Flight from Blight vs. Natural Evolution: Determinants of Household Residential Location Choice and Suburbanization

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Abstract: Using a unique dataset on the characteristics, origin, and destination of households who engaged in intrametropolitan moves in the Columbus, Ohio area, we estimate a hybrid conditional logit choice model of residential location that separately identifies the push/pull influence of local public goods, namely school quality and public safety, from household income and other lifecycle effects. Our results provide evidence of both a "natural evolution" of households, due to income and household structural changes, as well as a "flight from blight," due to higher crime rates, lower school quality, and lower quality of housing stock in the central city. In comparing the magnitudes of these variables, we find that the influence of public school quality is consistently larger than the influence of household income across all locations and particularly in the central city. Rather than being largely a result of the "natural evolution" of households as incomes grow over time, our results provide evidence that the central city's inferior public goods, most notably school quality, have played a much more dominant role in pushing households to suburban locations. This finding has important implications for central city, suburban, and exurban communities that seek to counteract the movement of population to the outer suburbs and beyond.

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Introduction

During the second half of the 20th century, U.S. metropolitan areas[1] more than doubled in population with a majority of this growth occurring outside the central cities. In the 1950's, 57% of MSA residents lived in central cities compared with approximately 37% in 1990. This outward trend continued throughout the 1990's with the development of "edge cities" in previously residential suburbs and low-density, scattered residential patterns reaching out into rural-urban fringe areas. These patterns reflect a redistribution of metropolitan population away from central cities to suburbs and exurbs, a trend that has been the dominant pattern in the spatial location of U.S. population in the past half-century. These changes have had wide-ranging interactions with metropolitan job and housing markets, development and land use changes within urban and rural areas, and the quality of life of people throughout the U.S.

Two main theories have been forwarded in the literature to explain this process of suburbanization: "natural evolution" and "flight from blight" (Mieszkowski and Mills, 1993). The former emphasizes demographic and lifecycle changes, e.g. changes in income levels, household size, and other attributes that would induce household demand for newer and larger housing located in suburban and rural areas. The model derives from the basic tenants of the urban bid rent model, in which competition for housing near urban centers drives up housing prices, inducing a negative price gradient and, because households substitute more land as the price of housing declines, lot sizes increase with distance from the urban center. As a household progresses through their lifecycle, e.g. as household size increases due to children and incomes rise over time, demand for newer and larger houses is hypothesized to increase and, as a result, households who have a preference for larger houses and lots are more inclined to locate in the suburbs where land is available in larger quantities. This theory also emphasizes the dynamic aspects of aging housing stock and changes in transportation networks. During the initial phases of city formation, houses are built within the central part of the city to minimize the cost of commuting to employment. As a city grows and transportation technology changes, new and larger houses are built

[1] A metropolitan area is defined by the U.S. Census Bureau as a county or a group of counties that contains at least one central city (or twin cities) with a population of 50,000 or greater.

around the periphery of the city in response to changes in housing demand that are driven by changes in the household's life cycle or income. The development of transportation networks linking city and suburbs plays a crucial role as well. Advances in transportation that lower transportation cost, combined with household demographic and economic changes, lead people to move away from the center of the city to surrounding locations where they can enjoy larger newer and larger houses.

On the other hand, the "flight from blight" hypothesis emphasizes the role of declining public services and quality of life in the central city relative to suburban and rural locations. Tiebout's (1956) notion that households have preferences over local public goods that vary across local jurisdictions underlies this second theory of suburbanization, which argues that amenities, as well as distance and land costs, influence households' location choices. The uneven distribution of private and public amenities across local jurisdictions—in particular, the inferior amenities associated with central cities relative to suburbs—are viewed as the main determinants of suburbanization. These problems include crime, violence, racial issues, low quality of schools and public services, and poor environmental quality that are often associated with central cities. The "flight from blight" hypothesis maintains that households that can afford to move to the suburbs will do so, in search of safer neighborhoods, better schools, nicer environments, and communities comprised of people more like themselves.

The literature on suburbanization has provided empirical evidence of various lifecycle factors and neighborhood characteristics that have influenced suburbanization (Bogart and Cromwell, 2000; Bradford and Kelejian, 1973; Clark, Deurloo and Dielman, 2000; Clark and Onaka, 1983; Cullen and Levitt, 1995 and 1996; Haurin and Brasington; 1996; Kendig, 198; Margo, 1992; South and Crowder, 1997). However, despite the relative abundance of these studies, none have attempted to identify the relative effects of individual-specific characteristics, such as age and incomes, vs. local public goods, such as schools and neighborhood safety. Identifying these *relative* magnitudes is important for theoretical reasons as well as for the design of policies aimed at retaining population in central areas and containing sprawl development at the urban-rural fringes. Theoretically,

the relative magnitudes of these effects would provide some evidence of which theory—"natural evolution" vs. "flight from blight"—is more robust as a theory of suburbanization. From a policy perspective, separating these effects is important because policy makers have control over the quantity and quality of publicly provided services, but have very little influence over changes in household-level characteristics. Therefore, if outward household migration is driven in large part by changes in the size and/or age structure of households, then investments in improving the quality of services in central areas may not have a discernable effect on household location decisions. Alternatively, if the quality of public services is a main determinant of household location choices, then improvements in urban services may significantly influence the pattern of suburbanization.

The purpose of this paper is to determine the importance of neighborhood features relative to key individual-level characteristics in determining households' relocation decisions. Using data from the Columbus, Ohio metropolitan area on deed transfer records, the locations of houses bought and sold by individual households, and data from a random survey of "mover" households, we are able to identify both individual-level and neighborhood-level characteristics associated with intrametropolitan moves by households. A multinomial discrete choice model of residential location is estimated that separately identifies the push/pull influence of local public goods, namely school quality and public safety, vs. household income and other lifecycle effects. Our results provide evidence of both a natural evolution of household mobility, due to changes in income and household structure, as well as flight from higher crime rates, lower school quality, and lower quality of the housing stock in the central city. An analysis of the effect of income on the probability of choosing a location shows that when income increases, so does a household's preference for wealthy suburban location. However, the income effect is found to be smaller than the school quality effect, as proxied by the percentage of teachers with master's degree, for all locations. This was found to be particularly true for central Columbus, for which the school effect was estimated to be many times the magnitude of the income effect. Based on these results, we conclude that, rather than being primarily a result of the "natural evolution" of households as incomes grow over time, suburbanization in our study area is characterized more by a "flight from blight" process in which the

central city's inferior public goods, most notably school quality, have pushed households into suburban locations. This finding has important implications for central cities and inner suburbs that seek to counteract the movement of population to the suburbs as well as for rural-urban areas seeking to control rising growth. The paper concludes with a discussion of these implications.

Empirical Evidence of the Causes of Suburbanization

The causes of metropolitan suburbanization can be classified broadly as (1) characteristics of individual households that lead to outward migration, e.g. changes in income and family structure, and (2) factors associated with cities and suburbs that "push" households out of cities and "pull" them into suburbs, e.g. higher crime rates and lower school quality tend to push people out of central cities while more homogeneous neighborhoods, greater availability of services, and a newer housing stock tend to pull people to the suburbs. These classifications correspond generally to factors that provide support for either the "natural evolution" or "flight from blight" theories respectively.

Evidence of the role of increasing per capita income in the decentralization process shows a positive effect of rising per capita income on decentralization. This result is consistent with the bid rent theory of residential location, which predicts a flattening of the population density gradient if the income effect associated with land consumption outweighs the substitution effect of a higher marginal cost of commuting. Margo (1992) provides empirical evidence of this using census data on the location of households in U.S. urban and suburban areas. A related literature, also based on the underlying tenants of the urban bid rent model, emphasizes the connection between employment and household location, arguing that decentralization of employment has led to population suburbanization (Boarnet, 1994; Thurston and Yezer, 1994). These studies have sought to empirically test the hypothesis that decentralization of jobs causes subsequent decentralization of employment by estimating a population density gradient as a function of lagged employment density gradients, a lagged population density gradient, and other exogenous variables. Alternatively, Greenwood and Stock (1990) present a simultaneous-equations analysis of intrametropolitan migration, which jointly estimates population,

employment, and housing stock flows. Results from these studies are varied, however, as to whether population decentralization is independent of employment decentralization.

A separate literature on lifecycle effects has provided empirical evidence that supports Rossi's (1955) lifecycle hypothesis that people adjust their housing consumption in order to fit changing household needs with their progression through the cycle of life, e.g. changes in household size, age of household members, and marriage status (Clark and Onaka, 1983; Kendig, 1984). For example, Clark, Deurloo and Dielman (2000) find that the ratio of household size/house size is a fundamental element of the mobility process. Their data reveal that, from 1986 to 1992, more than 50% of low-income household living in overcrowded houses had undertaken a move within two years. Taken together, empirical evidence of the importance of income, employment, and lifecycle effects support the natural evolution theory of suburbanization in which household-level changes determine the residential location choices of households.

Empirical evidence in support of the "flight from blight" theory, in which fiscal and social problems in central cities induce movement out of the city among more affluent households, has, for the most part, provided evidence of a relationship between the quality of local private and pubic services and household location choices. Cullen and Levitt, (1996) find evidence of the responsiveness of households to crime rates; specifically, that higher income, being white and the presence of a child under age 18 increase the responsiveness of a household to a change in crime rate. Declining quality of life in central cities not only has a direct impact on a household's willingness to leave, but also an indirect impact on the value of the neighborhood housing stock. Cullen and Levitt (1995) present evidence that rising crime rates lead to a decrease in property value that leads to a decrease of the property tax base which depletes a city's revenues.

Schools have also had a great impact on the residential location decision of households through their contribution to the demand for housing in a neighborhood (Bogart and Cromwell, 2000). The declining quality of inner city schools has driven many affluent households to the suburbs where, on average, schools are better. However, the

direction of causation—i.e. whether low quality schools have led to the depopulation of central cities or whether middle class flight has caused the deterioration of the quality of inner cities' schools—is debated. Regardless, it is clear that they affect each another. Kain and Quigley (1970) confirm the fact that neighborhood schools influence households' perception of housing stock quality. Haurin and Brasington (1996), based on the results of an empirical study on school quality and real house prices, argue that school quality has a very important impact on the housing prices. Ridker and Henning (1967) show that school quality is a determinant of residential property values: the better the school, the more valuable the housing stock in the neighborhood.

Other factors, such as racial composition, have also been found to be a major determinant of household location decisions. South and Crowder, (1997) provide evidence that suburbanization is in part driven by a desire for segregation in which higher class households will relocate in order to separate themselves from lower class households. Frey (1979) finds a positive correlation between the probability of a Caucasian household choosing a suburban location and the proportion of African Americans in central cities. Other research has provided evidence of similar interactions with urban poverty and its role in inducing outward movement among more affluent households (Adams, et. al, 1996; Bradford and Kelejian, 1973). Not all the evidence supports the "flight from blight" hypotheses though. Mills and Price (1984) estimate population and employment densities for U.S. urban areas between 1960-70 and find no significant relationship between these densities and several urban amenity variables, including crime, educational attainment, and tax rates.

Empirically distinguishing between the competing hypotheses has been difficult for a number of reasons. An obvious reason is that these theories are not at all mutually exclusive and it is very likely that there are a number of interactions among them, as Miezekowski and Mills (1993) emphasize. For example, income earnings are usually increasing with an individual's age, at least up to a certain point, and therefore, separating out an age effect from the income effect may be very difficult. In addition, income is also associated with the "flight from blight" hypothesis, which attributes outward migration of

more affluent households to differences in incomes across households. A second difficulty in separating out these effects has been the historical lack of spatially disaggregated household data. The majority of research on suburbanization in the urban economics literature, for example, describes suburbanization in terms of population density gradients. The shortcomings of this approach, including restrictive assumptions about functional form and assumptions that the urban spatial structure is monocentric, have been acknowledged in the literature (Mills, 1992; Mieszkowski and Smith, 1991). Lastly, distinguishing individual vs. neighborhood effects requires an estimation technique that can incorporate data on both individual household-level characteristics and neighborhood features. This implies a discrete choice framework, in which data on individual households as well as neighborhood features are used to explain residential choices. However, to the best of our knowledge, the residential choice models that have been estimated to-date are either a function of individual characteristics exclusively or as a function of neighborhood characteristics exclusively rather than a combination of these data. This shortcoming in the literature is likely due to computational difficulties in estimating a hybrid model, in which individual characteristics are combined with neighborhood variables, and lack of data on both individual and neighborhood variables.

A Model of Household Neighborhood Choice

Choosing a neighborhood in which to live can be viewed as the result of a decision making process that leads a household to weight the alternatives that are offered to them, estimate the costs and the benefits of each, and decide on the neighborhood that maximizes their net benefits. We assume that the neighborhood choice households make is the one that provides them their maximum expected utility and that locations vary in the public and private goods and other neighborhood attributes ascribed to them. Because location is a multi-dimensional variable and because many of the attributes that define a location vary discretely from one jurisdiction to the other, we assume that location is defined by a finite number of mutually exclusive discrete alternatives: $j = 1,...J$, where J is the total number of discrete locations that comprise a household's choice set. Each discrete alternative corresponds to a local jurisdiction or neighborhood that is comprised of a unique bundle of public services and neighborhood features. Writing the household's utility maximization

problem in discrete terms and expressing an individual household *i*'s utility from location *j* in terms of their indirect utility function, V_{ij}, we can specify the household's utility maximization problem as choosing location j from the set of location alternatives that is available to them such that utility is maximized:

(1) $$V_{ij} = Max\ [V_{i1}, V_{i2}, \ldots, V_{iJ}] \quad where\ j=1,\ldots,J$$

Because the researcher does not observe all the features associated with a particular location, the household decision is viewed as a stochastic process. Assuming that the observable and the unobservable components are additive and separable, the indirect utility V_{ji} provided to individual *i* by alternative *j* can be written as the summation of the observable component W_{ij} and the unobservable component ε_{ji}:

(2) $$V_{ij} = W_{ij} + \varepsilon_{ij}$$

This specification gives rise to the random utility model in which the probability of an individual *i* choosing a site *j* can be seen as the probability of the site *j* providing the maximum utility of all alternatives of the choice set to individual *i*:

(3) $$Prob(j=1) = Prob(W_{ij} + \varepsilon_{ij} > W_{ik} + \varepsilon_{ik}) \quad for\ all\ k \neq j$$

where *k* and *j* are locations indices. The random utility model assumes that individuals make choices among mutually exclusive alternatives based on the attributes of the alternatives (Haab and McConnell, 2001). It is based on an indirect utility function that assumes that among the individual's choice set, the chosen alternative is the one that provide the maximum utility. Note that, because W_{ij} is a function of both the individual *i* and the location *j*, the location choice that maximizes utility can vary across individuals.

A number of estimation issues arise in estimating such a model, including the assumptions of error distribution and functional form. Specification of an extreme value distribution of the stochastic term yields a multinomial logit model, which imposes the

Independence of Irrelevant Alternatives (IIA) assumption. This assumption states that the ratio of probability of an individual choosing between two alternatives is independent of all others (Hausman and Mc Fadden, 1984), which implies that the ratio of the probability of choosing between two alternatives is independent of all other alternatives. An alternative specification of the errors as normally distributed yields the multinomial probit model. This model is less restrictive in terms of the IIA assumption. Specifically, it allows for error dependencies across different alternatives, but presents the inconvenience of being difficult to compute when the number of alternatives exceeds four. The residential location choice set faced by households is usually comprised of many different neighborhoods or local jurisdictions and in most cases far exceeds four alternatives. For this reason, the multinomial probit model is generally not computationally feasible for studies of household location choice.

In specifying (4), we assume a multinomial functional form in which the explanatory variables vary over the alternatives of the choice set. This specification yields a conditional logit model in which the parameter estimates are constant over locations and therefore are interpreted as the contributions of the location characteristics on the probability of choosing any location. We further specify W_{ij} as being linear and separable in location specific features, x_j, and individual specific features, z_i. Given this, the probability that household *i* chooses alternative *j* can be rewritten as:

$$Prob(j=1) = \frac{Exp\ (\beta x_{ij} + \lambda z_{ij} + \varepsilon_{ij})}{\sum_j Exp\ \ (\beta x_{ij} + \lambda z_{ij} + \varepsilon_{ij})} \tag{4}$$

where β and λ are the corresponding parameter vectors to be estimated.

To incorporate individual-specific variables, we use a set of dummy interaction terms for each individual variable that correspond to each choice alternative. This method ensures that the variable varies across the location alternatives and therefore does not drop out of the model. The interaction dummies are normalized to the J^{th} alternative and

therefore the last row consists of all zeros. The result is a hybrid conditional logit model that is able to consider the effects of both alternative-specific features and individual-level characteristics on the residential choice location of a household.

A final estimation issue is the specification of the choice set. For the purpose of our study, we seek a delineation of geographical space that yields a reasonable amount of homogeneity in the characteristics of each location. According to these criteria, the best alternative is to define the school districts as the neighborhood unit. School districts are comprised of one or more tax districts and many times match the boundaries of a local jurisdiction.

Data and Estimation Results

In estimating a multinomial choice model of residential location, we are able to take advantage of a unique dataset that has been compiled by researchers at the Ohio State University and Cleveland State University.[2] Using deed transfer records for 2,074 households that undertook a move within Franklin County in 1995, researchers matched the location of houses bought and sold within this study area. In addition, a survey was conducted of these homeowners who undertook a move from one home to another within Franklin County in 1995. Our model is estimated with data from the 824 households that were surveyed. Of these surveyed households, 20% are minorities (defined as non-Caucasian households), 77% are married, 54% have one or more children, and the average annual income is between $60,000 and $80,000. The average age of males surveyed is 44.5 years and the average female age is 42.6 years. Seventy-nine percent of the heads of households attended college. In comparing the previous and current homes, the average household moved "up" in terms of lot size and house value: lot size increased by an average of 10% and house value by an average of 25.6%.

[2] The matched deed transfer data were made available by the Ohio Housing Research Network. Additional survey data was collected by Hazel Morrow-Jones, Associate Professor in City and Regional Planning at Ohio State University. We are grateful to both these parties for making these data available. Support for the research was provided by the Ohio State University Urban Affairs Committee and Ohio Center for Real Estate Education and Research.

While these data offer a very rich understanding of individuals' motivations for moving, they are also limited in several ways. The data include only the households who sold and bought homes in Franklin County in 1995. Homeowners represent 56.9% of Franklin County population. Households who moved across county lines or who moved to, from, or between rental units are not represented in the data set. Therefore, the results of the analysis must be interpreted with this qualification in mind.[3]

The empirical model is estimated with four types of variables: (1) local public service and public finance variables, (2) neighborhood socio-demographic variables, (3) neighborhood economic and geographic attributes, and (4) individual-specific variables. The first three types of variables correspond to the school district level, whereas the last category of variables corresponds to the individual household level. To account for the quality of the services provided by local governments, we incorporate variables that are proxies for these main services. First, the level of security in the school district is proxied by the estimated total number of crimes per capita.[4] Even though no distinction is made among the types of crimes committed, this aggregate statistic is expected to be highly negatively correlated with the overall level of public safety experienced by residents living in each school district. We expect that this variable will have a negative effect on the likelihood that a household moves to a particular jurisdiction. Second, the quality of public schools is proxied with two different measures of school quality: (1) the percentage of teachers within the school district with a master's degree and (2) the average high school drop rate in the school district.[5] In comparing the distribution of these variables to the ratings assigned by the State of Ohio's Department of Education, we find that both variables are strongly correlated with the State's overall rating of the school district and expect both of these variables to positively influence a household's location decision. Third, the quality of other locally provided public goods, including garbage collection, street maintenance, and parks and recreational facilities, are important in contributing to

[3] Tests by Morrow-Jones (2000) indicate that the surveyed cases represent the population of repeat homebuyers reasonably well.
[4] This variable was aggregated to the school district level from an estimate of total crimes per block group based on population data and data from the FBI Uniform Crime Report. These data are available from Applied Geographic Systems: http://www.appliedgeographic.com/.
[5] Both these variables are from the State of Ohio's Department of Education's "Local Report Card" website: http://www.ode.state.oh.us/rc_download.htm.

residents' quality of life. To proxy for the quality of these other public goods, a measure of the relative expenditures on leisure activities (e.g. parks and recreational facilities) is included. This variable is defined in terms of a ratio that measures the expenditures on leisure activities relative to the local jurisdiction's expenditures on security.[6] Holding the level of security constant, it is expected that this variable will have a positive effect on household location decisions. Finally, the level of taxes in a jurisdiction reflects the price that households must pay for the variety of public goods that are locally provided. In Ohio, the major tax paid by households is the property tax. This tax rate is included in the model as a proxy for the costliness of living in a particular school district. Holding the quantity and quality of public services constant, it is expected that this variable will deter a household from moving to a particular jurisdiction.

In addition to the hypothesized importance of the public services outlined in the previous section, researchers have provided evidence of the importance of neighborhood socio-demographic variables in influencing households' location decisions. We include in our empirical model several variables that account for some of the major socio–demographic characteristics of the school districts.[7] First, households are likely to have preferences over the racial composition of a neighborhood. As discussed in Chapter 2, evidence shows that people will often sort themselves into more homogeneous neighborhoods, suggesting a preference for the same racial/ethnic background. Here we use the percentage of African-Americans as a proxy for the racial composition of the neighborhood. Second, the ratio of the total population to the total housing units is included to account for the level of household crowding. We do so to account for the average size of households living in the school district. A large ratio will indicate that the school district's residents are on average large families.

Other socio-demographic characteristics that are included in the model include population density, the median per capita income of households living in the school

[6] These data are from local governments' comprehensive annual financial report and the State of Ohio's auditor's report on cities and villages and are reported by local governments as part of their annual financial services reporting.

[7] Each of these variables is from the 1990 Census of Population. They were aggregated from the block group to school district level using a spatial aggregation method implemented by ArcView GIS software.

district, the percentage of residents with a college degree, the mean owner-occupancy rate, and the unemployment rate. Population density is included to control for the varying levels of density that exist across school districts. The sign of this variable is an empirical question: a positive sign would indicate that there are positive agglomeration economies associated with higher density living whereas a negative sign would indicate congestion effects. This variable is specified in its logarithmic form. Median per capita household income and the percentage of residents with a college degree are included to control for differences in the relative wealth and education levels of residents within the school district. All else equal, we expect that these variables would have a positive influence on a household's location choice, although these signs may depend on the particular sample of households that undertake a move. If households tend to sort themselves into homogeneous groups within locations, then income and education levels would tend to have a positive effect if the observed sample of movers is above average in income and education levels. Likewise, homeowners may prefer to be surrounded by other homeowners and therefore households may be more likely to move into neighborhoods with higher owner-occupancy rates. We include this variable as a measure of the proportion of housing units within the school district that are owner-occupied. Lastly, unemployment is included in logarithm form to account for the vitality of the economic sector within the jurisdiction. All else equal, it is expected that unemployment will have a negative impact on the attractiveness of a location.

The next set of variables are those that describe selected economic and geographical characteristics of the school district. The central variable of the urban bid-rent model, access to the central business district, is included in terms of the estimated travel time from the central node of the school district to downtown Columbus. The inclusion of this variable is intended to capture the accessibility of the school district relative to major employment and entertainment destinations. In addition, because commercial and business activity occurs not just in the central downtown district, but throughout metropolitan areas, a measure of the local level of economic activity within each school district is also included. This variable is defined as the number of retail

businesses per capita within the school district.[8] Finally, the literature suggests a clear preference among households for newer housing stock. The percentage of housing units built before 1970 is included as a proxy for the age and the quality of the neighborhood's housing stock.

The last set of variables are the individual-specific variables. It is clear that households are not homogeneous in income and that income plays a primary role in determining the alternatives that enter a household's location choice set and ultimately, their destination choice. Data on the approximate income level of the surveyed households is available to us. This variable is a categorical variable that represents a corresponding range of income for each household. It varies from 2-12 and represents increasing levels of income in $20,000 increments. In addition to income, the presence or absence of school-aged children is a fundamental distinction between households because of the differences that exist in school quality across residential locations and the fundamental importance of public school quality to households. Information on the number and ages of children within the household is also available to us from the survey. We use this information to construct a dummy variable that is defined as 1 if there the household has at least one child between ages 5 and 18 and 0 otherwise.

The geographical extent of our study area is Franklin County, Ohio—the central county of the Columbus, Ohio metropolitan area. There are a total of eighteen school districts that are fully encompassed within the county boundary and that comprise our choice set. These districts exhibit a substantial range in terms of size, proximity to the central city, school quality, racial and economic composition, and the other features of residential location discussed above. Map 1 illustrates this choice set and Table 1 reports the values of selected school district variables.

The estimation results for the location-specific and individual-specific variables are reported in Tables 2A and 2B respectively. As expected, the crime rate has a significant

[8] Data on the number and sales level of retail businesses are estimated based on sales tax information at the county level and the distribution of population within each county. These data are from Applied Geographic Information Systems (AGS): http://www.appliedgeographic.com.

negative impact on a household's probability of choosing a locality. In addition the model reveals household's preference for higher school quality as proxied by the percentage of teachers with a master's degree. This estimate is positive and highly significant, indicating that as the percentage of teachers with master's degree increases in the school district, the probability of a household moving the this location increases as well. The other variable used to proxy school quality, high school drop rate, is not found to be significant. From the public finance variables include in the model, the expenditure on leisure (parks and other recreational activities) relative to security is positive and significant, indicating that the expenditure of local jurisdictions on "quality of life" services such as parks and recreational services is an important determinant of household location. The tax revenue variable, on the other hand, is insignificant. Turning next to the socio-demographic neighborhood variables, we do not find much significance in these variables. With the exception of the percentage of college graduates, none of the other socio-demographic variables are significant. It is likely that these variables are heterogeneous within school districts and therefore, aggregate measures of these features at the school district level are too coarse. Contrary to expectations, the percentage of college graduates within a school district is significant and negative. This is an unexpected result since higher education levels are usually correlated with higher quality neighborhoods. The economic and geographical attributes variables used in the estimation of the hybrid model are all significant and of the expected sign. The level of economic activities, as captured by the per capita number of retail businesses, is positive and significant, suggesting that shopping opportunities increases the desirability of a neighborhood. In addition, the percentage of old housing units is significant and has a negative influence on household location choice, as expected. Travel time to downtown Columbus is negative and significant, suggesting that the farther a location is from downtown Columbus, the lower the probability that a household will choose to locate there.

Lastly, we consider the influence of the individual-specific terms on household location choices. Because of the dummy interaction approach that allows these terms to be included in the conditional logit model, the model generates estimates of location-specific parameters, normalized to a particular location, for each of these individual variables.

Therefore each individual-specific variable has J-1 (in this case, seventeen) estimates associated with it. In the results presented in Table 2B, the interaction terms are normalized on the Worthington school district, which is one of the most desirable areas of Columbus. The interaction of household specific income with location alternatives shows that when income increases, households are significantly more likely to prefer Bexley, Plain Local and Upper Arlington school districts over the Worthington school district. Not surprisingly, these school districts are among the most desirable and exclusive places to live in Franklin County. On the other hand, the estimates show that Worthington is a better place to live for higher income households relative to the central city school district, Columbus, and the southern school districts of Canal Winchester, Groveport, Hamilton and South Western. The second individual-specific variable is the interaction between households with school-aged children and location choice. Again, these results are relative to the desirability of Worthington as a location choice. Not surprisingly, the results suggest that Worthington is one of the preferred destinations of households with school-aged children. In particular, we find that the probability of a household with school-aged children choosing the central city school district of Columbus is significantly lower relative to Worthington.

Discussion of Results

Our results indicate that, not surprisingly, households have a strong preference for safer neighborhoods and neighborhoods with higher school quality. These results support other findings in the literature that point to the role of high crime rates in the suburbanization process, including those of Bradford and Keleijian (1973) and Cullen and Levitt (1996). Like many U.S. metropolitan areas, higher crime rates are centralized in the Columbus MSA and therefore act to push households out of the central city. In addition, our results are also consistent with other findings in the literature (e.g. Bogart and Cromwell, 2000) with respect to the positive influence that quality of schools has on the desirability of a location as a residential location. Given the relatively low quality of the school in the central city school district of Columbus, our findings support the claim that better schools in the suburbs fuel "flight from blight" from the central city. We find that, holding crime rate constant, households have a preference for localities that spend more on

recreational activities relative to public safety. To the extent that public parks and recreational centers are more available in the suburbs, these public goods could be an additional reason motivating households to move outward. Lastly, our results do not offer any evidence in support of Gyourko and Voith's (1997) argument that taxes and subsidies have shaped U.S. metropolitan areas, given that the tax revenue variable was not found to be significant. In summarizing the public service and fiscal effects, our results point to the importance of safety, school quality and recreational opportunities in determining household location decisions. These results provide strong empirical evidence for the Tiebout hypothesis that argues that households will respond to the quality of public services in a jurisdiction and they support the "flight from blight" hypothesis, given the lower levels of public safety and school quality in the central city.

Other variables that relate to the "flight from blight" hypothesis include the socio-demographic variables associated with neighborhoods. Many scholars have argued that this plays an important role in driving affluent white households out of central cities, where the population is more diverse (South and Crowder, 1997). The results we obtained from the regression do not provide any evidence in support of this theory. The coefficient of the racial composition variable coefficient is not significant, implying that in Columbus, racial considerations do not greatly impact households' location choices. However, it is likely that this lack of significance reflects the fact that, outside of a couple of school district areas, the proportion of the population that is African American is relatively small, resulting in a relatively small amount of variation in this variable across the choice set. Two other key socio-demographic variables -- density and unemployment rate -- turn out not to significantly influence households location decision. We do find evidence that increases in the owner occupancy rate have a positive effect on the probability of choosing a location, suggesting that homeowners will choose a location with high homeownership rate over any other, *ceteris paribus*.

Turning now to variables that would provide evidence of the natural evolution/lifecycle theory of suburbanization, our results support the theory that households have a preference for newer housing (Levernier and Cushing, 1994). We find

that the older the housing stock is, the less likely households are to choose a location. This is an important result in support of the natural evolution theory, which holds that changes in a household's income and size will push houses to suburban locations, since, due to land availability, only the new homes that are built in suburban locations are able to take into account such changes in housing structure and size preferences. Based on this reasoning, we conclude that the positive and significant result on this variable provides evidence of household preferences for newer housing in suburban locations, *ceteris paribus*.

The level of business activities in the neighborhood has a positive impact on the probability of choosing a location. Scholars argue that there is a suburbanization of employment and households is a phenomenon where the causality goes both ways (Thurston and Yezer, 1994). The results show the number of retail businesses has a positive impact on a household facing a location choice. The presence of retail business in a location is attractive because it assures the availability of private goods and reduces the cost of searching (both in terms of time and distance). However, evidence in support of the traditional urban spatial structure is also found. Travel time to downtown Columbus is found to negatively influence household choice, suggesting a counter-suburbanization tendency. Locations close to Columbus are preferred over location farther away. In summary, the overall geographic location and physical appeal of a location has a significant impact on households' decision processes.

Lastly, there is evidence of the importance of the importance of household lifecycle characteristics in influencing residential choices. This is particularly so for the influence of both income and school-aged children on a household's probability of choosing the central city location (Columbus) relative to a suburban location (Worthington). In both cases, we find that increases in these household-specific variables will lower the probability of a household's move to the central city. These results provide further evidence in support of the natural evolution theory.

While the reported estimates in Tables 2A and 2B indicate the direction of the effects, they do not give an indication of the magnitude of the effects. This is because of

the nonlinear structure of the model, which generates estimates that are not equal to the marginal effects of the corresponding variable. To understand the relative magnitudes of the variables of interest, we conducted an inter-location analysis by computing the effect of a percentage change in a selected set of the location variables on the percentage change in the probability that a household chooses a particular school district from the choice set. These elasticities are derived by computing the percent changes in the probability of the kth alternative given a one-percent change in the level of a particular variable associated with alternative j, where k = 1,..,j,..J.

Among the policy variables that decision makers have available to them are policies that either directly or indirectly affect the quality and quantity of publicly provided services within their local jurisdiction, including public safety, school quality, and leisure. In addition, local jurisdictions may be able to influence their owner occupancy rate through incentive programs to homeowners. We first investigate the effect of a percentage change in the crime rate, school quality, and the owner occupancy rate in Columbus on the percentage change in the probability of choosing Columbus vs. a location in the surrounding suburbs. Table 3 presents in percentage terms the changes in choice probabilities that will results from a 1% change in these location characteristics. We find that reducing the crime rate in Columbus by 1% will only increase the probability of a household choosing Columbus by 0.3%. The most that this change is estimated to affect the choice probabilities of other locations is a reduction of just 0.1% for Whitehall, followed by 0.08% for Dublin. The small changes in location choice probabilities suggest that households are not sensitive to *marginal* crime rate changes in Columbus.
The second variable that we test for is the percentage of teachers with a master's degree. Our results suggest that efforts to improve school quality would be more effective as a policy tool aimed at retaining existing households and attracting new households than are improvements in safety. We estimate that a 1% increase in the percentage of teachers with a master's degree will generate a 6.8% increase in the probability of a households choosing Columbus. The increase in the percentage of teachers with a master's degree in Columbus is predicted to have a negative impact on the desirability of its surrounding suburban neighbors. On the other hand, a marginal change in the ratio leisure expenditure over

expenditure on security is not predicted to influence either the probability of choosing Columbus or the probability of choosing another school district. Lastly, our study suggests that 1% increase in the owner-occupancy rate within Columbus would increase the probability of a household choosing Columbus by 4.9%. To summarize, of the four local policy variables that were significant in the model, improving school quality and increasing the owner occupancy rate are the two that are predicted to be the most effective in the context of retaining and attracting households to Columbus. Reducing the crime rate is important, but is a marginal improvement that does not trigger a significant increase in the probability that a household chooses Columbus school district as residential location. An increase in spending on leisure relative to security in Columbus is not found to significantly alter the location choice probabilities at all.

In addition to the policy variables considered above, we are also interested in considering the impact of a change in a variable that is largely exogenous to *Columbus* policies on the probability of a household moving to Columbus. Those variables include changes in selected *suburban* locations' characteristics, including school quality, crime rate, and congestion. Table 4 presents the effects of a change in these characteristics for selected suburban school districts on the probability that a household would move to Columbus. In general, we do not find that changes in public services of these suburban locations trigger a substantial movement of households into the central city. For example, 1% changes in the crime rate in Upper Arlington and in Worthington generate and increase in the probability that a household will choose Columbus of 0.04% and 0.01% respectively. Improvements in school quality in these two locations are found to have slightly larger impacts, lowering the probability of choosing Columbus by 0.4% and 0.2% respectively. Finally, changes in the congestion levels associated with these suburbs would have a fairly minor impact on Columbus. For example, a 1% increase in congestion in Dublin would increase Columbus' probability choice by 0.8% and a 1% increase in commuting time from South-Western by 0.4%. On the other hand, when we consider how these changes affect the probability of a household moving to another *suburban* location (these results are not reported here), we find that these changes are much more likely to trigger movement to one of these locations, e.g. given a 1% change in the school quality of

Hilliard, an outer suburban school district, we find changes in the probability that a household will move to a surrounding suburban school that range from 1.2% to 1.4%.

Lastly, to test the magnitude of the lifecycle variables that associate changes in individual household characteristics with a change in the probability of a move, we compute the effect of a marginal change in a household's income for Columbus and selected suburban districts. Table 5 reports the results from this exercise. The results show that a marginal increase in income reduces the probability of a household choosing to move to Columbus by 0.41% relative to the probability of moving to Worthington. In other words, as income increases, there is a *decrease* in the probability that a household will choose to live in the central city vs. the suburban location of Worthington. This result supports the "natural evolution" theory, which suggests that a change in households' socio-demographic characteristics affects the probability of a choosing a central location. In addition, we find that the effect of a marginal increase in income is larger for lower income suburban school districts (e.g. Groveport, South Western and Whitehall) than it is for Columbus or other wealthier suburbs. This indicates that households in relatively poor suburban school districts are more responsive to an increase in income that households centrally located or that are already located in wealthier suburban districts. Lastly, the sign of the effect of a marginal change in income on the probability of choosing Upper Arlington and Plain Local, the wealthiest school districts in Franklin County, is positive. As income increases, household preferences for these wealthy residential location increases relative to their preference for Worthington.

A comparison of the income elasticities reported in Table 5 and the crime rate elasticities reported in Table 3 presented in the previous section does not allow any general conclusion regarding the relative importance of these two variables to be drawn. This is because there is not a clear dominance of one variable over the another across all locations. Depending on the school district, either the income effect dominates the crime effect (e.g. Columbus, Groveport, South-Western) or vice versa, the crime effect dominates the income effect (e.g. Dublin, Upper Arlington, Westerville, Whitehall). However, a general trend does emerge across all jurisdictions from the comparison of the elasticities of income

and school quality. For each of the school districts considered here, the increase in the probability of a household moving to that district given a marginal increase in its school quality (as proxied by the percentage of teachers with a master's degree) is much larger than the effect of an increase in a household's income level on these choice probabilities. For example, given a 1% increase in a household's income, the probability of this household moving to Columbus is reduced by 0.4%. On the other hand, a 1% increase in school quality in Columbus is estimated to increase the probability of a household moving to Columbus by 6.8%. The difference in these magnitudes is substantial. Put in terms of a hypothetical example, suppose that one thousand households currently live in Columbus choose to relocate either within Columbus or to a suburban location. A 1% increase in school quality will result in an average of 68 *additional* households that would have otherwise chosen to relocate in a suburban school district (in this case, Worthington) will choose to remain in Columbus. On the other hand, supposing that these one thousand households all experience a 1% increase in their income level, an average of an *additional* four households would leave Columbus for the suburban location as a result of the increase in income.

Conclusion

Several different theories have been forwarded in the literature to explain the causes of suburbanization in the U.S. The "natural evolution" theory emphasizes the role of household-level changes, e.g. changes in income levels, household size, and other attributes that would result in a change in households' demand for newer housing located in suburban areas. On the other hand, the "flight from blight" hypothesis, which derives from the Tiebout model, emphasizes the role of declining public services and quality of life in the central city relative to suburban locations. A central research question is the extent to which suburbanization is the result of deteriorating quality of life in central cities that push households to suburban locations vs. the result of a "natural evolution" of households, in which changes in household income levels, size, and other attributes result in a change in households' demand for newer housing located in suburban and rural areas.

By considering both individual and location specific variables in our model, we are able to distinguish the influence of specific public service variables from the influence of

important household-level characteristics that are hypothesized to influence location decisions. The inclusion of these individual-level variables allows us to relax the restrictive assumption that households are homogeneous and allow for variation across households in two of the most important dimensions that are hypothesized to affect household location choice: income and the presence of school-aged children in the household. This represents a significant improvement over other studies in the literature that have focused either exclusively on the influence of household characteristics on location choices without regards to the heterogeneity in locations or, vice versa, on the influence of location attributes on household location decisions without consideration of the heterogeneity that exists among households.

Our results provide evidence of both a "natural evolution" of households, due to income and household structural changes, as well as "flight from blight," due to higher crime rates, lower school quality, and lower quality of housing stock in the central city. We find that these forces act together to shape the Columbus metropolitan population distribution pattern. By using the estimated parameters to calculate the marginal effects of these variables, we are able to identify their relative magnitudes. An analysis of the effect of a change in income of the probability of choosing a location shows that when income increases, so does a household's preference for wealthy suburban location. However, the income effect is found to not be as important as is the school quality effect, as proxied by the percentage of teachers with master's degree. For all jurisdictions, we find that a change in household income does not have as large an effect on the choice probability as does a change in the quality of public schools. This was found to be particularly true for Columbus, for which the school effect was estimated to be on the order of seventeen times the magnitude of the income effect in terms of its effect on a household's location choice probability.

This finding has important policy implications for central cities and inner suburbs that seek to counteract the movement of population to the outer suburbs and beyond. Rather than being largely a result of the "natural evolution" of households as incomes grow over time, our results provide evidence that local jurisdictions do have significant control over retaining their residents by focusing on the improvement of specific public

services, most notably public schools. Such improvements could help to reverse the self-reinforcing "flight from blight" pattern that has historically characterized the movement of higher-income households from the city to the suburbs: as public services decline, an increasing number of non-poor households move out, which lowers the tax base in the central city and brings further declines in public service levels. The results of this study support the notion that this trend could be counteracted to some extent by improvements in public services, particularly public school quality. In fact, one could envision this self-reinforcing trend in reverse. There is some evidence that better schools attract more homeowners who are believed to be active participants in the improvement of their neighborhood by investing in their house (Aaronson, 2000). The increase of housing values will in turn increase the tax revenues of the central city and could support additional improvements in the public schools. From the social side, homeowners are likely to be more involved in neighborhood activities that make their community a better place to live (DiPasquale and Glaeser, 1998). However, the counteracting life-cycle effects should not be discounted altogether. Changes in household income and composition are significant factors and can be expected to continue to influence household preferences for larger lots and newer houses, which will push households outward regardless of changes in public service levels. We conclude that there is likely to always be a natural evolution of household movement outward, but that results from this research suggest that this movement can be significantly altered by improvements in the public service levels in the central city relative to the suburbs.

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Table 1: Selected School District Variables

School District	*Population (1994-95)*	*General Fund revenues per capita*	*Total expenditures per capita*	*Security expenditures per capita*	*Leisure expenditure per capita*	*Tax rate by $100*	*Average commute time*
Bexley	13,088	$477.72	$422.00	$229.27	$28.74	79.86463	4
Canal Win.	3,280	$1,565.27	$2,264.00	$78.56	$47.09	48.852272	15
Columbus	632,910	$652.27	$582.00	$401.52	$0.00	48.627507	0
Dublin	18,500	$1,450.90	$968.00	$7.94	$74.05	70.44688	20
Gahanna	27,791	$501.09	$379.00	$116.13	$28.99	63.765523	18
Grandview	7,269	$857.96	$707.64	$367.31	$82.28	63.435737	5
Grove Mad	3,113	$313.09	$1,472.00	$214.47	$93.32	54.400452	19
Hamilton	3,800	$715.04	$609.36	$208.59	$66.82	60.829004	16
Hilliard	15,779	$633.29	$590.00	$250.63	$104.73	68.282835	18
Madison	7,807	$230.97	$217.00	$137.17	$20.33	49.3	33
Plain Local	1,648	$1,573.72	$1,716.00	$446.33	$0.00	57.667685	27
Reynoldsburg	25,800	$119.89	$264.00	$146.73	$29.01	56.169795	19
South West	19,661	$602.31	$515.00	$166.91	$29.25	62.043602	15
Up. Arlington	34,245	$691.22	$494.00	$258.91	$49.30	61.438799	8
Westerville	30,269	$693.15	$458.00	$172.71	$0.00	61.140676	24
Whitehall	21,000	$639.07	$587.00	$279.41	$20.13	56.159411	17
Worthington	14,882	$903.98	$719.00	$373.88	$79.45	60.790765	17

Table 2A: Location-Specific Variable Estimates from the Hybrid Conditional Logit Model of Residential Choice

Location-Specific Variables	*Estimate*	*Probability [|Z|>z]*
Crime per capita	-20.46	0.00
Teacher with master degree (%)	0.20	0.03
High school drop rate (%)	-0.33	0.25
Leisure expenditure relative to security	0.57	0.02
Tax revenue	-0.0015	0.17
African-American population (%)	-19.25	0.52
Population per unit of housing (average)	1.14	0.25
Density (logarithm)	-2.52	0.11
Residents with college degree (%)	-24.96	0.00
Owner occupancy rate	15.73	0.07
Median income per capita	0.77	0.42
Unemployment rate (logarithm)	-0.17	0.93
Commuting time to CBD	-0.26	0.00
Number of retail businesses per resident	82.12	0.00
Houses built before 1970 (%)	-17.38	0.00

Table 2B: Individual-Specific Variable Estimates from the Hybrid Conditional Logit Model of Residential Choice

Individual-Specific Variables	*Estimate*	*Probability | Z | >z]*
HOUSEHOLD INCOME		
Bexley	0.57	0.00
Canal Winchester	-0.023	0.86
Columbus	-0.15	0.04
Dublin	-0.036	0.64
Gahana	0.043	0.58
Grandview	0.093	0.49
Groveport	-0.37	0.00
Hamilton	-0.44	0.05
Hilliard	0.0091	0.90
Madison	-0.25	0.50
Plain Local	0.25	0.02
Reynoldsburg	-0.10	0.38
South_Western	-0.14	0.07
Upper_Arlington	0.16	0.04
Westerville	-0.067	0.39
Whitehall	-0.27	0.35
SCHOOL-AGED CHILDREN		
Bexley	-0.36	0.64
Canal Winchester	-2.25	0.00
Columbus	-3.19	0.00
Dublin	-2.33	0.00
Gahanna	-1.55	0.00
Grandview	-0.15	0.85
Groveport	-0.95	0.10
Hamilton	2.31	0.45
Hilliard	-0.80	0.04
Madison	0.080	0.96
Plain Local	-0.67	0.31
Reynoldsburg	-0.72	0.21
South_Western	-0.97	0.01
Upper_Arlington	-0.64	0.17
Westerville	-0.45	0.27
Whitehall	-2.75	0.02

Table 3: Estimated Marginal Effects (in Elasticity Terms) of Selected Columbus School District Characteristics on Choice Probabilities of Selected School Districts

School District	*Crime per capita*	*Teacher w/ MS degree*	*Owner Occupancy rate*	*Leisure expenditure relative to security*
Canal Winchester	0.081	-1.813	-1.307	0.00
Columbus	-0.303	6.794	4.898	0.00
Dublin	0.083	-1.868	-1.347	0.00
Whitehall	0.101	-2.256	-1.626	0.00

Table 4: Estimated Marginal Effects (in Elasticity Terms) of Selected Suburban School District Characteristics on the Columbus School District Choice Probability

Suburban School District	*Crime per capita*	*Teacher w/ MS degree*	*Congestion (increase of commuting time)*
Upper Arlington	0.044	-0.451	0.090
Worthington	0.018	-0.419	0.201
Whitehall	0.025	-0.068	0.031
Dublin	0.034	-1.488	0.875
Groveport	0.005	-0.262	0.134
Westerville	0.028	-0.722	0.433
South-Western	0.045	-1.001	0.441
Hilliard	0 .042	-0.807	0 .489

Table 5: Estimated Marginal Effects (in Elasticity Terms) of Income on Choice Probabilities of Selected School Districts (normalized on the Worthington School District)

School District	*Household Income*
Columbus	-0.415
Dublin	-0.120
Groveport	-0.977
Hilliard	0.031
Plain Local	1.314
South-Western	-0.430
Upper Arlington	0.713
Westerville	-0.222
Whitehall	-0.812

Map 1: School District Choice Set
Franklin County, Ohio