

## Chapter 9

### Implications

This section will interpret the results of the analyses in the preceding chapters in concert with one another. Assessing all of the analyses together should clarify the understanding of the influence that economic centers have on household travel time and whether households that choose housing in sprawling developments (i.e., with less access to economic centers) do so at a cost of added travel time.

First, the implications of the results of the three models of household travel time will be assessed. The analysis of joined trips will be considered to determine whether joined trips explain variations in household travel time with access to centers. Lastly, the rent gradient estimation will be considered with particular attention being given to the consistency of the estimated gradient with the results of the models of household travel times. Whether the rent gradient is explained by household travel times will be considered. Whether joined trips explain any discrepancy between the findings concerning household travel times and the rent gradient will be considered. The analysis will attempt to reconcile the results of the three different analyses. The overall focus will be to determine whether sprawl – or low density suburban development with dispersed economic activity – imposes a travel time cost on its residents.

### Introduction

A coherent description of the influence of access to economic centers on household travel time is obtained from the results. As may be expected, in the city household travel time appears to be independent of access to subcenters. With the economic activity of the central business district close by subcenters appear to have little influence on households' travel. In the suburbs, however, the sprawl of the dispersal of economic activity from the central business district to subcenters has a clear leveling effect lowering household travel times, particularly to the west of the central business district. Areas to the east, where less dispersal of economic activity has occurred, have consistently higher predicted household travel times. These results suggest that the sprawl of business development provides a significant travel benefit to the area's residents (at least those in close proximity to the sprawl of business). The results of the

household travel time estimation for the outlying areas reinforce the interpretation of the results. In the outlying areas households appear to reduce travel time by living more distant from the central business district. Travel times, however, increase with income. These two results together suggest that those households in these areas that are dependent on the metropolitan economy travel the most to access the activity in the metropolitan area. Together the results are consistent with the economic theory that households in the outlying areas that choose to access the metropolitan area economic activity locate as close to the metropolitan area as possible. Instead of working in the rural economy these households undertake more travel than other people in the outlying areas to obtain the higher incomes found in the metropolitan economy.

The results suggest that in the developed suburbs (areas within an hour of the central business district) the dispersal of businesses beyond subcenters have also helped households to reduce travel time. This is evident from examining the rise in household travel time with the loss of access to the central business district and the nearest subcenter. In no case does the estimated rise in total household travel time equal the added time to a round trip to either the central business district or the nearest subcenter. In most areas it is far less than the time added to a round trip. The determination of economic centers showed that significant economic activity takes place in the area immediately surrounding centers. Economic activity is also widely dispersed throughout the metropolitan area. Households with less access to centers likely utilize the economic activity outside of centers and closer to their homes thereby minimizing the time added to their travel by their choice of locations with less center access.

A possible explanation for finding that household travel does not increase greatly with loss of access to economic centers is that households join trips. Households with less access to the economic activity found in centers are able to reduce time spent in travel by accessing multiple destinations on a single trip from home. The results of the joined trips estimation suggest that part of the reduction in household travel times occurs because households more distant from the city join more trips. This may occur in part because the lower densities found in areas removed from economic activity facilitate the use of joined trips.

The estimated rent gradient supports the conclusion that house prices do indeed increase with access to economic centers. The gradient, however, indicates that housing prices are far more dependent on access to the central business district than to other economic centers. A comparison of the estimated rent gradient with the results of the household travel time estimation suggests that economic theory may not accurately portray the relationship between household travel time and housing prices. The results instead suggest that while housing prices are consistent with a monocentric city form in which prices are primarily an increasing function of access to the central business district. Household travel time, on the other hand, is highly dependent on access to economic activity in and around subcenters. This finding lends to the conclusion that households do in fact realize a travel time gain from living in areas of disperse economic activity, which is not wholly reflected in the housing prices. In the area of subcenters households appear to save on household travel with little added to their housing price.

Considered together the results have several social implications. Most importantly, the sprawl of businesses in suburban areas appears to help households to limit time spent in travel. Households in suburban areas with a subcenter close by obtain travel time savings. This benefit does not, however, extend to outlying areas more than one hour from the central business district.

Greater auto use appears to reduce household travel time both directly and through the use of joined trips. Travel times were found to fall in all areas with increased auto use. The use of joined trips was found to increase with increased auto use. This finding suggests that the automobile facilitates reduction in household travel time by enabling people to travel more quickly and flexibly.

An important, yet not obvious, implication becomes apparent on comparing the map of the subcenters with the demographic maps. Most of the Washington, D.C. metropolitan area's subcenters are located to the west of the city proper. Areas with high concentrations of minority and low income households are predominantly to the east of the city proper. Consequently, the benefits of the dispersal of economic activity from the central business district and other economic centers do not appear to be realized by these predominantly low income and minority areas. The cause of this disparity cannot be decisively attributed. The Metro system appears to serve these areas well. Major road

access to the city center from the east, however, appears to be less comprehensive than from the west. This may be, in part, due to the inability of these households to afford auto transportation. In any case, the travel time benefits of the sprawl of business development have not reached all households. Instead the benefits seem to be disproportionately realized by households in areas composed of nonminority, middle and upper income households.

### *The Effects of Centers on Household Travel Time*

The results of all three empirical models of household travel time reveal a reduction in household travel times with improved access to economic centers. To develop a clear understanding of the implications of these results, it is helpful to first briefly examine the metropolitan area in parts – studying each model independently - then reconstruct those parts to obtain an understanding of the results as a whole.

Mean household travel time is lowest for households in the city sample. Within the city proper household travel times vary only with travel time to the central business district. Not surprisingly, other economic centers have no influence on household travel times of city residents. Residents appear to depend on economic activity in the city and to be independent of subcenters. More surprising is the lack of influence of other predictable determinants of household travel times, especially income. These results suggest that travel does not increase with income in the city as it does in the suburbs and that city residents have better access to all levels of the services and jobs. Additionally, travel constraints on low income residents may be overcome by the more accessible public transportation system of the city. If the goal of urban planning is simply to minimize household travel times, concentrating all development in a single, dense, mixed use urban center may accomplish that end. To do so, however, would be to ignore housing preferences.

If households are to be accorded the right to satisfy preferences by choosing housing in less dense forms, the suburban and outlying areas models must be considered. In the suburbs immediately surrounding the centers reduction in household travel times attributable to improved access to subcenters becomes discernable. Predicted travel times in the suburban model vary greatly depending on accessibility of the nearest subcenter.

The reduction in household travel times resulting from improved access to subcenters is best understood if the western and eastern suburbs are examined separately and then compared. The influence of subcenters on household travel times is especially strong in areas where multiple subcenters are clustered in close proximity to one another. By comparing these areas with areas more removed from the central business district and subcenters, the influence of subcenter access on household travel times becomes apparent. Household travel times rise as access to economic centers worsens reaching levels about one-half hour greater than those found close to the centers. This variation in household travel times suggests the urban form predicted by the limited polycentric model. Yet, the approximately one-half hour difference in household travel times is less than twenty five percent of the average household travel time for the sample. The eastern suburbs present an altogether different image spatial distribution of household travel times in the city. The graph of predicted household travel times is clearly centered at the central business district and rises sharply outward in the suburbs. As a result of the absence of subcenters, in the eastern suburbs predicted household travel times rise much faster with the decline in access of the central business district than do predicted travel times to the west. In the north and south, where some subcenter influence is perceptible, travel times are almost one hour less than those of households most removed from the central business district and subcenters in the extreme east. The shape of the graph of household travel times in the east supports the travel time conclusions of the traditional monocentric theory. In the suburban model the benefits to household travel times of the dispersion of economic activity are evident. Substantially lower predicted household travel times, both in and immediately surrounding the subcenters, show that the dispersal of economic activity to subcenters has allowed households in the suburbs to reduce time spent in travel.

Mean household travel time in the outlying areas is the highest in the metropolitan area. Access to the central business district was found to be a significant determinant of household travel times in the outlying areas model. Since subcenters were found to exert no influence on predicted travel times, household travel times decline uniformly with decreasing access to the central business district at the metropolitan fringe. Although travel times fall (rather than rise as might be expected) as one moves from the central business district the results are consistent with the logic of the monocentric model. As a city grows

and transportation systems are extended at the city's edge, fringe areas undergo a gradual conversion from rural to urban in both uses and population from the inside out. This conversion is implicit when effects of the income parameter and access parameter on household travel time are considered together. The increase in predicted travel time with household income suggests that residents of the outlying areas that are dependent on the higher paying metropolitan economy do so at a cost of greater travel time. The decrease in household travel time with decreasing access to the central business district suggests that the number of households that interact with the metropolitan economy declines with distance to the central business district.

The absence of influence of subcenters on household travel time in these areas suggests that the dispersion of development inside of the fringe has little influence on travel time of households residing at the fringe. Despite the differences in economic activity in the eastern and the western suburbs, households at the fringe on both sides of the city share the same travel burden. So, although development outside the center reduces travel times of households in the developed suburbs once at the fringe the dispersal of activity outside the central business district seems irrelevant. A possible explanation is that the lack of influence of subcenters on household travel times at the fringe suggests that congestion around subcenters may be an equivalent hinderance to travel as the extended trip to the central business district through areas of less dispersed economic activity.

When considered collectively, the models suggest that access to economic centers (including subcenters) influence household travel times in the Washington D.C. metropolitan area. The disparity between the eastern and western sides of the city in the suburban model show that areas lacking substantial economic activity bears substantially larger household travel time burdens. Interestingly, the benefit of that activity has limited reach. Results of the outlying areas model show that the travel time benefits of polycentricity do not extend to areas in transition from a rural environment to a suburban environment. Residents of those outlying areas desiring to obtain the benefits of the metropolitan area must bear similar travel burdens whether they travel through areas without economic activity to the central business district or into polycentric areas of disperse economic activity.

### *The Dispersion of Activity Beyond Subcenters and Household Travel Time*

The finding that household travel time is an increasing function of travel time to the nearest subcenter suggests that those centers reduce household travel time. Contrasting the eastern and western suburbs reinforces the conclusion that household travel times are reduced by the dispersal of economic activity from the central business district to subcenters. However, whether dispersal of economic activity beyond subcenters reduces household travel time is not obvious.

Although access to economic centers reduces household travel time the relationship between household travel time and time to access centers is always less than two-to-one (and at times less than one-to-one). This is the case even when combining the influences of access to the central business district and access to the nearest subcenter. In other words, in the worst case a household that chooses a housing location from which it takes both fifteen minutes more to access the central business district and fifteen minutes more to access the nearest subcenter adds less than thirty minutes to its predicted household travel time. So, choosing a housing location further from an economic center adds less to a household's travel time than would be added to a round trip to either center. This strongly suggests that the dispersal of economic activity from centers saves on travel time of suburban residents.

Prior to reaching that conclusion the possible explanations for the less than two-to-one relationship are worth considering. In any case, it implies that household's more distant from centers take less trips to centers. As already suggested, households more distant from centers may choose traveling to alternative locations over traveling to the central business district or a subcenter. Over sixty percent of all metropolitan area jobs are located outside of the economic centers used in this study. Identifying subcenters using lower employment density and total employment thresholds over forty-five percent of all jobs are located outside of economic centers. At the lower thresholds subcenters expand significantly in size suggesting that significant economic activity in the areas immediately surrounding subcenters. New subcenters are also identified both in close proximity to previously identified subcenters and in other areas altogether. This dispersion of activity presents people with two alternatives for reducing travel. They may travel toward a center accessing facilities in close proximity to the center without ever

accessing the center itself. Alternatively, people may travel to facilities in disperse locations removed from or unrelated to the centers. Clearly, the dispersion of economic activity has enabled households to reduce their time spent in travel. An alternative way to reduce the number of trips to centers is by joining trips.<sup>1</sup>

#### *The Relationship Between Joined Trips and Travel Time to Centers*

The analysis of joined trips found that the use of joined trips decreases with both the improvement of access to the central business district and the improvement of access to the nearest subcenter. This result supports the conclusion that economic centers continue to be important to households and to influence household travel behavior. By joining trips people reduce the travel time needed to access the locations that they desire. The increase in the use of joined trips as access to centers declines suggests that people value access to centers even if they are using the joined trip to access locations outside of centers. This is because the increase in joined trips shows that people need to use joined trips to reduce travel time that would be added with a location further from concentrations of economic activity.

The use of joined trips suggests that value of access to centers shown by travel times may not be equivalent to that shown by housing prices. If people have found a way to reduce the travel burden that comes with poorer access to economic centers, travel time may under estimate the value that people place on access to centers. This may be determined by examining the estimated rent gradient. Comparison of the rent gradient with the results of the travel time estimation should show whether differences in travel time measure of the value that people place on access to economic centers.

#### *The Relationship between the Rent Gradient and Household Travel Times*

The theory underlying rent gradients is that the value of a particular housing location is determined by the access that location provides to economic centers. Parcels

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<sup>1</sup> A third way that households may reduce the number of trips they take to centers is by taking less trips overall. Households with poorer access to centers may simply choose to travel to fewer destinations. This would simply be a reflection people's preferences. In this analysis, the trade off observed is that people that wish to access economic activity

decrease in price as the time needed to access economic centers rises because residents are thought to be forced to spend more time in travel to obtain the goods and services concentrated at those centers. The gradient is a reflection of the value that people place on living close to centers and according to theory should correspond closely to household travel times. Comparison of the results of the analysis of household travel times and the estimated rent gradient will provide a clearer understanding of the value that people place on access to centers. If the gradient does not correspond closely to predicted travel times people have either found alternative destinations at which to obtain the goods and services that they desire or have found ways in which to reduce the travel time necessary to access centers.

The estimated gradient falls sharply in all directions with declining access to the central business district. Although subcenters are statistically significant in the estimated gradient, the increase in house prices with improved access to the nearest subcenter is minor in comparison to the increase in house price with improved access to the central business district. The increase in prices attributable to subcenter access is greatest in the northwest where multiple subcenters are located. A comparison of the graph of the gradient and the graph of predicted household travel times from the suburban model reveals that the magnitude of differences in house prices is far greater than the difference in predicted travel times. At the extreme, directly east of the city, the predicted price of the mean house drops by almost one half with a decline of access to the central business district of three-quarters of an hour. Over the same range and in the same direction the predicted travel time of the mean household increases by only one seventh. The large disparity suggests that households value a housing location with good access to centers (particularly the central business district) but that households that choose locations with less access to centers have indeed found ways to minimize travel time regardless of their loss of center access. In addition, a comparison of changes in predicted housing prices and changes in predicted household travel time with changes in center access suggests that choosing housing removed from centers may be cost saving. The marginal time

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choose to live closer to centers. Those with less preference for travelling to economic activity choose to live further from the centers.

added to the household travel seems insignificant in light of the change in housing price realized by choosing a location with less center access.

The rent gradient suggests that people place a high premium on access to the central business district and that subcenter access has a minor but detectable influence on prices. The graph of travel times, on the other hand, suggests that people's travel times are dependent on access to the central business district or a nearby subcenter. In terms of reducing household travel time, access to either a subcenter or the central business district will reduce household travel time. The upshot is that people have found ways to keep travel times down that are not reflected in the rent gradient. Dispersal of economic activity to the subcenters is obviously one influence.

The advantage of subcenters is apparent when comparing the predicted travel times for locations to the east of the city with locations to the west of the city that have the same predicted house prices. Comparing households that pay equal prices for housing, households to the east, where there are no subcenters, are predicted to have higher household travel times than households to the west of the city. Even though travel times rise as subcenter access worsens, the amount of that rise does not attain the level that would be predicted by examining the rent gradient alone. The difference suggests that people have been able to substitute activity in the subcenters (and in the areas surrounding subcenters) for the activity of the central business district, yet, that substitution is not reflected in housing prices.

The results suggest that access to centers (particularly the central business district) is less important to travel time than central place theory presupposes. This does not, however, conclusively establish that the rent gradient is a poor measure of the advantages of access to the central business district. Clearly the central business contains the most jobs. Commercial and cultural activity is also concentrated there. People that choose to live further from the central business district may be choosing not to access it at the expense of utility. In this case they may be making a trade off of not availing themselves of the opportunities concentrated in that center for a reduction in housing prices. The analysis, however, does show that the trade off of travel time and housing prices assumed by monocentric and polycentric theory is not completely accurate.

### *The Use of Automobiles and Household Travel Time*

Both the results of the empirical analyses of household travel time and joined trips have implications for the use of public transportation versus automobiles. In all models of household travel time greater use of public transportation by a household implies more time is spent in travel. This occurs not only in the suburbs and areas distant from the city but also in the city itself. To the extent that the dispersal of economic activity and development facilitates easier auto use, that dispersal is likely to help households reduce travel time. Efforts to concentrate development in and around the central business district or dense suburbs that hinder auto use are therefore likely to add to household travel time.

The findings concerning joined trips also have implications for household travel time. Auto use facilitates joined trips as shown by the fact that use of public transportation reduces that likelihood that a person joins trips. This lends to the argument that concentrating businesses and facilities will increase household travel time. If this concentration is accomplished in a manner that reduces auto access travel times may be increased as people are forced to reduce their use of joined trips. Taken together the results of the household travel time analysis and the joined trips analysis suggest that the dispersal of economic activity has helped to reduce household travel time. To the extent that auto access can be facilitated that seems to help households reduce travel time burdens. Dense concentrations of activity, often advocated to stimulate use of public transportation (Cervero and Wu, 1998; Rabinowitz, et al.1991), tend to reduce auto use and make car use less time efficient.

The findings concerning auto use also have implications for the disparity that exists between the eastern and western sides of the metropolitan area. Major road access to the central business district appears to be substantially more difficult from the eastern suburbs than from the west. While major roads exist to the east of the city, only one provides direct access to the central business district. The road network to the west converges at the central business district providing major road access from multiple directions. While the difference should be accounted for in the travel times of households to the central business district, the absence of good access to the central business district likely compounds any additional travel burden to households to the east by limiting auto use by households in that area.

### *Demographics, the Distribution of Subcenters and Travel Times*

The relationship between population demographics and the location of subcenters is apparent after a brief examination of maps of subcenters and demographic factors. Subcenters are relatively few in areas with high concentrations of low income households and minority households. This relationship is especially troubling when considering the reduction of household travel times with improved access to subcenters. The higher travel times in areas to the east, which are removed from the subcenters, appears to disproportionately burden minority and low income households. The results are even more troubling when considering the housing price distribution shown by the rent gradient. Minorities appear to suffer higher travel time burdens. They also appear to lack the benefit of housing cost reductions that are predicted by theory to come from that additional burden. The travel time burden of poor access to subcenters is not fully compensated by a housing price reduction. This mismatch disproportionately burdens areas with high concentrations of minority and low income households.

Because the distribution of population, housing and business activity is the result of the actions of many institutions attributing causality to this outcome is not possible. One influence may be the metropolitan area's transportation system. The area to the east of the central business district is well served by the Metrorail system. The road system in this area appears to be less comprehensive than in the western suburbs. Businesses may choose not to concentrate to the east of the city because the lack of major roads in that area. Major road development, however, may not be as important to low income households that have difficulty affording automobile travel. Determining causality is further complicated by the absence of concentrations of economic activity in low income and minority areas. As a consequence, local business are not present to exert pressure on public institutions for the development of better major road service. Pressure for the construction of better roads in these areas may also be lacking as low income households are more reliant on public transportation instead of more expensive auto use. Given that household travel time declines with greater auto use and that joined trips increase with greater auto use, the less comprehensive major road system in these areas is particularly troubling. Since each of these factors likely influences the others one can only conclude that the travel time burden

found in areas without concentrations of business activity appears to disproportionately burden minority and low income populations.

### Conclusion

The dispersal of economic activity from the central business district and other economic centers reduces household travel time by providing households with alternative destinations to obtain the goods, service and employment that they desire. Households with less access to centers are able travel to alternative destinations closer to their homes. The automobile plays a critical role in this reduction of travel time. It provides households with greater travel flexibility making it easier to travel to more destinations on a single trip from home and easier to travel in areas of low density. It is also faster than other modes. The travel time benefit of sprawl has come without the need for paying a higher housing price, as housing prices do not decline as much with access to activity outside the central business district as travel times. Neighborhoods with high concentrations of minority and low income households tend to be most removed from the sprawl of businesses that have chosen to locate away from the central business district and other economic centers. This disparity suggests that although sprawl may reduce travel time this benefit is not equally distributed across all economic and racial populations. These findings have strong implications for the policy. Those policies implications, as well as further research needs, are taken up in the next chapter.