Chapter 2

Conceptual Framework

This chapter uses central place theory of urban economics to develop a conceptual framework with which to examine the relationship between sprawling development and household travel time. Prior research on the role of transportation in central place theory is reviewed. The contribution of this research and its distinction from past research are also discussed.

Urban Form and Central Place Theory

The Monocentric Urban Form

The predominant urban economic theory, central place theory, provides a useful context in which to analyze the relationship between dispersed settlement and household travel time. Alonso (1964), Muth (1969) and Mills (1972) developed central place theory to explain urban spatial form. It is a static theory founded on an assumption that agglomeration economies draw all of the economic activity of a city and the surrounding metropolitan area into or around the central business district. The theory uses an assumed trade off between the price of land and the cost of travel to predict land prices throughout the area. As the cost of accessing the central business district from a parcel rises the price of the parcel is predicted to fall. Since parcels of land closer to the central business district provide less costly access to the services and jobs located in the center they will bring a higher price.[1] A second price reducing effect occurs due to the increase in the supply of land along radial extensions from the central business district. This increase in the supply of land compounds the price reducing effect resulting from the distance from the amenities at the center. The theory's application generates a rent gradient that describes a decrease in land prices as distance from the center increases.[2]

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[1] Some models, such as Muth's (1969), do not assume that all employment and commercial activity take place in the central city. Instead any employment outside of the center is at a reduced wage so that workers are indifferent between working in the remote location and commuting to work in the central city. These models, however, maintain the assumption that only accessibility to the central location has value.

[2] Recall that the theory is static, so, the dynamics of city growth are not captured by the model.

Concomitant with the prediction of land prices decreasing in distance from the central business district is a prediction of decreasing residential population densities in distance from the center. According to the theory, since households that must travel more to access the city face lower land prices, these households tend to be those with a preference for consuming more land. Households choosing to reside at locations with costly housing close to the city center, on the other hand, are predicted to save on housing costs by choosing housing forms that consume less land. Economic models have captured these general predictions through the derivation of density gradients that predict residential densities as a declining function of distance from the central business district.

The validity of the predictions about housing prices and spatial form hinge on the supposed relationship between the access to the central business district and travel time.[3] People residing in locations with less access to the central business district are assumed to expend more time in travel as they are postulated to have less access to the employment, goods and services that they desire. Based on this relationship they are assumed to make a trade off of travel time and housing prices. If the trade off is in fact occurring, households with less access to the center spend more time in travel but also pay a lower unit price for housing. The lower prices in areas more distant from the central business district attract households that prefer to reside in lower density areas. The prediction conforms to the accepted notion that suburban residents must endure greater travel in order to live in low density settlements.

Transportation and the Monocentric Urban Form

Transportation plays an integral part in central place theory, as it is access to the center that is purported to determine household travel time. Household travel time, in turn, determines the value of parcels and the density of development throughout the metropolitan area, as well as the extent of the urban area. The theory assumes that land at the fringe of the urban area will be put to the non-metropolitan use that brings the highest rent, such as agriculture. The cost of housing (including land and improvements) and the access to the

[3] Applications often use travel time as a proxy for travel costs (Hamilton, 1982; Hamilton, 1989; Dubin, 1991; Small and Song, 1992 and; Giuliano and Small, 1991). This is justified be the close correlation of travel time and travel costs.

center provided by its location will determine this boundary, as the total cost of housing includes both its purchase price and the time that its residents must be devote traveling to and from the center. If access is improved– say by the construction of a new road - the use some of the fringe land is predicted to be converted to housing since it often can bring a higher rent in residential use. People moving out to this fringe development will both develop at the lowest density and decrease the density of development inside the fringe.

A progression of such extensions of the urban fringe occurred in the U.S. starting in the late 1800s and continuing through the middle of this century. Transportation innovations from the trolley car to the automobile, along with the extension of the infrastructure to support them reduced travel times and facilitated new development at the fringe of the urban area. The success of the initial suburban settlements often hinged on their local provision of basic goods and services (Jackson, 1985). These developments, however, rarely provided the panoply of employment and public, commercial and cultural services desired by their residents, so city access remained important. As long as this tie to the central business district remained the standard monocentric model described the urban form and household transportation time quite well.

The Breakdown of Monocentricity

As the reach of urban development surrounding the central business district was extended more travel time was required to access to the central business district from the newly developed outlying areas. Congestion in and around the center contributed to this increase in travel time. Even with the decline in housing prices in outlying areas, the opportunity cost of the time needed to access the center would have eventually exceeded most people's willingness to pay and development of outlying areas would have tapered off. Yet, this travel burden was overcome partly by businesses willing to move from city centers to outlying areas reducing travel of employees and customers living in the suburbs. As suburban populations grew to a size able to provide an employment base and to support cultural and social facilities and a full range of commercial good and service providers those institutions developed outside of cities. The willingness of these institutions to move outside the city center has allowed the continued expansion of the the urban area as residents of these new suburban areas no longer needed to travel to the city

center for jobs or the goods and services they desire (Cervero, 1986). Evidence of the decline of the importance of central business districts is found in the decreases in rent and density gradients over time (Anas, Arnott and Small, 1998 at 1436-7).[4]

The dispersal of economic activity from traditional centers requires relaxation of a fundamental assumption of the central place theory. The institutions people desire to access are no longer all located at the center. While this may diminish the ability of the theory to predict household travel time, housing prices and residential densities, the theory's underlying premise - that travel is traded off against housing prices - seems logical and may remain valid. In some metropolitan housing markets, however, different people access different jobs, goods and services in different locations. So, the value of a parcel to a person may now be determined by the access that parcel provides to the various locations people wish to access rather than its access to the city center. This complicates any application of the theory since access to a variety of locations may determine household travel time and housing price rather than access to a single location, the central business district. Application of the theory is further complicated since different people may choose to access different places making the value of a particular parcel (in terms of travel time and housing price) differ for each person.

The Limited Polycentric Urban Form

In an attempt to address these changes in urban form economists have modified and adapted the monocentric model. The most popular of these extensions, with both economists and other social scientists, specifies a limited polycentric model of the city (Garreau, 1991; Sasaki, 1990; White, 1976).[5] These models acknowledge the dispersal of economic activity from the central business district. They, however, are not models of sprawl as they maintain an assumption that the economic activity that has moved from the center concentrates in a limited number of subcenters due to agglomeration

[4] Decreases in travel costs also help to explain the decline in rent and density gradients (Anas, Arnott and Small, 1998 at 1436-7).

[5] Ogawa and Fujita (1980) use a nonmoncentric model rather than a polycentric model to examine the optimal urban form. Under the model cities take on either a monocentric, polycentric or disperse form depending on the assumptions concerning commuting and transportation costs.

economies.[6] These limited polycentric extensions maintain the assumption of a trade off of housing prices and travel time. The trade off, however, involves weighting the access to the different subcenters rather than the considering access to only the central business district.[7]

Household Travel Time and Central Place Theory

Economists and urban experts have relied on both the standard monocentric model and limited polycentric extensions and estimates of the dispersal of jobs to subcenters to examine the consequences of changes of employment distribution on residential housing form (Small and Song, 1994; Song, 1994, Heikkila et al., 1989; Gordon, Richardson and Wong, 1989; Waddell, Berry and Hoch, 1993). These analyses determine the densities and property values of residential locations throughout the city using the distance or travel time to the central business district and the different subcenters. The assumption driving all of these models continues to be that people's residential location choices are motivated by their preferences to trade access to the various economic centers against land prices. Implicit - and unquestioned - is the assumption that people with less access to these central locations are forced to spend more time in travel.

Household Travel Time and the New Sprawling Urban Form

The travel time assumption of the monocentric and limited polycentric models is suspect because of the dispersal of economic activity from identifiable economic centers. Evidence of this dispersal is plentiful. In the last 25 years over eighty percent of all new job growth and over eighty percent of all new office, industrial and retail construction has occurred in the suburbs (Hayward, 1996). Researchers that rely on monocentric and

[6] Some extensions of the monocentric model use general equilibrium analysis to derive conditions that lead to the formation of subcenters. Under these models the dispersal of employment centers and economic activity from the central business district is attributed to congestion limiting access to the city center. The concentration of noncentral economic activity in subcenters is believed to arise out of agglomeration economies similar to those that drive the formation of the central business district (Fujita and Ogawa, 1982; Anas and Kim, 1996).

limited polycentric models have found that substantial employment and economic activity is located outside of centers. Cervero and Wu (1998) found that over half of the employment in San Francisco was located outside identified centers. Giuliano and Small (1993) found that over two thirds of all employment in the Los Angeles metropolitan area was located outside of the central business district and the city's subcenters. This dispersal of economic activity has severed the tie of many suburban residents to the central business district, to economic centers identified by polycentric models. This has reduced the travel time of accessing employment, goods and services from housing locations that are distant from the economic centers identified under monocentric and limited polycentric theory. As a consequence, access to those centers has less influence on both household travel time and housing choices.

The dissipation of economic activity from traditional centers, however, is not total. Transportation and telecommunications developments have weakened many agglomeration economies, but those economies continue to exist. Buildings and infrastructure developed in central business districts and suburban centers remain, as do concentrations of economic activity. The congestion confronted in accessing the dense concentrations, however, has driven many people to obtain the employment, goods and services they desire in less concentrated locations. These changes in urban form suggest that the limited polycentric models may not go far enough in accommodating dispersion of economic activity in cities. Gordon and Richardson (1996) and Song (1994) argue that we have dispersed "beyond" the limited polycentric model to a more disperse form. Such a new urban form may be characterized by an indeterminant number of "centers" of various sizes and constitutions, ranging from the traditional central business district to suburban strip malls and office parks. Each of these "centers" exerts an influence on urban form; yet, none has influence that spans the entire metropolitan area. A complete model of an urban area with this new form is certainly intractable. If, however, this new disperse model of urban areas is accurate, continued reliance on the monocentric theory and its limited polycentric extensions leads to a misunderstanding of household travel

[7] By maintaining that economic activity concentrates in a limited number of subcenters, economists have not conceded that we have a sprawling urban form. Sprawl would be characterized by an unlimited number of centers.

time and its influence on housing prices and residential densities in our urban areas. This model will examine the validity of central place theory's assumptions concerning travel by examining the relationship between household travel times and access to identified centers under those models.

An Empirical Study of Household Travel Times under Central Place Theory

The study of travel under monocentric and limited polycentric theories of the city is not entirely new. This study, however, will go beyond prior research by examining whether observed household travel time is consistent with the predictions of the theory.

Previous Studies of Travel under Central Place Theory

A number of studies have examined commuting behaviors (not total time spent in travel) under the monocentric theory (Hamilton, 1982; Hamilton, 1989; Dubin, 1991; Small and Song, 1992; Giuliano and Small, 1991). These studies have typically analyzed the travel time savings realized by residents of a city due to firm decentralization. Under an assumption of monocentricity firms that decentralize do so in a manner such that jobs remain more concentrated than population. So despite decentralization, all residents are predicted to locate so that they can continue to commute radially into the city thereby minimizing total commutes. Under assumptions of job, income and preference homogeneity the assumption of commute minimization as firms decentralize has been consistently rejected (Hamilton, 1982; Small and Song, 1992). Modifications of the model that relax the monocentric assumption and instead accommodate the actual distribution of jobs and workers have also rejected the assumption that residential locations are chosen to minimize commutes (Small and Song, 1992; Giuliano and Small, 1993). When differences in preferences, incomes and housing and neighborhood characteristics are included in the model, however, the results are less certain. Cropper and Gordon (1991) found that much of the excess commuting is undertaken to satisfy housing and neighborhood preferences.

With the relaxation of the assumption of monocentricity, a few studies have examined commuting behaviors in polycentric models of the city (Giuliano and Small, 1993; Cervero and Wu, 1997; and Cervero and Wu, 1998). In each case, the analysis focused on the differences in commuting times and distances to various job locations.

Using the actual distribution of jobs and workers Giuliano and Small (1993) found that minimum required commutes to subcenters are significantly longer than minimum required commutes to non-central employment. Actual commutes to jobs in subcenters, however, were found to be only slightly longer than commutes to non-central jobs. Cervero and Wu (1997) found that commute times to subcenters were substantially lower than commute times to the central business district. In a further study of limited polycentric form, Cervero and Wu (1998) examined the differences in commute times to the central business district and subcenters. They found that commute times and distances to both the central business district and to subcenters have risen with metropolitan growth and job decentralization with the greatest increase in commuting distances and times occurring in peripheral, fast growing subcenters. These studies clearly contribute to the understanding of cities and the monocentric and polycentric models. They all, however, work within the confines of the theory rather than attempting to analyze its validity. This study will examine the assumption that location is governed by commuting time, which drives many of the theory's predictions.

A Broader Study of Household Travel

This research will, by necessity, be broader than prior studies. Previous studies have limited their scope to the examination of commuting behaviors. This study will examine all household travel. Considering only individual commuting behaviors when examining the relationship between access to economic centers from a housing location and household travel time implies that households value access to only the employment in these centers. Non-work travel, however, exceeds commuting travel (Ben-Akiva and Bowman, 1998). To fairly assess the strength of any model that predicts urban form based on the cost of access to economic centers requires that all travel be considered. In the case of the limited polycentric model the argument for considering all travel is even stronger. In the limited polycentric model the price of land, and therefore urban form, depends on access to multiple centers from the areas housing locations. For polycentric gradients to be meaningful access to multiple centers must be valued. Any examination of the validity of the model must therefore be capable of discerning the value that a household places on access to many centers at once. Consideration of both work and

non-work travel satisfies this need since a household may value a residential location's access to many different centers for the different work and non-work opportunities they offer. In addition, stopping on trips to and from work is common. These multipurpose trips make distinctions between work and nonwork travel illusory. If instead all household travel is considered a more complete understanding of the choice of household location may be realized.

The New Urban Form, Auto Travel and Joined Trips

The critical role of transportation in dispersal of economic activity is evident in the transition to a transportation system dominated by the automobile. The preference for and reliance on an auto dependent transportation system is in large part responsible for any evolution of urban form. In an auto-reliant transportation system the concentration of activity in centers often leads to greater congestion and increases travel times to central locations (Cervero, 1986, at 35). In densely developed centers people must suffer in slower traffic or rely on slower modes of transportation. Even in areas where auto traffic congestion could be overcome with public transportation, demand for automobile accessibility of workplaces and social, cultural and commercial facilities has led to the dispersal of economic activity from traditional centers. The continued development of suburban economic activity and the transportation system that supports it now enable auto travel to most locations, goods and services (Cervero, 1986). A less concentrated urban form allows people far greater choice as to where to seek out employment, goods and services. These locations may be accessed more quickly with the auto, reducing household travel time.

The speed and flexibility of auto travel in less congested outlying areas contribute to households overcoming the apparent disadvantages of poor access to economic centers. Households can effectively use the automobile to reduce travel times by making joined trips. In a joined trip a person accesses multiple locations and performs multiple tasks on a single trip from home or on the way to or from work. Time spent in travel of residents of locations more distant from centers may be significantly reduced if people are able to accomplish several tasks during a single trip to a center.

The use of joined trips is not necessarily inconsistent with the theoretical

foundations of the monocentric and limited polycentric forms. Both are founded on an assumption that most business is conducted in centers. The concentration of economic activity in centers provides firms with the opportunity to conduct much of their business in close proximity to their facilities thereby reducing transportation costs. Likewise, a household may realize significant savings in travel by being able to accomplish many tasks on a single trip to an economic center. This use of joined trips would reflect the importance of accessing those centers and the economic opportunities they offer. Using a joined trip in this manner, however, a household cannot overcome, but only mitigate, the apparent disadvantages of a residential location more removed from the centers.

The use of joined trips, however, may enable people to avoid centers altogether. In suburban areas goods, services and economic activity are dispersed in a variety of locations. Using an automobile on the relatively uncongested roads in these areas a person may travel to a variety of locations for goods and services on a single trip from home. Depending on the housing location, a person that joins trips in this fashion may realize travel savings by avoiding central locations. An examination of joined trips, in which many tasks are performed in one trip from the home, will provide more insight into the importance of accessing economic centers. Through this analysis a better understanding of any transition from the monocentric and limited polycentric form to a more disperse urban form may be developed.

Household Travel Time and the Rent Gradient

Much of the work related to central place theory has focused on the rent gradients, which it predicts. Under the theory it is the predicted household travel times that cause this gradient. The estimation of a rent gradient and its comparison with predict household travel times will further aid in understanding whether our urban areas continue to have a monocentric or limited polycentric form. In both the estimation of the rent gradient and the household travel time equation, the influence of factors other than access to economic centers will be controlled for. This will allow the examination of whether access to economic centers' influences housing prices and household travel times differently. Any observed differences will be examined in light of the region's

demographics to determine if their relationship to any transition to a new disperse urban form.

Conclusion

Since the mid-1960s economists have relied on central place theory and its limited polycentric extensions to explain and predict urban form. These models posit that in choosing residential housing locations people make a trade off of land prices and travel time. This study will use transportation survey data to examine whether household travel times for all travel vary with access to economic centers defined under monocentric and limited polycentric theory. If total household travel times are not explained by the travel times to centers, we should question whether our cities are of the form described by the theory.

Much of the criticism of low density suburban development (i.e. multi-centric beyond polycentric) is based on the notion that suburban residents are forced to spend too much time in travel. To mitigate this supposed harm urban and transportation experts advocate concentrating development in dense clusters, mixing land uses and limiting outward growth of our cities. If the travel time assumptions of monocentric and polycentric theory do not hold these policy prescriptions must be questioned. If we have spread across larger areas of land without increased travel times it suggests that business, social, commercial and cultural activities have dispersed in a way that accommodates residents of disperse housing. In the light of such a finding, efforts to redirect development into dense forms to reduce travel times may be misguided.