UCI-ITS-WP-91-1

Is the Journey to Work Explained by Urban Structure?

UCI-ITS-WP-91-1

Genevieve Giuliano [1]
Kenneth A. Small [2]

[1] Department of Urban and Regional Planning, University of Southern California
Los Angeles, California 90089, U.S.A., giuliano@usc.edu

[2] Department of Economics and
Institute of Transportation Studies, University of California, Irvine
Irvine, California 92697-3600, U.S.A., ksmall@uci.edu

January 1991

Institute of Transportation Studies
University of California, Irvine
Irvine, CA 92697-3600, U.S.A.
http://www.its.uci.edu

Is the Journey to Work Explained by Urban Structure?

Genevieve Giuliano

Urban and Regional Planning
University of Southern California

Kenneth A. Small

Department of Economics
University of California at Irvine

Working Paper, No. 107

The University of California Transportation Center
University of California at Berkeley

1. INTRODUCTION

The length of the urban work trip, and especially how it is influenced by land-use patterns, have become critical issues for urban economic theory and for public policy toward transportation and land use. Many economic models and policy analyses hinge on the belief that land-use patterns affect commuting importantly; yet the empirical evidence for this belief is weak. In this paper, we use disaggregate data for a very large urban region to examine this key relationship anew.

The standard model of urban economics (e.g. Mills 1972) relies on a basic assumption about household behavior: that choice among residential locations is determined primarily by a tradeoff between commuting cost and land cost. This assumption, which we term "cost minimization," has come under increasing criticism. Evidence is accumulating that in modern cities the effects of commuting cost are swamped by variations in household characteristics, preferences, and locational amenties (Wheaton 1979; Lowry 1988; Giuliano 1989). Furthermore, direct comparisons of actual commuting distances or times with those implied by some version of the standard model reveal a huge discrepancy: people live much further from their place of work than the standard model would predict, even when controlling for the actual distribution of jobs and for people's preferences for amenities. These studies are reviewed in the next section.

Public policy has also begun to focus on the relationship between commuting distance and the locational patterns of job sites and housing units. Increased congestion, particularly in suburban areas, has been linked to numerical imbalances and mismatches between jobs and housing (Cervero 1989a; Downs 1989). Imbalances occur when the number of workers who can be housed in an area differs substantially from the number of jobs there. Mismatches occur when prices or other characteristics make housing in the area unsuitable for the workers who hold jobs there. Both make inter-area commutes necessary. Proposed remedies include far-reaching policies to promote *jobs-housing balance* by redirecting new employment and housing at a metropolitan-wide scale (e.g. Southern California Association of Governments 1988).

These theoretical and policy issues are conveniently linked by the concept of the *required commute*, i.e., the minimum average commute required by the actual spacial patterns of housing units and job sites. *Excess commuting* is simply the difference between the average actual commute and the required commute. These concepts, devised mainly to test the standard theoretical model, also provide both an objective measure of jobs-housing imbalance and a rigorous framework for defining mismatches.

We examine excess commuting using disaggregate data in a larger and more dispersed region than has been analyzed before: the urbanized portion of the five-county Los Angeles region. Our data include 1980 journey-to-work information for 1146 zones. We first demonstrate the existence of substantial excess commuting for the overall region. We then examine excess commuting at the level of subareas, and at the level of individual employment centers. Finally, we examine whether this excess commuting is caused by mismatches between the locations of jobs for specific occupational groups and the locations of houses suitable for members of those groups.

The results suggest that commuting distance and time are not very sensitive to variations in urban structure, and are far in excess of what can be explained by jobs-housing imbalances, even when occupational mismatches are accounted for. We conclude that the behavioral assumption of cost minimization in the standard model is inadequate to explain commuting, and that large-scale changes in urban structure designed to promote jobs-housing balance would have only small effects on commuting.

2. PRIOR RESEARCH

The literature on jobs-housing balance and that on excess commuting provide two approaches, quite different on the surface, to the question of how urban structure affects commuting. We review each in turn.

2.1 Jobs-Housing Balance

Most discussions of jobs-housing balance have been anecdotal, documenting cases where housing is inadequate or expensive near regions of high employment, so that workers are drawn from a wide area. Giuliano (1991) reviews much of this evidence, finding it less than fully persuasive. She demonstrates that most municipalities are balanced; that subregional imbalances caused by rapid growth tend to disappear over time; and that commuting trips seem only tenuously related to such imbalances when they occur. Furthermore, the definition of affordable housing used in this literature has often been oversimplified by assuming just one worker per household and one household per housing unit.

Nowlan and Stewart (1991) examine the effects of reducing jobs-housing imbalance where it is greatest: the central city core. They find that although substantial new office construction occured in central Toronto between 1975 and 1988, much of its impact on peak-hour work trips entering the area was offset by accelerated housing construction. The implication is that a large portion of newly constructed central housing was occupied by people working there, a fact borne out by a separate survey which they report (p. 174). How large an effect this had on the average commute distance for the region is not known.

Cervero (1989a, 1989b) attempts to provide more systematic evidence that serious jobs-housing imbalances exist in suburban areas and cause long commutes. He relies especially on two cross-sectional studies, one of census tracts in the San Francisco Bay Area in 1980, the other of 18 to 26 suburban employment centers from all over the United States.

Using the Bay Area data, Cervero estimates a gravity-type model to explain interzonal commute flows. He finds that a census tract with high employment draws more workers from outside its boundaries if: (1) it has little land zoned for residential use, and (2) it has a high housing cost. The first finding should be no surprise: if housing has been excluded from an employment area, the workers obviously must be commuting from somewhere else. The second finding is misleading because high housing cost is endogenous: the scarcity of housing in jobs-rich areas will itself drive up housing prices, which therefore are not demonstrated to be an independent cause of long commutes. In any case, census tracts are small areas, so we learn little from this about why commuting distances average more than a few miles.

Cervero's nationwide cross section is based on data from selected suburban employment sites covering a wide range of sizes and types. Using stepwide regression, he finds that a high ratio of jobs to on-site housing units lowers the percentage of work trips made by walking and cycling, and raises the level of congestion on nearby expressways. However, a more appropriate jobs-housing ratio would be for the area surrounding the employment center, not just the center itself. Furthermore, stepwise regression can produce spurious findings by excluding pertinent variables. Finally, the estimated coefficients are barely significant at a conventional significance level, and would almost surely become insignificant if the estimated standard errors were adjusted for the "data mining" inherent in stepwise regression (as suggested, for example, by Lovell 1983).

Except for central Toronto, then, the case for jobs-housing balance having an imortant influence on commuting distances or times has not been made; and nowhere has it been made on a metropolitan-wide bases.

2.2 Excess ("Wasteful") Commuting

Hamilton (1982) investigates how well our knowledge of urban structure alone can predict average commuting distance. He does so in the context of the standard monocentric model of urban economics. Hamilton measures exponentially declining density functions for employment and population, and uses them to calculate the average distance from home to work of commuters who follow the behavioral dictates of the model. Using data from 14 U.S. metropolitan areas, he finds this distance to be 1.12 miles, compared to an average actual commuting distance of 8.7 miles. Hence 87 percent of actual commuting is excess ("wasteful" in Hamilton's terminology) in the sense of being unexplained by the standard monocentric model. For 27 Japanese cities, the explained distance is 1.83 miles compared to an actual between 6 and 8 miles.

Hamilton's method does not determine whether this excess commuting contradicts monocentricity or cost minimization. The latter is the more fundamental assumption to urban economics, and it can be tested independently. To see how, observe that in the standard urban model, freely adjustable capital and housing prices guarantee that individual households, each minimizing its housing plus commuting cost, will achieve an equilibrium with no cross-commuting: i.e., one which minimizes aggregate commuting cost given the distributions of housing and job locations.[1] White (1988) tests this implication in isolation, by applying a linear program to the existing distribution of housing and job locations, reassigning workers to housing locations so as to minimize average commuting cost. That is, the assignment algorithm minimizes the quantity

$$Z = \sum_{i} \sum_{j} c_{ij} X_{ij} \tag{1}$$

subject to the constraints

$$\sum_{i} X_{ij} = D_j \,, \qquad \sum_{j} X_{ij} = O_i \,, \qquad X_{ij} \geq 0 \,, \qquad \text{for every } i,j \,, \tag{2}$$

where X_{ij} is the number of workers commuting from zone i to zone j, c_{ij} is the corresponding travel cost (either time or distance), D_j is the employment in zone j, and O_i is the number of workers residing in zone i. We can approximate c_{ij} by the average time or distance for observed commutes between the two zones, or within one zone in the case of c_{ii}. The minimized value of Z, divided by the number of workers, is the required commute.

Using 25 U.S. metropolitan areas and measuring commuting cost by travel time, White finds the average required commute to be 20.0 minutes, compared to the average actual commute of 22.5 minutes, for an excess commute of only 11 percent. Hamilton (1989), using the same technique except based on distance,

---

[1]This is demonstrated by the linear programming formulation of Herbert and Stevens (1960), as amended by Wheaton (1974) and interpreted by Senior and Wilson (1974). (See Los 1979, pp. 1246-1248, or Berechman and Small 1988, pp. 1292-1294, for a concise summary.) The equilibrium conditions for individual households minimizing housing plus commuting cost emerge as the first-order conditions of a linear program which minimizes aggregate commuting cost.

finds an excess commute of 47 percent for Boston. However, Small and Song (1992) show that the level of aggregation in White's and Hamilton's data greatly bias these calculations against finding excess commuting. They find find an excess commute of 66 percent using time and 69 percent using distance, based on disaggregate data for Los Angeles County. (They also verify Hamilton's (1982) finding of an even larger excess commute relative to a monocentric model.)

Cropper and Gordon (1991) extend White's approach to account for mismatches between households and housing characteristics. They do this by estimating a hedonic utility function as part of a logit model of location choice, using a sample of households from the Baltimore area. The required commute is then calculated by applying the above procedure to the housing and job locations represented in this sample, but for two cases: one with just constraint (2), the other with the additional constraint that no household's predicted utility may be decreased through reassignment. Homeowners and renters are treated as separate populations. The matching constraint makes a difference of less than one mile in the required commute, so it does not appear that mismatches between the characteristics of households and those of available houses add much to jobs-housing imbalance. Even with the matching constraint applied, excess commuting is more than 50 percent.

A different way of accounting for mismatches is used by Hamburg et al. (1965), who apply this same assignment algorithm to the Buffalo metropolitan area, constraining the reassignments to be within population segments based on household income, race, and auto availability. They find that the actual commute is two to three times the required commute, and conclude that job location has only a limited influence on housing-location choice.

There are, then, a number of published calculations on excess commuting, covering a wide variety of methods, types of metropolitan areas, and times. Table 1 summarizes them. It seems clear that commuting is vastly longer than predicted by the monocentric model with dispersed employment. Even taking the actual urban structure as given, however, it appears that commuting is two to three times as large as can be accounted for by the behavioral assumption of cost minimization. This is true whether commuting cost is measured by time or distance, and whether or not a constraint is placed on the assignment process to represent housing preferences, type of ownership, race, or income.

3. EMPIRICAL RESULTS FOR THE LOS ANGELES REGION

Our study area contains most of the urbanized portion of the United States' second largest Consolidated Metropolitan Statistical Area.[2] The region, containing 10.6 million people and 4.6 million jobs in 1980, is well known for its sprawl and its pattern of suburban subcenters (Frieden 1961; Gordon et al. 1986; Heikkila et al. 1989; Giuliano and Small 1991). These traits, along with very high housing prices near many job centers, create the potential for long required commutes. Hence if large-scale jobs-housing imbalances are important anywhere, it should be here.

We use 1980 journey-to-work data coded to geographic units known as transportation analysis zones, as defined by the Southern California

---

[3]The Los Angeles Consolidated Metropolitan Statistical Area consists of four Primary Metropolitan Statistical Areas (PMSAs). The largest PMSA is Los Angeles County; it was formerly classified as the Los Angeles—Long Beach Standard Metropolitan Statistical Area (SMSA) and is the area used in the other studies cited that include Los Angeles (including Small and Song 1992, who use a subset of the data used in this study). The other three PMSAs are: Anaheim—Santa Ana—Garden Grove (Orange County), San Bernardino—Riverside (San Bernardino and Riverside Counties), and Oxnard—Ventura (Ventura County).

Association of Governments (SCAG). Our data set includes 1146 zones,[3] and is extracted from the data created for the Urban Transportation Planning Package (UTPP). The data include aggregate zone-to-zone commute flows, and some aggregate characteristics of workers by zone of employment. These data are supplemented by estimates of inter- and intra-zonal distances and peak-period travel times on the highway network, provided by SCAG and generated by its transportation network model; these are the sources of our c_{ij}. Note that just as with White's data, our intra-zonal costs c_{ii} do not necessarily reflect an optimized situation; but since our zones are small, it does not matter very much.

Our data portray a region with a wide variety of urban environments and many employment subcenters, described more fully in Giuliano and Small (1991). Despite the region's sprawl, its central area retains a dominant influence. This is indicated by the sheer size of the employment centers at and near downtown Los Angeles, and by the steep decline in employment and population densities as one moves away from downtown. The central area is very densely developed, with employment concentrated along a corridor extending westward from the Los Angeles central business district some 20 miles to the Pacific Ocean. Adjacent to it are suburban areas with much lower densities but still a great deal of employment: the San Fernando Valley to the northwest, the older communities of Los Angeles County to the south and east, and Orange County further to the south. The more remote and less developed counties of Riverside, San Bernardino, and Ventura are lower still in density and were not closely integrated into the region in 1980.

[3]Thirty-three of them have no employment, so are excluded when we report trips by place of employment.

Figure 1 shows four subareas in Los Angeles County, whose boundaries we have chosen for the present study to roughly maximize the proportion of commuting that takes place within subareas. Together with the other four counties, this gives us a total of eight subareas across which to examine variations in jobs-housing balance and commuting patterns. We also examine variations across the 32 major employment centers identified by Giuliano and Small (1991). For this purpose, an employment center is defined as the largest set of contiguous zones, each with gross employment density at least 10 per acre, that contains at least 10,000 employees (7,000 in the three outer counties). These centers, shown by size rank in Figure 1, contain almost one-third of the region's employment.

Table 2 presents some summary statistics for the eight subareas.[4] We see that job sites are substantially more concentrated in Central Los Angeles County than are workers' residences, implying a general in-commuting pattern. All the other subareas, in contrast, have some excess of resident workers over jobs, generally the more so the less developed the subarea.

3.1 Required and Actual Commutes: Regionwide Optimization

The results of applying the assignment algorithm developed by Hamburg et al. (1965) and White (1988), described in the previous section, are shown in Table 3. Taking peak-period travel time on the UTPP highway network as representing commuting cost, the regionwide optimization yields a required regionwide average commute of just 8.4 minutes, leaving unexplained nearly

---

[4]These statistics are compiled from the origin-destination matrix in the UTPP data files. There are small discrepancies with the numbers in the resident summary file and the employment summary file, which are used in Giuliano and Small (1991) and in section 3.4 of this paper.

two-thirds of the actual commute of 23.0 minutes (last row of the table). This verifies the findings of most other such studies: a large fraction of commuting cannot be explained by the sheer geographical imbalances in current locations of housing and jobs. Using distance to represent cost yields a similar result (last column).

The other rows of the table compare required to actual commute for employees working in each of the subareas. These are simply the disaggregated components of the regionwide optimization results; the optimization is not repeated for each separate subarea. Hence, the finding of a required average commute of 5.2 minutes for northeast Los Angeles (L.A.) County means that in the cost-minimizing pattern for the entire region, people holding jobs in that subarea would commute an average of 5.2 minutes one way.

As expected, the required commute tends to be higher where the ratio of resident workers to jobs is low. Only in central L. A. County, however, is the jobs-housing imbalance so great as to increase required commuting time above the 5-7 minutes range. Orange County has the second highest required commute, just under 7 minutes.

The actual average commute to each of these areas shows a somewhat similar but less precise relationship to worker-jobs ratio. For example, the actual average commute to jobs in central L. A. County, which is jobs-rich, is high; but it is just as high in northwest L. A. County, which is jobs-poor. Actual commutes to the other counties do tend to be shorter than to Los Angeles County. What is most striking, however, is that the average commuting time to each subarea is at least twice as large as it would be in the cost-minimizing pattern, and in most cases more than three times as large.

3.2 The Effects of Employment Centers

The results for central L. A. County conform to expectations regarding commutes to employment concentrations. Employment centers must draw workers from surrounding areas, thus requiring longer commute trips than would be the case for employment that is distributed in concert with the population. The effect of employment concentration is further identified by dividing our sample into jobs located in employment centers and jobs located outside employment centers. Table 4 gives the results. Employment centers clearly require longer commutes, ranging from 9 to 20 minutes, than do zones outside centers, where required commutes are only 3 to 6 minutes. Actual commutes, however, are only slightly longer to centers than to noncenters in most subareas – in fact, they are shorter in two of the outer counties. Overall, required commutes are more than three times longer to centers than elsewhere, whereas actual commutes are just 23 percent longer to centers than elsewhere.

Table 5 lists the required and actual commute to jobs in each center. Actual commutes are much longer than required commutes in most cases,[5] and show far less variation across the region. The important exception is the downtown Los Angeles employment center, where the actual commute is only 4.0 minutes longer than required by its heavy concentration of jobs (469,000 in a 20-square-mile area.

It is clear from these results that the polycentric pattern of employment

---

[5]Actual commutes to two centers, Oxnard (Ventura County) and Fullerton (Orange County), are <u>shorter</u> than what would occur in a regionwide optimization. This is possible because the optimization criterion is regionwide, hence need not minimize commuting for just the limited set of workers commuting to any one center. Detailed analysis of the flows to both Oxnard and Fullerton reveals that in the regionwide cost-minimizing pattern, the center draws its workers solely from residential zones on the side away from downton Los Angeles, whereas in the actual pattern it draws more evenly from all nearby zones. In other words, there is substantial outward commuting that does not occur in the cost-minimizing pattern.m

centers, along with the dispersal of many jobs outside of centers altogether, creates the potential for shorter commutes than those experienced by people working in downtown Los Angeles. However, commuters are taking little advantage of this potential, choosing instead to commute only a few minutes less that downtown workers. At the same time, given the size of the region, commutes are clearly much shorter than they would be if workers chose randomly among all avaiable housing locations. One must conclude that commuting costs affect residential location choices somewhat, but are far from the sole consideration.

3.3 The Special role of Central Los Angeles County

These results show that central L. A. County is quite different from other parts of the region. It has a substantially longer required commute than other subareas, and a longer actual commute than all but one of the other subareas. These facts appear to be caused primarily by its containing the region's largest employment center, downtown Los Angeles, which has the longest required commute (though not the longest actual commute) of any employment center. By way of contrast, the other eleven employment centers in this subarea, including the second, third, and fourth largest in the region, do not stand out as having unusual commuting patterns.

As a further check, we computed an alternative measure of jobs-housing balance by repeating the optimization of the previous section eight times, once for each subarea, each time minimizing transportation cost only for commutes to jobs in that subarea. That is, we computed the shortest average commute that could be achieved by people working within that subarea regardless of the effect on other subareas' commutes. We found that this lowered the required commutes shown in Table 3 by only a minute or so except for central L. A. County, where it lowered it by 4.0 minutes. This indicates that there are enough residents living in or near central L. A. County so that its jobs could be filled with an average commute of only 8.6 minutes. The average commute to its twelve employment centers (including downtown Los Angeles) falls more than six minutes, to 12.3, using this calculation. Hence the long required commutes to these job centers result not only from insufficient nearby housing, but also from the existence of jobs outside the Central L. A. subarea that absorb many of the workers who live in that housing.

3.4 Mismatches: The Effects of an Occupational Constraint

Our results thus far corroborate those of previous studies showing that the structure of job and residential distributions do not account for the amount of commuting we observe. We turn now to the issue of mismatches between worker and housing characteristics. Are such mismatches preventing workers from achieving the lower commuting times that our calculations have shown are compatible with the existing urban structure?

We can address this question by adding additional constraints to the cost minimization of equations (1)-(2). Although the mismatch most commonly cited involves income level, it is very difficult to define accurately the relationship between observed incomes and feasible housing prices. Indeed, this is one of the chief weaknesses of the literature on jobs-housing balance. We therefore turn to occupation as a proxy for income level, and apply a rather stringent constraint on occupational groups: namely, that the only houses feasible for a given worker are those currently occupied by members of the same occupational group. There are seven occupational groups identified in our data, so adding this constraint amounts to doing the cost minimization seven times, once for each group.[6]

The results are shown in Table 6. Introducing the occupational constraint raises the average required commute to 10.3 minutes, an increase of 22 percent. Interestingly, this increase is of similar magnitude to that resulting from the quite different constraint applied by Cropper and Gordon (1991). Hence mismatches could lengthen commutes some, but more than half of the average commute time remains unexplained.

Differences in the required commute across occupational categories are moderate and do not appear to be related to income or status. In particular, these figures provide no support for the belief that lower-paid workers are forced into long commutes by lack of suitable housing near their jobs. Such instances may occur, but they do not dominate the regional averages; on the contrary, it is the higher-paid administrative and technical workers whose required commutes are slightly longer.

Of course, there are many other ways that mismatches could be taken into account. However, each of them is to some extent arbitrary, because in reality people have options to alter their consumption patterns rather than accept constraints as absolute. This is illustrated by the high proportion of income spent on housing in some coastal areas in California.

---

[6]Thurston and Yezer (1991) also use these seven occupational groups to represent heterogeneity among workers. However, they do so within a monocentric model, so there is nothing analagous to our matching constraint; rather, the different results they get when distinguishing occupations are due solely to differences in the estimated monocentric density functions associated with each occupational group. These in turn reflect differences in estimation errors, not the effects of heterogeneity on jobs-housing imbalances.

3.5 Explaining Intraregional Variations in Commuting Time

Our results show that actual commuting times and distances in the Los Angeles region are far greater than necessary given the intermixing of jobs and houses, either overall or within occupational categories. Nevertheless, they may be influenced by this degree of intermixing. In this section, we examine this question through simple regressions explaining actual commuting time.

Regression (1) in Table 7 uses the subarea as the unit of analysis. It confirms our earlier observation of a negative relationship between the worker/job ratio and average commuting time. However, the size of the coefficient is not very large, indicating that an increase in the ratio by 0.2 (for example, from 0.8 to 1.0) lowers commuting time by only three minutes.If instead jobs/housing balance is measured by the required commute, it has no discernable effect at the subarea level (regression not shown).

Regression (2) uses the employment center as the unit of analysis (excluding the three subcenters in the outermost counties), and portrays the relationship in the data of Table 5. In this case the required commute does have a statistically significant relationship with actual commute, but it is weak: a 4-minute reduction in required commute cuts just one minute from the actual commute. If the three outer centers are included, the relationship disappears (not shown).

Regressions (3)-(6) attempt to explain average commuting time to each zone by various measures of jobs-housing imbalance. One measure is the required commute to that zone, which automatically takes account of the surrounding area through the workings of the linear programming algorithm. Another measure is the worker-jobs ratio, computed alternately for the entire subarea in which the zone is located and for a smaller area known a Regional Statistical Area (RSA). (SCAG has defined 33 RSAs for our study area.)

The results show a clear relationship between both measures of jobs-housing imbalance and commuting time to zones. Comparing regressions (3) and (4), we see that the broader measure of worker-jobs ratio, that of the subarea, has more explanatory power than the narrower measure. This may indicate that the relevant region for jobs-housing balance is quite large.

To test whether regression (3) is just reflecting the difference between central Los Angeles and the rest of the region, we add in regression (5) a dummy variable for those zones in the central L.A. County subarea. The coefficient is insignificant and of unexpected sign, and other coefficients are little affected. The same is true if the dummy variable includes just those zones in the downtown L.A. employment center (regression not shown).

Finally, regression (6) allows for nonlinearity in the influence of required commute time. Nonlinearity is apparent, but explanatory power is little improved. This equation suggests that the marginal effect of required commute time t_R on actual commute time t is $\partial t/\partial t_R = 0.570\text{-}0.0168t_R$, which is 0.49, 0.43, and 0.30, respectively, for required commutes typical of noncenters (4.7 minutes), all zones (8.4 minutes), and centers (16.3 minutes). This is a larger influence than that in regressions (2)-(4), but still not large enough suggest major effects of changes in jobs-housing balance.

Regression results explaining commuting distance were similar to the results explaning commute time, but with poorer fit, and thus are not shown here.

4. CONCLUSION

These results, then, suggest that jobs-housing balance, whether measured by the ratio of resident workers per job in a broad subarea or by the required commuting time, has a statistically significant but not very large influence on actual commuting times. The main exception is that the extreme imbalances of the downtown Los Angeles employment center does increase commuting times.

Consequently, policies that attempt to alter the metropolitan-wide structure of urban land use, even if successful in changing the degree of jobs-housing balance, are likely to have disappointing impacts on commuting patterns. This is because they do not address the main sources of dispersion in location patterns. Neither does the standard economic analysis of urban location, which relies upon the tradeoff between land costs and commuting costs as the primary determinant of residential location.

Why does the journey to work play only a limited role in residential location choice? We cannot say from our data, but we can offer a few hypotheses. First, perhaps commuting time is not very onerous for short trips, serving instead as a psychological buffer between home and work activities; there is some evidence for this in a modal choice study by Ben-Akiva and Lerman (1985, pp. 174-177). Second, rapid job turnover and high moving costs may cause households to seek accessibility to an array of possible future jobs rather than just the current job. Third, job heterogeneity may prevent two-worker households from finding jobs close together, making it impossible for both workers to have short commutes. Fourth, the increasing importance of non-work trips (Richardson et al. 1991) modifies the tradeoff between land and transportation costs. Fifth, urban residents may care about such a variety of housing and neighborhood characteristics that transportation costs are simply overshadowed in importance by other priorities.

All of these hypotheses are consistent with the view that commuting costs matter in location decisions. It is no accident that urban areas have grown up with a high degree of intermixing of jobs and housing of various types, nor that most commutes are shorter than 30 minutes even in an area as large as Los Angeles. At the margin, however, it does not appear that people will respond to land-use or transportation policies as though minimizing commuting costs were their dominant consideration.

Figure 1
The Los Angeles Region

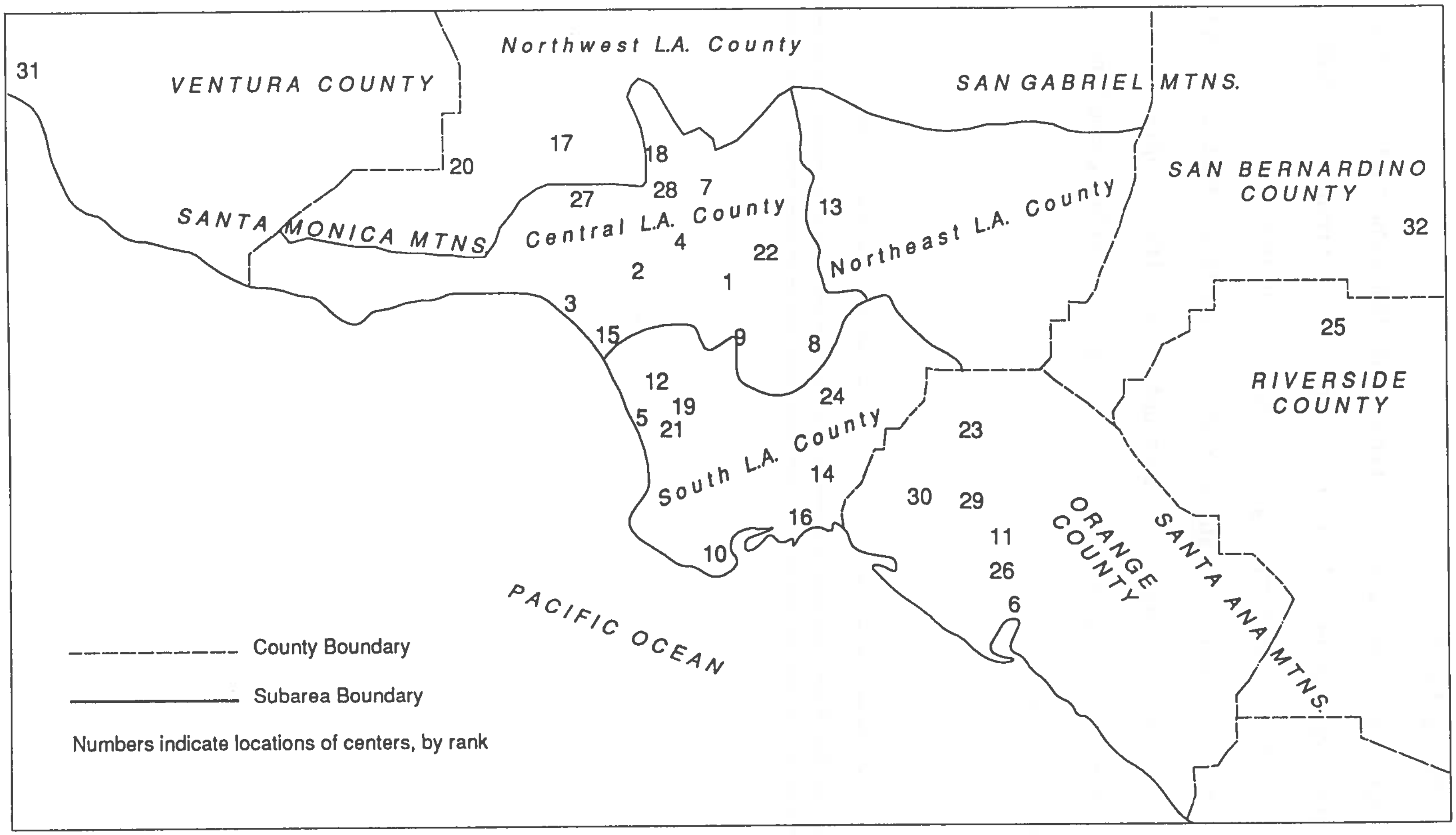

Table 1
Summary of Prior Studies of Excess Commuting

Author	Data	Case	Results		
			Required Commute	Actual Commute	% Excess
A. Calculations Assuming Monocentricity					
Hamilton (1982)	14 U.S. metro areas		1.12 mi.	8.7 mi.	87.1
Hamilton (1982)	27 Japanese cities		1.83 mi.	6-8 mi.	70-77
Small and Song (1992)	Los Angeles – Long Beach metro area	Min. Dist. Min. Time	2.16 mi. 3.59 min.	10.03 mi. 22.06 min.	78.5 83.7
B. Calculations Using Actual Urban Structure and Highway Network					
Hamburg et al. (1965)	Buffalo metro area	Low Income Med. Income High Income	3.8 min. 5.0 min. 6.9 min.	11.7 min. 14.0 min. 15.8 min.	67.5 64.3 56.3
White (1988)	25 U.S. metro areas		20.0 min.	22.5 min.	11.1
Hamilton (1989)	Boston metro area		4.82 mi.	9.11 mi.	47.1
Cropper & Gordon (1991)	Baltimore metro area	Unconstrained: Owners Renters Constrained: Owners Renters	 4.39 mi. 3.65 mi. 5.04 mi. 4.17 mi.	Approx. 10.2 mi.	Approx 50-64
Small and Song (1992)	Los Angeles – Long Beach metro area	Min. Dist. Min. Time	3.10 mi. 7.59 min.	10.03 mi. 22.06 min.	69.1 65.6

Table 2
Summary Statistics: Los Angeles Region, 1980

Subarea	Job's (1,000's)	Population (1,000's)	Resident Workers/Job[a]
Central L.A. County	1,603	2,862	0.78
South L.A. County	890	2,013	1.01
Northwest L.A. County	356	905	1.16
Northeast L.A. County	466	1,402	1.27
L.A. County Total	3,315	7,183	0.95
Orange County	872	1,902	1.08
Riverside County	103	321	1.14
San Bernardino County	194	648	1.23
Ventura County	102	509	1.31
Region Total	4,587	10,563	1.00

[a] Resident workers means employed persons by place of residence

Table 3
Required and Actual Mean Commutes:
Regionwide Unconstrained Optimization

Subarea	Resident workers per job	Based on Commute Time			Based on commute distance
		Required (minutes)	Actual (minutes)	Excess (%)	Excess (%)
Central L.A. Co.	0.78	12.63	25.30	50.1	53.3
South L.A. Co.	1.01	6.61	23.61	72.0	76.3
Northwest L.A. Co.	1.16	5.09	25.50	80.0	78.5
Northeast L.A. Co.	1.27	5.16	20.04	74.3	77.2
L. A. County Total	0.95	9.15	24.13	62.1	65.2
Orange County	1.08	6.95	21.25	67.3	70.6
Riverside County	1.14	5.34	17.89	70.2	75.4
San Bernardino Co.	1.23	5.75	17.52	67.2	62.8
Ventura County	1.31	5.50	16.07	65.8	69.9
Region Total	1.00	8.42	22.98	63.4	66.3

Table 4
Required and Actual Mean Commutes:
Regionwide Unconstrained Optimization, Centers versus Noncenters

Subarea	% of jobs in centers	Average commute time to jobs in centers			Average commute time to jobs not in centers		
		Required (minutes)	Actual (minutes)	Excess (%)	Required (minutes)	Actual (minutes)	Excess (%)
Central L.A. Co.	60.4	18.65	26.76	30.3	3.44	23.08	85.1
South L.A. Co.	27.4	11.37	28.32	59.9	4.81	21.83	78.0
Northwest L.A. Co.	15.7	8.88	26.83	66.9	4.39	25.25	82.6
Northeast L.A. Co.	7.6	9.02	20.88	56.8	4.84	19.97	75.8
L. A. County Total	39.3	16.61	26.89	38.2	4.32	22.33	80.7
Orange County	15.5	14.02	23.56	40.5	5.65	20.83	72.9
Riverside County	12.9	9.62	16.34	41.1	4.70	18.12	74.1
San Bernardino Co.	3.6	14.18	17.63	19.6	5.43	17.52	69.0
Ventura County	8.1	19.90	14.72	-35.2[a]	4.24	16.19	73.8
Region Total	32.0	16.31	26.38	38.2	4.71	21.38	78.0

[a]A negative excess commute for a given center can occur because the optimization is carried out for the entire region. See text, note 6.

Table 5
Required and Actual Commute Time by Job Center

Rank (by employment)	Name	Required Commute	Actual Commute
Central L.A. County			
1	Downtown L.A.	24.99	28.99
2	L.A. West	16.89	24.51
3	Santa Monica	6.57	22.31
4	Hollywood	10.02	24.32
7	Glendale	8.30	20.49
8	Commerce	15.65	26.24
9	Vernon/Hunting.Park	11.46	27.92
15	Marina Del Rey	3.81	27.98
18	Burbank Airport	20.91	27.30
22	L.A. East	21.62	28.72
27	Sherman Oaks	7.65	24.64
28	Burbank SW	8.72	22.45
South L.A. County			
5	L.A. Airport	14.78	30.26
10	San Pedro	20.61	38.61
12	Inglewood	6.91	26.05
14	Long Beach Airport	12.16	25.44
16	Long Beach	6.03	22.81
19	Hawthorne	4.34	24.03
21	Lawndale	5.83	25.40
24	Downey	8.96	26.19
Northwest L.A. County			
17	Van Nuys Airport	11.86	28.11
20	Canoga Pk/Warner Ctr	5.08	26.50
Northeast L.A. County			
13	Pasadena	9.02	20.88
Orange County			
6	Orange Co. Airport	20.63	26.01
11	Santa Ana	8.25	21.83
23	Fullerton	24.04	21.74
26	Santa Ana So.	5.82	21.90
29	Anah/Orange/Gar.Grv	6.55	24.23
30	Gar.Grv/Stanton	7.39	22.98
Riverside County			
25	Riverside	9.62	16.34
San Bernardino County			
32	San Bernardino	14.18	17.63
Ventura County			
31	Oxnard	19.90	14.72

Table 6
Required Travel Times: Regionwide Constrained Optimization, by Occupation

Occupational Category	Percent of Workers	Average required commute time (minutes)
Administrative	25.70	11.69
Technical	3.16	11.88
Sales	10.62	9.72
Clerical	19.41	9.92
Craft	28.23	10.07
Service	11.64	8.16
Farm	1.23	11.38
All Occupations	100.0	10.27

Table 7
Regressions Explaining Intraregional Variations in Commuting Time

Regression number	(1)	(2)	(3)	(4)	(5)	(6)
Type of observation	Sub-area	Job center	Zone	Zone	Zone	Zone
Number of observations	8	29	1113	1113	1113	1113
Regression coefficient:						
Constant	38.1** (6.9)	22.6** (1.3)	29.99** (0.77)	22.59** (0.47)	32.59** (1.72)	29.62** (0.76)
Required commute time		0.25** (0.10)	0.279** (0.022)	0.282** (0.024)	0.281** (0.022)	0.570** (0.052)
Required commute time squared						-0.0084** (0.0014)
Resident workers per job in subarea	-15.4** (6.1)		-9.95** (0.71)		-12.18** (1.50)	-10.35** (0.70)
Resident workers per job in RSA				-2.69** (0.37)		
Dummy for central L.A. Co. subarea					-1.05 (0.62)	
Standard error of regression	2.7	3.3	4.4	4.6	4.4	4.3
Coefficient of determination (R^2)	0.52	0.20	0.27	0.18	0.27	0.29

** Significant at 5% level, two-tailed test
RSA = Regional Statistical Area (smaller than a subarea)

REFERENCES

Ben-Akiva, M., and S.R. Lerman (1985), Discrete Choice Analysis: Theory and Application to Travel Demand. Cambridge, Mass.: M.I.T. Press.

Berechman, J., and K.A. Small (1988), Modeling land use and transportation: an interpretive review for growth areas (Research policy and review 25), Environment and Planning A, 20, 1285-1309.

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

Cervero, R. (1989b), America's Suburban Centers: The Land Use-Transportation Link. Boston: Unwin Hyman.

Cropper, M. and P. Gordon (1991), Wasteful commuting: A re-examination. Journal of Urban Economics, 29(1), 2-13.

Downs, A. (1989), The Need for a New Vision for the Development of Large U.S. Metropolitan Areas. New York: Brookings Institution.

Frieden, Bernard J. (1961), Locational Preferences in the Urban Housing Market, Journal of the American Institute of Planners 27, 316-324.

Giuliano, G. (1989), New directions for understanding transportation and land use, Environment and Planning A, 21, 145-159.

Giuliano, G. and K. Small (1991), Subcenters in the Los Angeles region, Journal of Regional Science and Urban Economics, 21, 163-182.

Gordon, P., H. Richardson and H. Wong (1986), The distribution of population and employment inn a polycentric city: the case of Los Angeles. Environment and Planning A, 18A, 161-173.

Hamburg, J., C. Guinn, and G. Lathrop (1965), Linear programming test of journey to work minimization, Highway Research Record, 102, 67-75.

Hamilton, B. (1982), Wasteful commuting, Journal of Political Economy, 90, 1035-1053.

Hamilton, B. (1989), Wasteful commuting again, Journal of Political Economy, 97, 1498-1504.

Heikkila, E., P. Gordon, J. Kim, R. Peiser, H. Richardson, and D. Dale-Johnson (1989), What happened to the CBD distance gradient?: Land values in a polycentric city. Environment and PLanning A, 21A, 221-232.

Herbert, John D., and Benjamin H. Stevens (1960), A model for the distribution of residential activity in urban areas, Journal of Regional Science, 2(2), 21-36.

Los, M. (1979), Combined residential-location and transportation models, Environment and Planning A, 11, 1241-1265.

Lovell, Michael C. (1983), "Data Mining" Review of Economics and Statistics, 65, pp. 1-12.

Lowry, I. (1988), Planning for urban sprawl, in Looking Ahead: The Year 2000, Transportation Research Board Special Report 221, 275-312.

Mills, Edwin S. (1972), Studies in the structure of the urban economy. Baltimore: Johns Hopkins Press.

Nowlan, D. and G. Stewart (1991), "Downtown population growth and commuting trips", Journal of the American Planning Association, 57(2), 165-182.

Richardson, H., P. Gordon, and Y. Choi (1991), Tests of the standard urban model: A micro (trade-off) alternative, unpublished paper. School of Urban and Regional Planning, University of Southern California, Los Angeles, CA.

Senior, M.L., and A.G. Wilson (1974), Explorations and syntheses of linear programming and spatial interaction models of residential location, Geographical Analysis, 6, 209-238.

Small, Kenneth A., and Shunfeng Song (1992), "'Wasteful' Commuting: A Resolution," Journal of Political Economy, 100 (forthcoming August).

Southern California Association of Governments (1988), Growth Management Plan. Los Angeles, CA: Southern California Association of Governments.

Thurston, Lawrence, and Anthony M. Yezer (1991), Testing the Monocentric Urban Model: Evidence Based on Wasteful Commuting, Journal of the American Real Estate and urban Economics Association, 19, 41-51.

Wheaton, William C. (1974), Linear programming and locational equilibrium: The Herbert-Stevens model revisited, Journal of Urban Economics, 1, 278-287.

Wheaton, William C. (1979), Monocentric Models of Urban Land Use: Contributions and Criticisms, in Peter Mieszkowski and Mahlon Straszheim, eds., Current Issues in Urban Economics, 107-129. Baltimore: Johns Hopkins.

White, M. (1988), Urban commuting journeys are not 'wasteful', Journal of Political Economy, 96, 1097-1110.