption and Cities: a Comparison of U.S. Cities with a Global Survey," *Journal of the American Planning Association* 55 no. 1 (1989): 24–37.

transit.[9] Moreover, those residing near a suburban rail station and working near a different rail station were particularly inclined to patronize transit—well over 60 percent of those who worked near a Metrorail station and who resided within 1,000 feet of another station took the train to work. The relationship held true for high-income households as well. In the case of a townhouse near the Grosvenor Metrorail station where units sold for $250,000 and up in 1989, the transit mode share was 33 percent.[10] Thus, even where household incomes and automobile ownership rates are fairly high, suburban workers and residents in the United States will patronize mass transit if service quality is good and access to stations is convenient.

Clearly, the lessons from Scandanavia, Canada, and our own nation's capital appear to be that suburban workers and residents will opt for mass transit if a supportive land-use environment is provided, transit service is quick and efficient, and some limits are placed on automobile usage, mainly in the form of restricted supplies of parking and relatively high vehicle ownership and usage fees. In tandem, clustered, mixed-use developments, high-quality transit services, and higher prices for automobile usage appear to work in favor of one another in suburban employment settings, whether in the United States or abroad.

Acknowledgement

This research was supported by a University of California faculty research grant. The author wishes to thank Patrick Lo for his assistance in preparing the data set and carrying out some of the analyses.

9. JHK & Associates, *Development-related Ridership Survey II* (Washington, DC: Washington Metropolitan Area Transit Authority, 1989).

10. JHK & Associates, *Development-related Ridership Survey II.*