Which Reduces Vehicle Travel More: Jobs-Housing Balance or Retail-Housing Mixing?

Robert Cervero and Michael Duncan

Which land-use strategy yields greater reductions in vehicular travel: improving the proximity of jobs to housing or bringing retail and consumer services closer to residential areas? We probe this question by examining the degree to which job accessibility is associated with reduced work travel and how closely retail and service accessibility is correlated with miles and hours logged getting to shopping destinations. Based on data from the San Francisco Bay Area, we find that jobs-housing balance reduces travel more, by a substantial margin. The article concludes by discussing policy measures that have been introduced in California to bring housing, workplaces, and retail centers closer together.

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Mixed land uses are a signature feature of smart growth. Transportation planners call for balancing jobs and housing as a way to reduce peak-period travel and rationalize commute sheds (Cervero, 1989; Ewing, 1996). In Maryland and Delaware, jobs-housing balance is promoted through the offering of cash grants to workers who purchase homes close to their places of employment. New urbanists mix uses by locating retail shops and consumer services near housing. Seaside, FL, and Kentlands, MD, boast of neighborhood shops and cafés in their marketing brochures. In *Suburban Nation*, Andres Duany and his co-authors (2002) cite "a 5-minute walk to most everyday activities" and "neighborhood mixed land uses" as essential features of a well-designed community.

Both land-use strategies aim to reduce miles and hours of vehicular travel. Placing jobs and retail shops close to housing should compress travel distances and convert motorized trips to walking, cycling, or transit modes. Research has found that locating retail stores and services near residences can "de-generate" vehicular trips for shopping by upwards of 25% (Cervero, 1996b). Locating jobs and housing in close proximity should rationalize commutation patterns by reducing cross-haul trips. Research suggests that jobs-housing balance can reduce a region's vehicle miles traveled (VMT) by upwards of 15% (Ewing, 1996).

However, considerable resistance to balanced growth and mixed land uses remains. Euclidean zoning is built on the premise that potentially incompatible land uses should be physically segregated. Fears that nonresidential uses will tarnish a neighborhood's image and lower property values can unleash a NIMBY backlash against mixed-use projects. Other factors, like the presence of multi-worker households and the growing importance of local school quality in residential location decisions (Downs, 2004; Giuliano, 1991), also work against efforts to create self-contained, balanced places.

This article focuses on whether jobs-housing balance or locating retail and services close to residential areas yields greater travel-reducing benefits. Using 2000 travel-diary data from the San Francisco Bay Area, we match job accessibility to the work-tour VMT of individual commuters and retail-service accessibility to the shopping-tour VMT of individual shoppers. In addition to studying the effects on VMT, the analysis also examines effects on vehicle hours traveled (VHT), since lost time imposes large costs to both individuals and society.

As our literature review discusses, the question of whether built environments significantly shape travel behavior is hardly a settled question. We were thus prepared for the possibility that neither jobs-housing balance nor mixing housing and retail would have a significant bearing on VMT and VHT in the San Francisco Bay Area. We conclude by tying our findings to the larger debate over whether the transportation–land use connection matters.

Previous Research

Two distinct strands of research on the travel-demand impacts of mixed-use growth have emerged. One focuses on the value of placing nonresidential uses, notably retail shops, in or near residential areas. This work emphasizes relationships at a neighborhood scale and sheds light on new urbanists' claims about the benefits of mixed use. The other looks at jobs-housing balance, which is more regional in scope, with potential to reduce peak-period traffic congestion and improve air quality. Building upon a long tradition of writings on land use and travel (Alonso, 1964; Chapin, 1957; Mitchell & Rapkin, 1954), Handy (1993) was among the first to articulate how travel might be influenced by both the immediate neighborhood and the larger region. While the literature suggests that putting jobs and retail shops in close proximity to housing can substantially reduce motorized travel, it says little about which forms of balance and mix yield the greatest dividends.

Mixed Land Uses and Travel

Mixed uses reduce travel by: (1) bringing origins and destinations closer together, thus reducing trip distances and durations; (2) inducing people to walk, bike, or ride public transit in lieu of driving (in part due to the shorter distances involved); and (3) eliminating or shortening vehicle trips by capturing travelers at new, more convenient destinations. The last of these can occur as a result of: *internal capture*, such as when people walk between offices and retail shops within a master-planned mixed-use project; *pass-by capture*, such as when motorists make an intermediate stop along the route, for example, to buy gas; or *route diversions*, such as when someone makes a small detour, for example, to buy a loaf of bread. Few studies have successfully sorted out to what degree these behaviors reduce motorized travel under different circumstances. The Institute of Transportation Engineers' *Trip Generation Handbook* (2001) does contain adjustments for internal captures, pass-by captures, and route diversions, based largely on experience in Florida. It recommends, for example, a 2% downward adjustment in vehicle trips to work when housing is in an office park and a 38% reduction in vehicle trips for shopping when retail and residences are commingled.

Most studies of mixing land uses have examined impacts on travel generally rather than for single purposes like shopping. Typically studies are cross-sectional, using multiple regression or matched-pair approaches to draw statistical inferences. In synthesizing the literature, Ewing and Cervero (2001) report a "typical" elasticity between local land-use mix and VMT of −0.05 (a doubling of mixed use, as measured by a heterogeneity index like a measure of entropy, is associated with a 5% decline in VMT). Empirical evidence, however, is far from consistent. Among the studies that show that mixing land uses reduces vehicular travel are those by Cervero (1988, 1991, 1996b); Ewing (1995); Frank and Pivo (1995); Cervero and Kockelman (1997); Rutherford, McCormack, and Wilkinson (1996); and Dieleman, Dijst, and Burghouwt (2002). Others have found modest or statistically insignificant relationships (Boarnet & Sarmiento, 1998; Crane & Crepeau, 1998; Ewing, DeAnna & Li, 1996; Stead, 2001).

While most studies have focused on nonwork travel, a few have shown that neighborhood retail can prompt residents to walk, cycle, or take transit to job sites that are reasonably close (Cervero, 1996b; Cervero & Kockelman, 1997). Locating retail in and around office projects also influences commuting, mainly by reducing the need for workers to have cars at the worksite (Cervero, 1988; Cambridge Systematics, Inc., 1994).

Several studies from the San Francisco Bay Area have focused on the influence of mixed uses on shopping-trip behavior specifically. Handy (1993) found that those living in areas with high accessibility to both local and regional retail centers devoted fewer VMT to shopping on average. Handy's work and a matched-pair analysis by Cervero and Radisch (1996) hint at a substitution effect: Shopping trips that would otherwise be made by car to destinations outside the neighborhood are instead made by foot within mixed-use neighborhoods. In a more recent study of teleshopping in the Bay Area, Ferrell (2004) found that those living in areas with high retail accessibility travel shorter total distances and spend less time traveling for shopping purposes.

Krizek (2003a) published one of the few studies to examine the influence of retail accessibility on shopping tours (round trips beginning and ending at home with intermediate stops at retail destinations). Using travel diary data from the Puget Sound area, he found that households living in areas with high retail accessibility leave home more often (i.e., make more tours), but make fewer stops per tour. Moreover, Krizek found that most shopping took place outside of neighborhoods (only 20% of shopping destinations were within two miles of residences), leading him to conclude that "the often touted VMT savings of living close to services appears to be negligible because this represents only a fraction of maintenance travel" (p. 406). This lends support to Crane's (1996) argument that residents of areas with high retail accessibility may shop more often and drive more miles overall, since lower transportation costs stimulate travel. However, another study by Krizek (2003b) using the same data found that people relocating to dense, mixed-use neighborhoods with high retail accessibility generally averaged lower VMT after moving. While the research findings are not consistent, the weight of evidence suggests that mixed-use environments do moderate travel.

Jobs-Housing Balance and Travel

Research shows that jobs-housing balance shortens commute distances. This may seem obvious, but the fact that the number of jobs in an area is similar to the number of resident workers does not necessarily mean people will work close to home. The evidence suggests the odds of working close to home are less in unbalanced settings, however. In a study in the Puget Sound, Frank and Pivo (1995) found the average distance of work trips ending in balanced census tracts (those with jobs-to-housing ratios of 0.8 to 1.2) was 29% shorter than for those ending in less balanced tracts. Ewing's 1998 study of over 500 Florida communities found that the share of those commuting within their home community was significantly higher where jobs and housing were in balance. A study using travel diary data from metropolitan Portland, OR, found lower average VMT in areas with high accessibility to jobs, although trip frequency was higher (Kasturi, Sun, & Wilmot, 1998). Another study in the Portland area found that only extremely imbalanced neighborhoods, in particular job-poor bedroom communities, averaged high VMT per capita (Peng, 1997). In contrast, a study of Toronto by Miller and Ibrahim (1998) found the ratio of jobs to residents and the number of jobs within 5 km of residences had little influence on vehicle kilometers traveled to work. Additionally, Giuliano and Small (1993) found that jobs-housing balance in greater Los Angeles had a statistically significant, albeit small, influence on commuting durations, prompting them to conclude that factors other than proximity to workplace are more important explainers of contemporary residential location choice.

Several studies have associated widening jobs-housing imbalances with the suburbanization of employment (Cervero & Wu, 1997). Between 1980 and 1990, those working in the suburbs of the San Francisco Bay Area experienced a 23% increase in VMT for commuting, though mean travel times fell. Eighty percent of the VMT increase was attributed to longer distances between home and work (Cervero & Wu, 1998). In the case of low-income households, Levine (1992) similarly found commutes lengthened as employment suburbanized, in part due to shortages of affordable housing nearby. A follow-up study suggested low-to-moderate-income, single-worker households benefit the most from jobs-housing balance policies since they are most likely to relocate to affordable projects (Levine, 1998). A more recent study based on time-series data from the American Housing Survey by Crane and Chatman (2003) challenges these earlier results, finding that job suburbanization is associated with shortened commute distances: A 10% increase in employment in a metropolitan area's outlying counties is associated with a 3% reduction in average commute distance.

The literature also shows mixed results on the degree to which jobs-housing imbalances are self-correcting. Studies from the Los Angeles region (Wachs, Taylor, Levine & Ong, 1993) and greater Washington, DC, area (Levinson & Kumar, 1994) suggest imbalances recede over time as jobs and housing co-locate since workers prefer to commute less. Other research, however, suggests exclusionary policies and market distortions can prevent this. In a longitudinal study of the Bay Area, Cervero (1996a) found that while bedroom communities became balanced over time as employers and retailers moved closer to labor and shoppers, the same did not hold for well-to-do communities with a surplus of jobs over housing. From 1980 to 1990, jobs-housing imbalances worsened in 8 of the region's 10 most job-rich cities, and average commutes of workers to those places rose nearly 30%.

Previously mentioned work by Krizek (2003b) sheds further light on the potential travel impacts of jobs-housing balance. Using longitudinal panel data from the Puget Sound area, he found that a shortened commute distance was associated with lower VMT and more frequent tours, suggesting "households who shorten their commute are more prone to participate in more tours through the course of the day" (p. 274).

Data, Methods, and Case Setting

The relationship between land-use mixing, jobs-housing balance, and travel is complex, as the review of past research reveals. Many factors account for inconsistent results, including differences in measurement, methods, and interpretations (Boarnet & Crane, 2001). This section reviews the approaches and measurements used in the present study, including the key data sources that informed the research, measures of accessibility used to reflect degrees of land-use mixing, measures of travel outcomes, and a description of the case setting.

Data Sources

Our primary data source was the 2000 Bay Area Travel Survey (BATS). BATS data provide detailed 2-day travel diaries kept by persons aged 16 and over residing in over 16,000 randomly sampled households. Data on employment by place of work came from the Census Transportation Planning Package (CTPP), Part II (at the block group level), and from the Metropolitan Transportation Commission (MTC, the nine-county Bay Area's designated Metropolitan Planning Organization) for individual traffic analysis zones (TAZs). Zone-to-zone travel distances and durations on highway networks during a.m. peak hours were also obtained from MTC.

Figure 1 shows the location of each sampled household in the 2000 BATS survey for the nine-county Bay Area. The sample generally mirrors the spatial distribution of population within the region.

Accessibility

We used the principle of accessibility (opportunities for reaching desired destinations) to study the relationship of travel behavior to land use. We measured access by counting job and retail or service destinations within defined distance-rings of the homes of BATS respondents (e.g., number of retail shops within 5 miles). Such measures, however, require that the researcher choose the appropriate distance. BATS showed median one-way distances for work and shopping trips of 9 miles and 3 miles, respectively. These reflect travel choices in the absence of smart-growth planning, which presumably would produce shorter journeys. Accordingly, we opted to measure accessibility for a range of distances from 1 to 9 miles, and relied upon empirical results to identify which distance rings best predicted actual travel behavior.[1] Handy and Niemeier (1997) concluded that, "no one best approach to measuring accessibility exists; different situations and purposes demand different approaches" (p. 1181). We opted for this type of measure not only because it is intuitive, but also because it allowed us to examine balanced growth in clear spatial terms. In addition, our measures can be used to determine what size commute sheds and retail sheds yield the greatest public utility, as discussed later.

Job Accessibility. We used two measures of accessibility to employment opportunities. One was a count of all jobs within a given distance of each survey respondent's home. The second measure, what we call "occupationally matched accessibility," tabulated only jobs in the same occupational category as that held by the survey respondent. We grouped occupations into three basic categories: executive/professional, support/service, and blue collar.[2]

Retail and Service Accessibility. Expressing the relative proximity of residences to retail and service activities also poses measurement challenges. Some analysts have used square footage of retail to gauge the shopping potential available, though this does not capture the intensity of retail use. A large furniture warehouse outlet, for example, might serve relatively few customers per square foot. Thus, like most other studies of neighborhood accessibility (reviewed in Handy & Clifton, 2001) we used the number of retail and service industry jobs within specified distances to capture the relative drawing power of retail and service activities.

Travel Measures

We studied travel using two measures: VMT and VHT. VMT is associated with energy consumption and tailpipe emissions (of local pollutants and greenhouse gases; see Greene, 2004; Kenworthy & Laube, 1999) that have implications for public-sector planning. VHT is more reflective of impacts on individuals.

We did not count trips by foot or bicycle in VMT or VHT since these measures include only travel in motorized vehicles. We also did not count trips by mass transit in VMT or VHT using the logic that they add no new vehicles to streets and cause no additional fuel to be consumed. We did adjust VMT to reflect occupancy levels in private vehicles. For example, we assigned a two-person carpool half the VMT per person as a solo car trip of the same length.

While we could have studied other aspects of travel consumption, such as trip frequency and mode choice, both of these are imbedded in VMT and VHT calculations. In their review of the literature on transportation and land-use relationships, Ewing and Cervero (2001) found trip length and duration to be more related to the built environment than were trip frequency and mode choice.

Home-based tours are home-to-home travel loops, potentially linking several different stops (Krizek, 2003a; Thill & Thomas, 1987), which can make defining the trip purpose of a tour tricky. We categorized tours as follows. We defined all links of a tour that included a workplace destination to be work travel,[3] and any tour with at least one shopping, service, or eating destination that did not also include a work destination as a shopping and personal-services tour.[4] Thus we counted shopping or visiting a fitness center on the way to or from work as work travel. As noted later, the nonwork segments generally constituted a small share of the total distances and times of work-based tours according to 2000 BATS data.

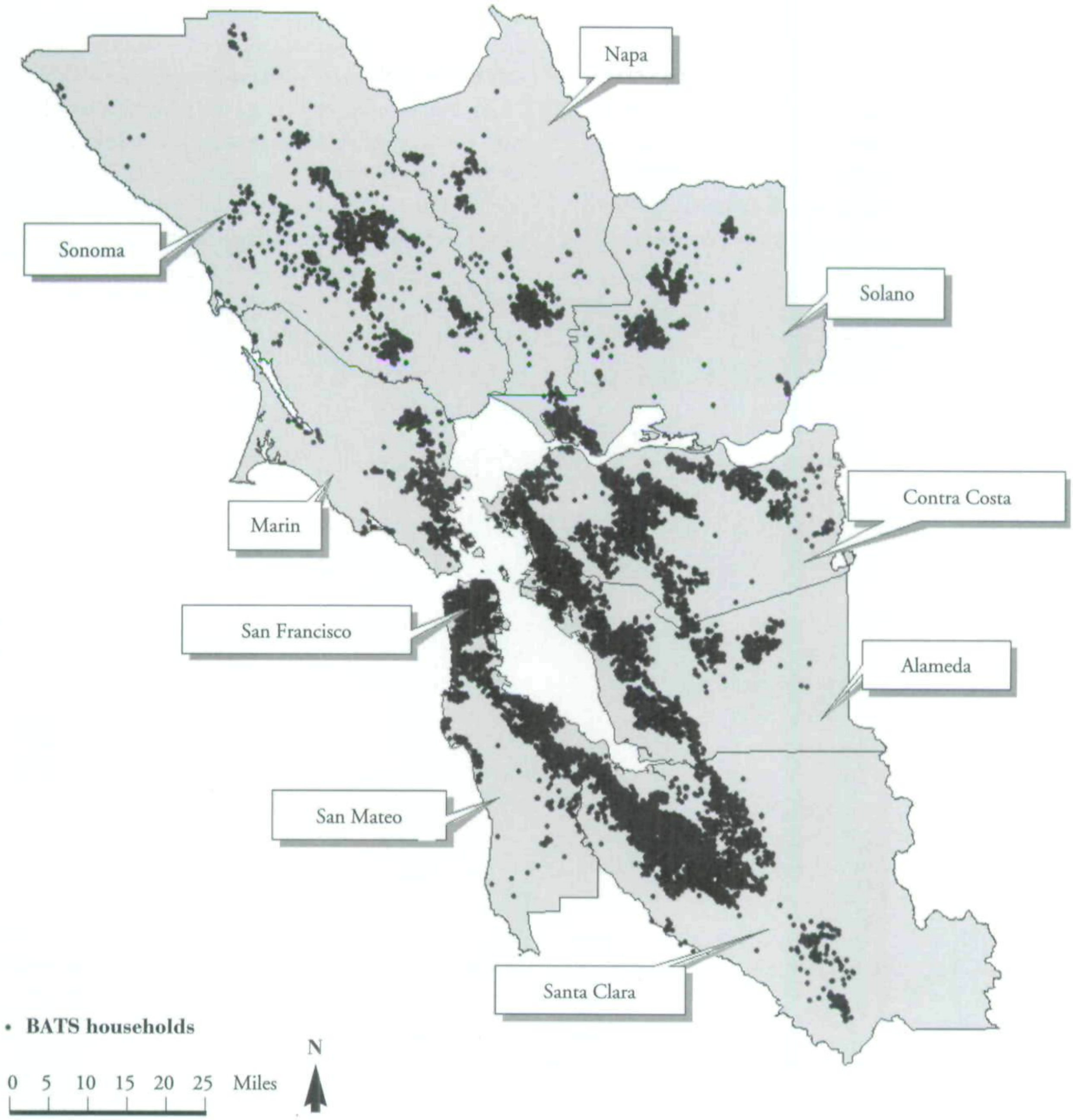

Figure 1. Locations of sampled households in 2000 BATS survey of nine-county San Francisco Bay Area.

Case Context

Exceptionally good data have supported a number of recent studies on jobs-housing balance (Cervero, 1989, 1996a) and land-use mixing (Cervero & Kockelman, 1997; Cervero & Radisch, 1996) in the San Francisco Bay Area, where high housing prices coupled with fiscal competition among municipalities have separated where people live from where they work, and shop. Balanced, mixed-use development is today a high public priority in the area. In recent years, regional planning entities including MTC and ABAG (Association of Bay Area Governments) have joined forces with pro-business organizations like the Santa Clara Valley Manufacturing Association and public-private collaborations like the Bay Area Alliance for Sustainable Communities to pursue jobs-housing balance and traditional neighborhood designs as ways to promote smart growth and economic development.

Accessibility Levels

Figure 2 shows sampled households coded by the number of occupationally matched jobs within four-mile radii of their residential locations in 2000. Households in the highest quartile had more than 31,000 occupationally matched jobs within four miles of their homes, and were concentrated in or near central business districts and the large employment centers ringing the San Francisco Bay, areas rich in white collar jobs. Earlier research findings showed that Bay Area workers in professional-managerial occupations enjoy the highest job access, in part because high housing prices often displace lower-paid employees to outlying neighborhoods (Cervero, Rood, & Appleyard, 1999). This also matches Horner's (2004) observation that job accessibility in Atlanta, Baltimore, and Wichita "tapers

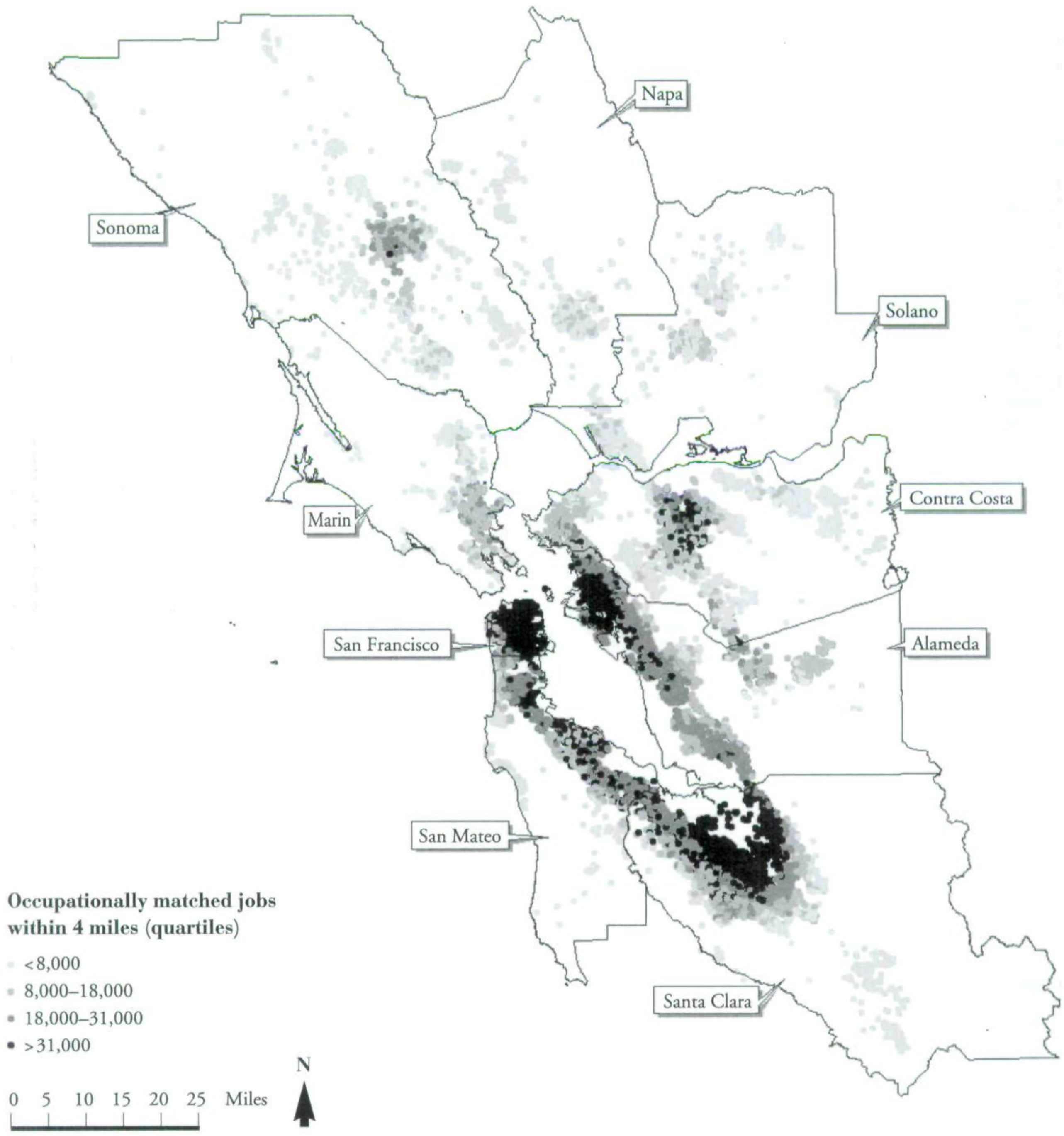

Figure 2. Occupationally matched job accessibility of BATS households, 2000.

off as one moves from the central urban area out toward peripheral locations" (p. 278).

Figure 3 shows a similar, though less pronounced, spatial pattern of access to retail and service activities. Again, those residing in dense urban districts, notably the region's three largest cities (San Jose, San Francisco, and Oakland), enjoy the greatest retail-service access.

Job Accessibility and Travel

This section presents best-fitting regression models that shed light on the influences of job accessibility on the VMT and VHT of work tours. As a spatial metric, job accessibility incorporates the key costs of overcoming distance found in travel-demand models (Harris, 2001). We isolate the effects of job accessibility on journeys to

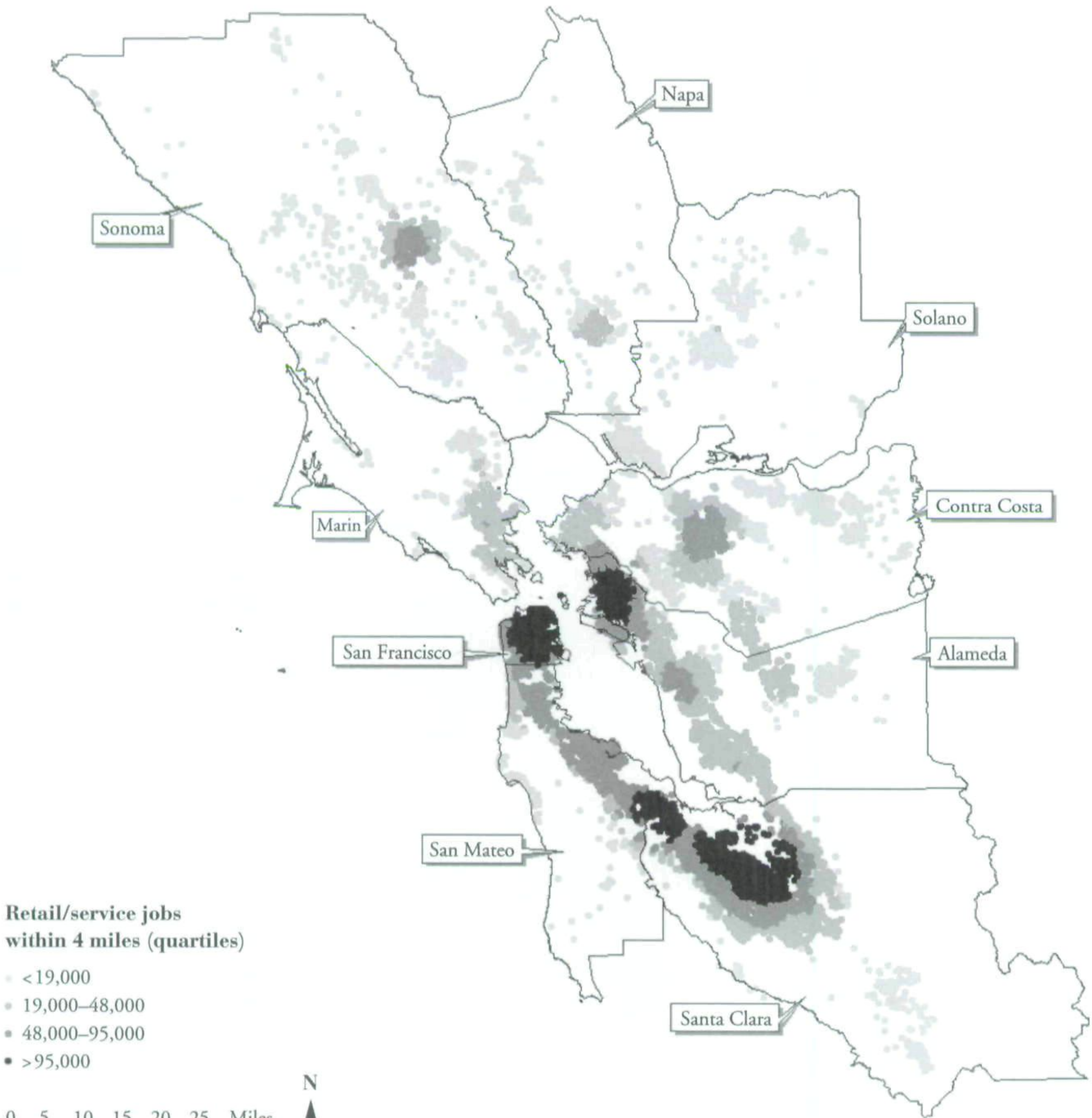

Figure 3. Retail-service accessibility of BATS households, 2000.

work by also controlling for sociodemographic factors (car ownership levels, ethnicity) and workplace policies (flex-time work privileges) consistent with theories of travel behavior (Kanafani, 1983). Table 1 presents all the variables in our regression models along with descriptive statistics. The coefficients of variation suggest that the relative variation in job accessibility and retail-service accessibility are similar. Each estimated coefficient on a variable that is not a dummy represents an elasticity (percent change in the dependent variable given a 1% change in an explanatory variable) because dependent and (nondummy) explanatory variables are expressed in natural logarithms.

Effects on VMT

Table 2 presents two models for estimating work-trip VMT impacts. Model 1 is based on the occupationally matched measure of job accessibility, and Model 2 is based on total employment opportunities (regardless of occupation), allowing us to gauge the usefulness of making the occupational adjustments. While we measured job accessibility indices within radii of 1 to 9 miles around survey respondents' residences, the best-fitting estimates were for 4-mile radii; thus we present only these results.[5]

We found the occupationally matched measure of job accessibility to have the strongest relationship: All things being equal, every 10% increase in the number of jobs in the same occupational category within 4 miles of one's residence is associated with a 3.29% decrease in daily work-tour VMT. All other variables in both models match our expectations: Commute VMT is generally highest for males, those with driver's licenses, those who work in executive/professional occupations, those employed in the private sector and therefore more likely to receive travel allowances (Cervero & Griesenbeck, 1988; Ferguson, 2001), those who own more cars, and those who enjoy flex-time work privileges. Flexible schedules often work against carpooling (Cervero & Griesenbeck, 1988). Coefficients for the other potential control variables were insignificant and were thus not included in the models.

Effects on VHT

Our findings for VHT were similar, as Table 3 shows. Again jobs within a 4-mile radius provided the best fit statistically. The elasticities of VHT with respect to job accessibility were slightly higher than those for VMT. As before, the occupationally matched measure of job accessi-

Table 1. Descriptive statistics: Dependent, policy, and control variables.

	Mean	Standard deviation	Coefficient of variation
Dependent Variables			
Daily work tour VMT	40.45	53.68	1.33
Daily work tour VHT	1.36	1.38	1.01
Daily shopping-services tour VMT	16.92	30.15	1.78
Daily shopping-services tour VHT	0.66	0.80	1.21
Policy Variables (Accessibility)			
Occupationally matched jobs within 4 miles	30,942	40,346	1.30
Total jobs within 4 miles	98,346	115,304	1.17
Retail and service jobs within 4 miles	56,217	67,443	1.20
Control Variables			
Motor vehicles per licensed driver	1.06	0.42	0.40
Driver's license (no = 0, yes = 1)	0.98	0.15	0.15
Personal income > $40,000 per year (no = 0, yes = 1)	0.89	0.31	0.35
Executive/professional employment (no = 0, yes = 1)	0.22	0.42	1.91
Private sector job (no = 0, yes = 1)	0.85	0.36	0.42
Full-time student (no = 0, yes = 1)	0.01	0.04	4.00
Employee flex-time privileges (no = 0, yes = 1)	0.62	0.48	0.77
Age (years)	42.70	12.10	0.28
Latino (no = 0, yes = 1)	0.06	0.23	3.83
Male (no = 0, yes = 1)	0.54	0.50	0.93

Table 2. Models predicting job accessibility's effect on daily work-tour VMT.

	Dependent variable: Vehicle miles traveled (LN)					
	Model 1			Model 2		
	Coeff.	Std. error	Prob.	Coeff.	Std. error	Prob.
Occupationally matched jobs within 4 miles (LN)	−0.329	0.013	.000	—	—	—
Total jobs within 4 miles (LN)	—	—	—	−0.299	0.011	.000
Motor vehicles per licensed driver (LN)	1.101	0.047	.000	1.106	0.047	.000
Driver's license (no = 0, yes = 1)	2.467	0.099	.000	2.488	0.099	.000
Male (no = 0, yes = 1)	0.061	0.030	.041	0.090	0.030	.003
Full-time student (no = 0, yes = 1)	−1.023	0.305	.001	−0.985	0.305	.001
Private sector job (no = 0, yes = 1)	0.247	0.025	.000	0.233	0.024	.001
Executive/professional employment (no = 0, yes = 1)	0.317	0.037	.000	0.126	0.036	.082
Employee flex-time privileges (no = 0, yes = 1)	0.145	0.032	.000	0.152	0.032	.000
Constant	3.234	0.160	.000	3.286	0.163	.000
F (prob.)	544.23 (.000)			344.13 (.000)		
R^2	.188			.188		
N	16,503			16,503		

bility had the greatest predictive power, and control variables were consistent with expectations.

Retail Accessibility and Travel Consumption

We then conducted a similar analysis focusing on the degree to which retail-service accessibility levels influence shopping tour VMT and VHT. As before, we estimated log-linear regression equations and thus the coefficients on variables that are not dummy variables denote elasticities.

Effects on VMT

As with the study of job accessibility, the 4-mile radius provided the best statistical fit for estimating the influences of retail-service accessibility levels on the VMT of tours for shopping and personal services. Table 4 shows the best-fitting results. The partial regression coefficient on our accessibility measure reveals a fairly modest elasticity: Every 10% increase in the number of retail and service jobs within 4 miles of one's residence is associated with a 1.68% reduction in shopping and personal-service VMT, all else being equal. While this elasticity is lower than the one we found for work tours, we obtained a better fitting model overall. The results for our control variables match our expectations: Daily miles logged for shopping and personal services were generally highest for older people, who studies show generally make more single-purpose car trips for shopping (Pucher & Renne, 2003); for non-Latino women, who are similarly more car dependent, in part because of a higher propensity to chain trips (Rosenbloom & Burns, 1994); those with driver's licenses; those who own more cars; and those who have higher income levels.

Effects on VHT

Table 5 shows that the influence of retail-service accessibility on shopping and personal-service VHT was similar in magnitude to that found in the VMT analysis: all else being equal, a doubling of accessibility to retail and service activities was associated with a 13.7% decline in daily hours spent getting to and from shops and consumer-service outlets. The influences of control variables on shopping and personal-service VHT were also similar to the previous model in terms of the sizes and signs of coefficients. This VHT model provided the best overall statistical fit among all models estimated.

Which Reduces Vehicular Travel More?

Since the coefficients of the predictive models represent elasticities, we can compare the effects on travel of access to

Table 3. Models predicting job accessibility's effects on daily work-tour VHT.

	Dependent variable: Vehicle hours traveled (LN)					
	Model 1			Model 2		
	Coeff.	Std. error	Prob.	Coeff.	Std. error	Prob.
Occupationally matched jobs within 4 miles (LN)	−0.338	0.013	.000	—	—	—
Total jobs within 4 miles (LN)	—	—	—	−0.306	0.012	.000
Motor vehicles per licensed driver (LN)	1.101	0.047	.000	1.184	0.051	.000
Driver's license (no = 0, yes = 1)	1.177	0.051	.000	2.725	0.106	.000
Male (no = 0, yes = 1)	0.236	0.032	.000	0.183	0.029	.000
Full-time student (no = 0, yes = 1)	−1.025	0.326	.002	−0.984	0.326	.003
Private sector job (no = 0, yes = 1)	0.247	0.025	.000	0.228	0.026	.000
Executive/professional employment (no = 0, yes = 1)	0.317	0.037	.000	0.104	0.039	.007
Employee flex-time privileges (no = 0, yes = 1)	0.108	0.034	.001	0.118	0.034	.000
Constant	3.937	0.171	.000	3.988	0.174	.000
F (prob.)		544.13 (.000)			539.68 (.000)	
R^2		.188			.186	
N		16,503			16,492	

jobs and access to retail and services. Figure 4 shows that occupationally matched job access had roughly twice the effect of retail-service access on VMT and VHT. However the share of total VMT and VHT devoted to work tours and shopping tours differ. We adjust for this by computing Advantage Indices (AIs), as shown in equations 1 and 2 below, choosing the type of travel that makes up the larger share of VMT (work travel in this case) for the numerator.

Equations 3 and 4 show the results of calculating these advantage indices for VMT and VHT.[6] While elasticities for work tours are considerably higher than those for shopping and service tours, the share of daily VMT and VHT devoted to shopping and personal services is higher. In 2000, an estimated 42.8% of total VMT in the San Francisco Bay Area was for shopping and personal services versus 36.7% for commuting. Thus, access to jobs reduces vehicle miles of travel 72.5% more than access to shopping and services. Similarly, access to jobs reduces personal time spent in travel by vehicle nearly 88% more than access to shopping and services.

$$AI(VMT) = \frac{\left(\frac{\textit{Work tour VMT}}{\textit{Total VMT}}\right) \times (\textit{Elasticity of work tour VMT relative to job-accessibility index})}{\left(\frac{\textit{Shopping tour VMT}}{\textit{Total VMT}}\right) \times (\textit{Elasticity of shopping tour VMT relative to shopping/service-accessibility index})} \tag{1}$$

$$AI(VHT) = \frac{\left(\frac{\textit{Work tour VHT}}{\textit{Total VHT}}\right) \times (\textit{Elasticity of work tour VHT relative to job-accessibility index})}{\left(\frac{\textit{Shopping tour VHT}}{\textit{Total VHT}}\right) \times (\textit{Elasticity of shopping tour VHT relative to shopping/service-accessibility index})} \tag{2}$$

$$AI(VMT) = \frac{(.367) \times (-.338)}{(.428) \times (-.168)} = 1.725 \tag{3}$$

$$AI(VHT) = \frac{(.346) \times (-.329)}{(.443) \times (-.137)} = 1.876 \tag{4}$$

Table 4. Model predicting retail and service accessibility's effect on daily shopping-tour VMT.

	Dependent variable: Vehicle miles traveled (LN)		
	Coeff.	Std. error	Prob.
Retail and service jobs within 4 miles (LN)	−0.168	0.008	.000
Motor vehicles per licensed driver (LN)	0.211	0.040	.000
Driver's license (no = 0, yes = 1)	0.669	0.071	.000
Personal income > $40,000 per year (no = 0, yes = 1)	0.012	0.007	.070
Age (years, LN)	0.218	0.034	.000
Latino (no = 0, yes = 1)	−0.151	0.062	.015
Male (no = 0, yes = 1)	−0.080	0.025	.002
Constant	2.215	0.174	.000
F (prob.)	629.44 (.000)		
R^2	.289		
N	12,405		

Table 5. Model predicting retail and service accessibility's effect on daily shopping-tour VHT.

	Dependent variable: Vehicle hours traveled (LN)		
	Coeff.	Std. error	Prob.
Retail and service jobs within 4 miles (LN)	−0.137	0.009	.000
Motor vehicles per licensed driver (LN)	0.202	0.037	.000
Driver's license (no = 0, yes = 1)	0.631	0.066	.000
Personal income > $40,000 per year (no = 0, yes = 1)	0.010	0.006	.109
Age (years, LN)	0.278	0.031	.000
Latino (no = 0, yes = 1)	−0.141	0.058	.012
Male (no = 0, yes = 1)	−0.098	0.023	.000
Constant	2.795	0.162	.000
F (prob.)	661.35 (.000)		
R^2	.299		
N	12,405		

One caveat is that by our definition, work tours could include trip segments made for nonwork purposes, including shopping. Research shows that shopping trips are often embedded in chained trips (Ma & Goulias, 1997), shopping trips are the most likely type of trip to be chained (Goulias, Pendyala, & Kitamura, 1990; Misra & Bhat, 2000), and shopping trips are the type of trip purpose most often combined with work trips (Kim, Sen, Sööt, & Christopher, 1994). However, according to the BATS data, only 7.1% of the total VMT for work tours were for nonwork travel, suggesting that omitting nonwork travel would not have altered our conclusions much. The same holds for our travel time calculations.

Bringing jobs closer to residences is likely to reduce the distance from home to shopping, as some of the jobs locating close to residences will be retail and service jobs. Thus overall, the evidence is fairly compelling that jobs-housing balance offers more promise for reducing motorized travel than mixing retail and residential land uses.

Spatial Extent of the Effects

Our work also helps gauge the spatial extent of benefits associated with balanced growth and mixed land uses. Since we measured accessibility to jobs within circles of varying radii, the distances associated with the greatest reductions in VMT and VHT can be identified. Figure 5 plots the estimated elasticities for accessibility at distances ranging from 1 to 6 miles, using the regression specifications shown previously in Tables 2 through 5. The lower the point on the graph, the stronger is the relationship. Figure 5 shows that a 4-mile radius for job accessibility was most strongly associated with VMT reduction for work tours, while radii of 3 to 4 miles were most strongly associated with shopping-tour VMT reductions. Patterns were similar for plots of VHT. These thresholds could be of value to planning agencies seeking to identify the appropriate spatial dimensions for monitoring the impacts of mixed land use activities over time.

Local Initiatives to Balance Growth of Jobs and Housing

Moving from the principle to the execution of balanced development can be a huge leap. Some communities have at least taken beginning steps. Palo Alto, CA, for example, has rezoned land from commercial to residential uses and set affordability mandates for new housing in an effort to contain local traffic. Through its Below Market Rate (BMR) program, at least 10% of housing units of

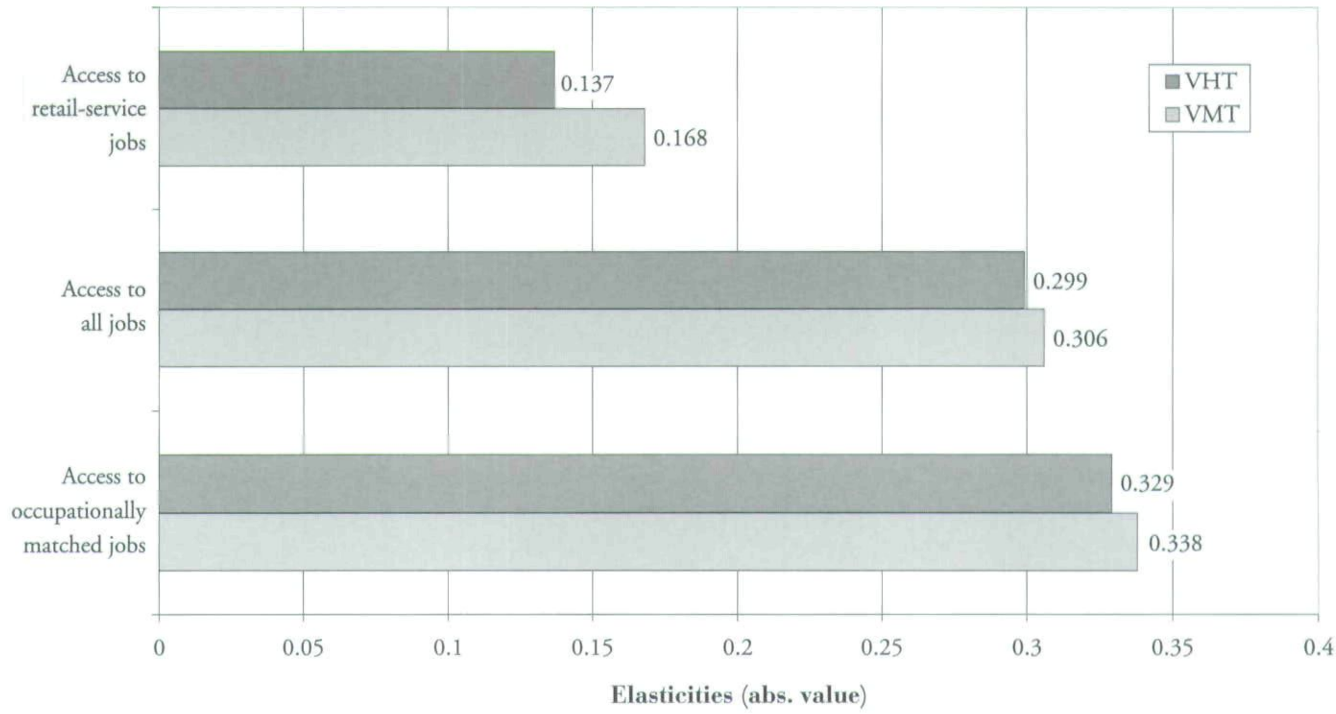

Figure 4. Comparing the elasticities of measures of job and retail-service access with respect to VMT and VHT (in absolute terms).

new developments of 10 or more units must be affordable to low- and moderate-income households. Boulder, CO, has a similar program combined with an aggressive zoning reclassification policy. There, zoning changes have allowed the city to reduce the projected amount of nonresidential development by an estimated 12,000 jobs while increasing new housing units comparably. As two well-to-do university towns with high and steadily rising housing prices, Palo Alto and Boulder are in a better position than most U.S. communities to regulate development and enact inclusionary zoning. While the need to provide housing opportunities for school teachers and firefighters is the primary motivation for imposing affordable housing mandates in such places, the prospect of reducing car traffic is a widely recognized side benefit.

Affordable housing mandates and inclusionary zoning are but a few of a long list of regulatory approaches found in the planning literature and available for communities to move closer to parity in numbers of jobs and housing units (Cervero, 1989; Ewing, 1998; Levine, 1998). Another approach, which requires policy intervention by higher levels of government, is tax-sharing. In theory, this removes the incentive to zone out apartments and other land uses that yield low tax revenues and generate high demand for public services. The Minneapolis–St. Paul region pioneered this approach; however, other smaller areas are also taking steps in this direction. The city of Modesto, CA, and surrounding Stanislaus County, for example, recently entered into an agreement to share 1% of local sales taxes with an eye to increasing this share over time.

In contrast to regulatory approaches like affordable housing mandates and tax-base sharing, some places in the United States have turned to incentive-based policies in seeking balanced growth. Some financial incentives, such as Maryland's Live Near Your Work program, aim to sway the residential location choices of individual households through cash grants. Others, such as California's jobs-housing balance grants, reward communities rich in jobs for zoning for and increasing the supply of housing units. Montgomery County, MD's inclusionary program has something for both individuals and developers who contribute to balanced growth. Residents who work in the County have had priority to buy the more than 15,000 affordable units created to date under Montgomery County's inclusionary housing program. Under the program, developers of 50 or more housing units must sell or lease 12.5% to 15% of the units below market rate. In return, they receive density bonuses of up to 22%.

In nearly built-out Berkeley, CA, the approach to balancing jobs and housing is to create local jobs rather than

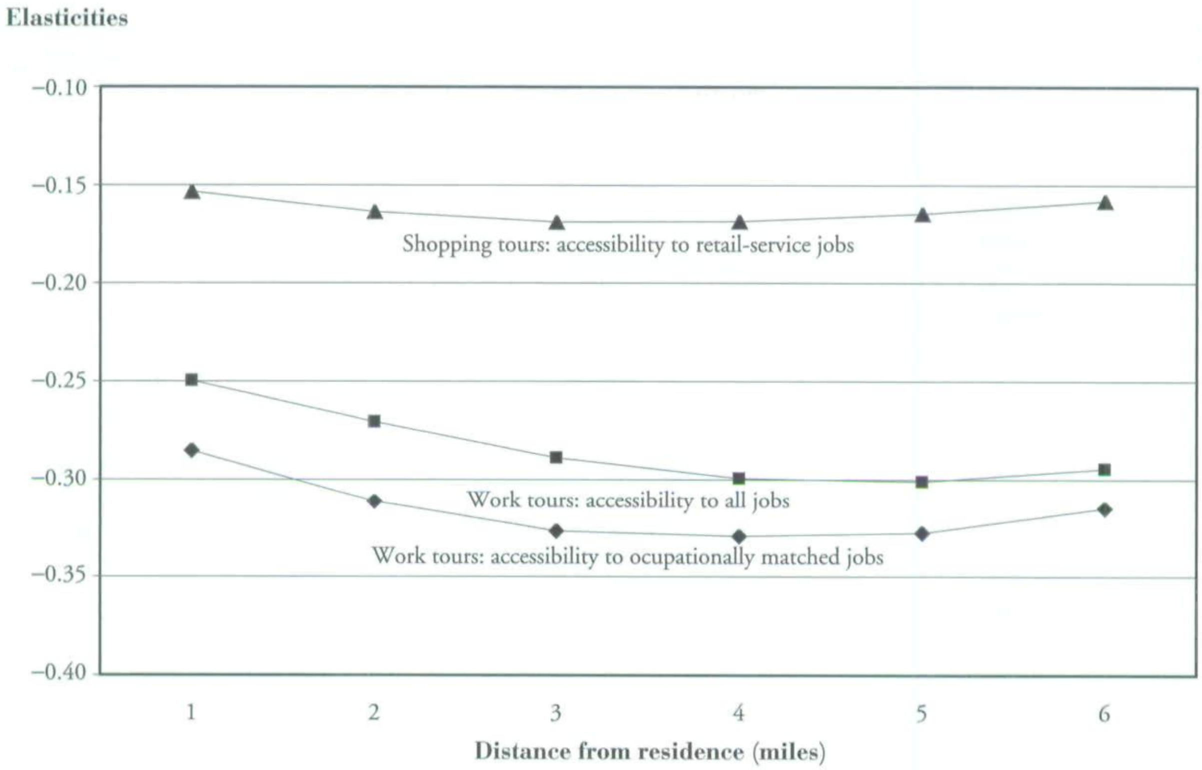

Figure 5. VMT elasticities with respect to accessibility across distance rings.

to develop new housing. The city's First Source program encourages businesses to hire local residents, especially for entry- and intermediate-level jobs, and sponsors vocational training to ensure residents are employment-ready. While the program is voluntary, some 300 businesses have used it to date, placing more than 3,000 city residents in local jobs since it was launched in 1986. When needed, these carrots are matched by sticks, since the city is not shy about negotiating corporate participation in First Source as a condition of approval for development permits.

Supra-Regional Initiatives to Balance Growth of Jobs and Housing

The need to come to grips with the jobs-housing imbalance dilemma in pricey housing markets like the San Francisco Bay Area has never been greater. In the next 25 years, the nine-county Bay Area is expected to add another 2 million people and 1.4 million new jobs. Where these people live and where these jobs are located will indelibly shape the future of the region. If past patterns of housing construction continue, the number of workers commuting into the region will nearly double by 2030. The Regional Livability Footprint Project, sponsored by ABAG, held a series of workshops that challenged participants to envision land-use futures and, with the help of a real-time computer-graphics tool, to examine the influences of land-use assumptions on the future distribution of population and employment. MTC, which controls the region's transportation purse strings, has thrown its weight behind a balanced growth, pro-transit scenario. The agency recently approved a bold but controversial policy that new transit projects will not be funded until cities plan and zone for a minimum number of homes around rail stops.

Institutional reforms that hold promise for more balanced land-use futures are also underway. In California, regional planning boundaries generally do not correspond to those of labor markets, or air- or watersheds. California legislators passed a bill in 2000 that created an inter-regional partnership pilot project to improve the balance of jobs and housing. Five fast-growing counties (Alameda, Contra Costa, Santa Clara, San Joaquin, and Stanislaus), spanning two separate MPOs, formed such a partnership with state funding support. The partnership's first act was to establish a jobs/housing opportunity zone that promotes housing construction in areas rich in jobs, and employment centers in areas well endowed with housing.

Mountain House, a 4,784-acre new town (the first built in California in 20 years) located 50 miles east of San Francisco in San Joaquin County, could be a bellwether. When built out, it is to feature 16,000 housing units, a 120-acre mixed-use town center, and three commercial centers and business parks with as many as 27,000 jobs (Lockwood, 2005). According to developers, this will work out to one local job for each projected working resident. The anticipated wages of the local workers will be monitored to ensure affordable and suitable new housing is built.

Conclusions

Notwithstanding the many obstacles to jobs-housing balance, there is little ambiguity in our findings: Linking jobs and housing holds significant potential to reduce VMT and VHT. These results do not support the thesis (which would pertain mainly to nonwork travel) that enhanced accessibility increases travel by reducing the cost per trip (Crane, 1996). Krizek (2003b) found that people moving to mixed-use neighborhoods with better access to retail employment made more tours following the move (consistent with Crane's arguments), but also had lower daily VMT (consistent with our findings) and made fewer stops per tour. Although the models were not presented in this article, we did find positive correlations between accessibility (across all distance rings) and numbers of tours and trip links (for all purposes), using the BATS database. However, because both work- and shopping-based tours made by those living in accessible locations tend to be shorter, the association between accessibility and the VMT and VHT of tours was negative. In sum, high accessibility, and by extension, balanced, mixed-use growth, reduces total travel, both in distance and in time spent traveling. In the context of the larger debate over the effect land use has on travel, our results are unequivocal: Plentiful jobs within four miles of home significantly reduce VMT and VHT for work trips. That is, jobs-housing balance matters.

Our results are consistent with findings from a recent national study that examined the influences of seven dimensions of land use in 1990 on subsequent changes in commute times in 2000 for a sample of 50 large U.S. urban areas (Sarzynski, Wolman, Galster, & Hanson, 2006). That study found that housing-job proximity was the only built-environment variable negatively and significantly associated with commute time. A mixed-use factor as well as several density variables were positively associated with journey-to-work times, though these relationships were not statistically significant. This study, combined with our own results, suggest that achieving jobs-housing balance is one of the most important ways land-use planning can contribute to reducing motorized travel.

These findings should not be interpreted to mean that siting retail and services near residences is inconsequential from a transportation standpoint or not worth pursuing. There are many sound reasons for encouraging mixed-use development, and we do not advocate pursuing smart-growth policies purely to affect travel. After all, transportation is a means to an end, whether getting to work, purchasing groceries, or visiting a friend. Still, since cities and regions like metropolitan Portland, OR, set VMT containment policies, and most large metropolitan areas suffer serious air-quality problems that are exacerbated by factors like rising VMT and VHT, our findings give credence to using jobs-housing balance as a smart-growth strategy, and help define a spatial context for setting balanced-growth targets. And, of course, there is no reason that a community or region should not pursue both jobs-housing balance and housing-retail-service mixing. The VMT and VHT reduction elasticities we estimated for both policies were well above zero. Because many retail and service trips are linked to work tours, pursuing both strategies could very well yield synergistic benefits in many settings. For example, placing shops and services near workplaces and at neighborhood gateways could induce trip-chaining and more efficient automobile travel. Jobs-housing balance and mixed-use development, we should be reminded, are complementary, not substitute, land-use strategies.

Notes

1. We employed two approaches to measuring accessibility. One measure involved using GIS to define census block groups within a given Euclidean (i.e., straight-line) distance of a BATS respondent's residence. (Block groups provide the most fine-grained geographical units for employment data.) We then summed jobs inside a series of such radii in 1-mile intervals, beginning at 1 mile and going up to 9 miles. For block groups that fell partially within a given radius, we used the proportion of total land area within the radius to impute the share of that block group's job count to include. We also calculated accessibility using network travel distance. Using TAZ-to-TAZ network travel distances provided by MTC, we identified the TAZ of each BATS respondent's residence, and all other TAZs within a specified distance, so that the cumulative count of jobs could be summed. However, TAZs are larger than block groups (4.8 square miles, on average, compared to 1.6 square miles for census block groups). Thus estimating travel distances from the centroids of such large zones can introduce measurement errors depending on how far a respondent's home is from a centroid. Since this approach produced models with slightly weaker predictive powers, we opted to use data from census block groups and Euclidean distances.

2. The professional/management category included the following occupational groupings: finance, computing, mathematics, architecture, engineering, sciences, law, education, arts, sports, and community services. The service/support category included: health care, protective services, food service, personal care, sales, and office-administrative support. The blue-collar category included: building maintenance, construction and excavation, installation and repair, production and manufacturing, and transportation.

3. Some authors have referred to these as "complex work plus maintenance plus leisure" tours (Krizek, 2003a; Reichman, 1976).

4. Others have called these "multi-purpose shopping tours" (Limanond, Niemeier, & Mokhtarian, 2005), or "complex maintenance plus leisure only tours" (Krizek, 2003a).

5. While we present results only for occupancy-adjusted measures of VMT, the results for total (unadjusted) VMT were very similar. The same held for the study of VHT.

6. The results are based on occupationally matched measures of job accessibility.

References

Alonso, W. (1964). *Location and land use.* Cambridge, MA: Harvard University Press.

Boarnet, M. & Crane, R. (2001). *Travel by design: The influences of urban form on travel.* New York: Oxford University Press.

Boarnet, M., & Sarmiento, S. (1998). Can land use policy really affect travel behavior? *Urban Studies, 35*(7), 1155–1169.

Cambridge Systematics, Inc. (1994). *The effects of land use and travel demand management strategies on commuting behavior.* Washington, DC: U.S. Department of Transportation, Technology Sharing Program.

Cervero, R. (1988). Land use mixing and suburban mobility. *Transportation Quarterly, 42*(3), 429–446.

Cervero, R. (1989). Jobs-housing balancing and regional mobility. *Journal of the American Planning Association, 55*(2), 136–150.

Cervero, R. (1991). Land use and travel at suburban activity centers. *Transportation Quarterly, 45*(4), 479–491.

Cervero, R. (1996a). Jobs-housing balance revisited. *Journal of the American Planning Association, 62*(4), 15–42.

Cervero, R. (1996b). Mixed land uses and commuting: Evidence from the American housing survey. *Transportation Research A, 30*(5), 361–377.

Cervero, R., & Griesenbeck, B. (1988) Factors influencing commuting choices in suburban labor markets: A case analysis of Pleasanton, California. *Transportation Research A*, 22 (3), 151–161.

Cervero, R., & Kockelman, K. (1997). Travel demand and the 3Ds: Density, diversity, and design. *Transportation Research* D, *2*(3), 53–62.

Cervero, R., & Radisch, C. (1996). Travel choices in pedestrian versus automobile oriented neighborhoods. *Transport Policy, 3*(3), 135–144.

Cervero, R., Rood, T., & Appleyard, B. (1999). Tracking accessibility: Employment and housing opportunities in the San Francisco Bay area. *Environment and Planning A, 31*(7), 1259–1278.

Cervero, R., & Wu, K. L. (1997). Polycentrism, commuting, and residential location in the San Francisco Bay area. *Environment and Planning A, 29*(5), 865–886.

Cervero, R., & Wu, K. L. (1998). Subcentering and commuting: Evidence from the San Francisco Bay area. *Urban Studies, 35*(7), 1059–1076.

Chapin, F. S. (1957). *Urban land use planning.* New York: Harper Brothers.

Crane, R. (1996). Cars and drivers in the new suburbs: Linking access to travel in neotraditional planning. *Journal of the American Planning Association, 62*(1), 51–65.

Crane, R., & Chatman, D. (2003). As jobs sprawl, wither the commute? *Access, 23*, 14–19.

Crane, R., & Crepeau, R. (1998). Does neighborhood design influence travel? A behavioral analysis of travel diary and GIS data. *Transportation Research D, 3*(4), 225–238.

Dieleman, F., Dijst, M., & Burghouwt, G. (2000). Urban form and travel behavior: Micro-level household attributes and residential context. *Urban Studies, 39*(3), 507–527.

Downs, A. (2004). *Still stuck in traffic: Coping with peak-hour traffic congestion.* Washington, DC: Brookings Institution Press.

Duany, A., Plater-Zybeck, E., & Speck, J. (2002). *Suburban nation: The rise of sprawl and the decline of the American dream.* New York: North Point Press.

Ewing, R. (1995). Beyond density, mode choice, and single-purpose trips. *Transportation Quarterly, 49*(4), 15–24.

Ewing, R. (1996). *Best development practices.* Chicago: APA Press.

Ewing, R. (1998). *Transportation and land use innovations.* Chicago: APA Press.

Ewing, R., & Cervero, R. (2001). Travel and the built environment: A synthesis. *Transportation Research Record, 1780*, 87–113.

Ewing, R., DeAnna, M., & Li, S. C. (1996). Land use impacts on trip generation rates. *Transportation Research Record, 1518*, 1–6.

Ferrell, C. (2004). Home-based teleshoppers and shopping travel: Do teleshoppers travel less? *Transportation Research Record, 1894*, 241–248.

Ferguson, E. (2001). *TDM and Public Policy.* Aldershot, U.K.: Ashgate.

Frank, L., & Pivo, G. (1995). Impacts of mixed use and density on utilization of three modes of travel: Single-occupant vehicle, transit, and walking. *Transportation Research Record, 1466*, 44–52.

Giuliano, G. (1991). Is jobs-housing balancing a transportation issue? *Transportation Research Record, 1305*, 305–312.

Giuliano, G., & Small, K. (1993). Is the journey to work explained by urban spatial structure? *Urban Studies, 30*(9), 1485–1500.

Goulias, K., Pendyala, G., & Kitamura, R. (1990). Practical method for the estimation of trip generation and trip chaining. *Transportation Research Record, 1285*, 47–56.

Greene, D. (2004). Transportation and energy. In S. Hanson & G. Giuliano (Eds.), *The geography of urban transportation* (pp. 274–293). New York: Guilford Press.

Handy, S. (1993). Regional versus local accessibility: Implications for nonwork travel. *Transportation Research Record, 1400*, 58–66.

Handy, S., & Clifton, K. (2001). Evaluating neighborhood accessibility: Possibilities and practicalities. *Journal of Transportation and Statistics, 4*(2/3), 67–78.

Handy, S., & Niemeier, D. A. (1997). Measuring accessibility: An exploration of issues and alternatives. *Environment and Planning A, 29*(7), 1175–1194.

Harris, B. (2001). Accessibility: Concepts and applications. *Journal of Transportation and Statistics, 4*(2/3), 15–30.

Horner, M. (2004). Exploring metropolitan accessibility and urban structure. *Urban Geography, 25*(3), 264–284.

Institute of Transportation Engineers. (2001). *Trip generation handbook.* Washington, DC: Institute of Transportation Engineers.

Kanafani, A. (1983). *Transportation demand analysis.* New York: McGraw-Hill.

Kasturi, T., Sun, X., & Wilmot, C. (1998). Household travel, household characteristics, and land use: An empirical study from the 1994 Portland activity-based travel survey. *Transportation Research Record, 1617*, 10–17.

Kenworthy, J., & Laube, F. (1999). *An international sourcebook of automobile dependence in cities, 1960–1990.* Boulder: University Press of Colorado.

Kim, H., Sen, A., Sööt, S., & Christopher, E. (1994). Shopping trip chains: Current patterns and changes since 1970. *Transportation Research Record, 1443*, 38–44.

Krizek, K. (2003a). Neighborhood services, trip purpose, and tour-based travel, *Transportation, 30*(4), 387–410.

Krizek, K. (2003b). Residential relocation and changes in urban travel: Does neighborhood-scale urban form matter? *Journal of the American Planning Association, 69*(3), 265–281.

Levine, J. (1992). Decentralization of jobs and emerging suburban commute. *Transportation Research Record, 1364*, 71–80.

Levine, J. (1998). Rethinking accessibility and jobs-housing balance. *Journal of the American Planning Association, 64*(2), 133–149.

Levinson, D., & Kumar, A. (1994). The rational locator: Why travel times have remained stable. *Journal of the American Planning Association, 60*(3), 319–332.

Liminond, T., Niemeier, D., & Mokhtarian, P. (2005). Specification of a tour-based neighborhood shopping model. *Transportation, 32*(2), 105–134.

Lockwood, C. (2005). Mountain house. *Urban Land, 64*(5), 90–95.

Ma, J., & Goulias, K. (1997). *An analysis of activity and travel patterns in the Puget Sound transportation panel.* Oxford: Pergamon.

Miller, E., & Ibrahim, A. (1998). Urban form and vehicular travel: Some empirical findings. *Transportation Research Record, 1617*, 18–27.

Misra, R., & Bhat, C. (2000). Activity-travel patterns of nonworkers in the San Francisco Bay area: Exploratory analysis. *Transportation Research Record, 1718*, 43–51.

Mitchell, R., & Rapkin, C. (1954). *Urban traffic—A function of land use.* New York: Columbia University Press.

Peng, Z. R. (1997). The jobs-housing balance and urban commuting. *Urban Studies, 34*(9), 1215–1235.

Pucher, J. & Renne, J. (2003). Socio-economics of urban travel: Evidence from 2001 NHTS. *Transportation Quarterly, 57*(3), 49–78.

Reichman, S. (1976). Travel adjustments and life styles: A behavior approach. In P. Stopher & A. Meyburg (Eds.), *Behavioral travel-demand models* (pp. 143–152). Lexington, MA: Lexington Books.

Rosenbloom, S. & Burns, E. (1994). Why working women drive alone: Implications for travel reduction programs. *Transportation Research Record, 1459*, 39–45.

Rutherford, S., McCormack, E., & Wilkinson, M. (1996). Travel impacts of urban form: Implications from an analysis of two Seattle area travel diaries. *Proceedings from TMIP Conference on Urban Design, Telecommunicating, and Travel Behavior* (p. 21). Washington, DC: U.S. Department of Transportation, Federal Highway Administration.

Sarzynski, A., Wolman, H., Galster, G. & Hanson, R. (2006). Testing the conventional wisdom about land use and traffic congestion: The more we sprawl, the less we move? *Urban Studies, 43*(3), 601–626.

Stead, D. (2001). Relationships between land use, socio-economic factors, and travel patterns in Britain. *Environment and Planning B, 28*(4): 499–528.

Thill, J., & Thomas, I. (1987). Toward conceptualizing trip-chaining behavior: A review. *Geographical Analysis, 19*(1), 1–17.

U.S. Department of Transportation, Bureau of Transportation Statistics. (2003). *National Household Travel Survey 2001 highlights report* (BTS03-05). Washington, DC.

Wachs, M., Taylor, B., Levine, N., & Ong, P. (1993). The change in commute: A case study of the jobs-housing relationship over time. *Urban Studies, 30*(10), 1711–1729.