IMPACT OF LOCAL PUBLIC SERVICES AND TAXES ON DWELLING CHOICE
WITHIN A SINGLE TAXING JURISDICTION: A DISCRETE CHOICE MODEL

Bulent Uyar
Economics Department
College of Business Administration
University of Northern Iowa
Cedar Falls, IA 50614-0129
e-mail: uyar@uni.edu

and

Kenneth H. Brown
Economics Department
College of Business Administration
University of Northern Iowa
Cedar Falls, IA 50614-0129
e-mail: Ken.Brown@uni.edu

JEL Classification: R20; C25.
Key Words: Local public finances; dwelling and neighborhood choice; discrete choice models.

January 23, 2004

NOTICE: This material may be protected by copyright law (title 17, U. S. Code)
IMPACT OF LOCAL PUBLIC SERVICES AND TAXES ON DWELLING CHOICE
WITHIN A SINGLE TAXING JURISDICTION: A DISCRETE CHOICE MODEL

ABSTRACT
All discrete choice models of household location assume local public finance variables remain the same in a given taxing jurisdiction. To our knowledge, no such model has actually tested to see how valid the assumption is. We use McFadden’s (1978, 2001) discrete choice model to test for the significance of dwelling-specific local taxes and public services on household location decisions within a single taxing jurisdiction. We find that such variables are significant determinants of location decisions even within a single taxing jurisdiction, and they should not be assumed away. This is important because failure to include such variables in a model may, therefore, result in biased statistical results. (R20; C25)
Impact of Local Public Services and Taxes on Dwelling Choice Within a
Single Taxing Jurisdiction: A Discrete Choice Model

I. Introduction

The discrete choice models of household location decisions all have a common assumption: local public finance variables such as taxes and public services vary across different taxing jurisdictions but remain the same in a given taxing jurisdiction. To our knowledge, no discrete choice model of household location has actually tested to see whether taxes and public services are the same in a given jurisdiction. This is an important point because if the statistical results do not support the assumption, the estimates based on that assumption will be biased.

In this paper, we apply McFadden’s (1978, 2001) discrete choice (multinomial logit, MNL) model to a single municipality that is coterminous with a school district, and test for the impact of dwelling-specific local taxes and public services on household location decisions within that municipality. Our results show that such variables are statistically significant determinants of location decisions even within a single jurisdiction, and they should not be assumed away. Failure to include such variables in a model may, therefore, result in biased statistical results.

II. Previous Literature

The household location literature has developed along two methodological tracks (Nechyba and Strauss, 1998). Most of the earlier studies use hedonic price models. More recent studies employ discrete choice models. Hedonic price models are essentially capitalization
studies and "it remains unclear to what extent empirical evidence on capitalization can inform us about the importance of (such variables) in (household) location choice." (Nechyba and Strauss, 1998, p. 53.) In addition, the choice of a dwelling involves selection from among discrete bundles of attributes and is, therefore, an "all-or-nothing" decision (Friedman, 1981, p.348). Hedonic price models cannot properly account for choices among discrete bundles either.

For these reasons, discrete choice models are better suited than hedonic price models for studying household location decisions. In discrete choice models, the decision maker seeks to maximize utility by finding the most desirable alternative out of the many heterogeneous and discrete alternatives available (Earnhart (2002), McFadden (1978, 2001)). Most discrete choice models of housing markets to date have investigated household tenure decisions (to own or to rent) and/or transportation choices.\(^2\) There have been relatively few discrete choice models that have attempted to incorporate the impact of local public finances on household dwelling choice. Even then, however, such studies have focused on location decisions among "neighborhoods" located in different taxing jurisdictions such as cities and even counties.\(^3\) (See, for example, Bajari and Kahn (2001), Bayer et al. (2002), Chattopadhyay (2000), Friedman (1981), Lerman (1979), Nechyba and Strauss (1998), and Quigley (1985).) In doing so and as succinctly summarized by Chattopadhyay (2000, p.26), they have all made the same assumption concerning the local public finance variables:

Characteristics, such as property tax rates and quality of public services, vary across cities but remain the same within a city. Similarly, within a city the neighborhood attributes, such as general standard of living, vary across neighborhoods or census tracts and remain the same within a given neighborhood.
We contend that this assumption oversimplifies the actual decision making process and may have led to biased statistical results in the existing discrete choice models of household dwelling choice.

There are several reasons why this approach oversimplifies the actual decision making process. Households compare taxes in different jurisdictions. With all else the same, a utility maximizing household selects the jurisdiction with the lowest tax burden, however defined.\(^4\) Once a household finds its most preferred neighborhood (however defined) in its most preferred jurisdiction, its focus is on identifying its most preferred dwelling in that neighborhood. This means that the interjurisdictional differences in taxes are internalized in all the decisions already made by that stage, and the household, therefore, has to take as given the nominal tax rates prevailing in the chosen location. This, however, is not the end of the decision making process. At this stage, it is the effective tax rates that vary across the dwellings available in that location and have to be considered next by the household. After all, each dwelling implies a specific tax burden for the potential buyer. By the same token, while it is true that the level and the quality of public services vary across jurisdictions\(^5\), it is not necessarily true that the “public services remain the same within a city.” Even a casual drive through any jurisdiction or neighborhood often reveals rather drastic differences in the delivery and quality of public services from one street or even block, to the next. Thus, even within a single taxing jurisdiction, a utility maximizing household selects the dwelling-neighborhood combination that matches its most preferred tax burden-public service combination.

So far as we know, no discrete choice model of household dwelling location has tested for the statistical significance of the differences in effective tax rates or public services within a single jurisdiction. If the differences are statistically insignificant, then the assumption made in
the prevailing literature would be justified. If the differences are statistically significant, however, the exclusion of the relevant variables from the model would bias the estimation results. Furthermore, if the model is a nested multinomial logit model (NMNL), the bias would be transmitted from the dwelling-level estimates to the other levels through the inclusive values. To our knowledge, ours is the first discrete choice model testing for the impact of dwelling-specific, effective property tax rates and local public services on household location decisions in a single taxing jurisdiction. Our results show that these variables are statistically significant; therefore, they should be included in models of household choice rather than being assumed away.

Our study area is a midsize municipality in the Midwest. According to the Census reports, it had a population of approximately 45,000 at the time of the study. It is a single fiscal jurisdiction, and includes a single school district that is divided into ten school “zones” for administrative purposes. Thus, school expenditures per pupil are constant throughout the city. Families are required to enroll their children at the school located in the zone where they live. The nearest urban settlement of comparable size and employment opportunities is 75 miles away. Thus, we are able to treat our municipality as a single, self-contained job market and control for the impact on household location of a number of local public finance variables while still including the school achievement scores, condition of the streets, and the effective property tax rates in our multinomial logit model. The last two variables are our dwelling-specific local public finance variables.
III. The Model

In our model, a household (m) chooses a dwelling (i) and a neighborhood (n) in a single taxing jurisdiction. The objective of the household is to locate the dwelling-neighborhood combination that maximizes its utility subject to household income. The utility, \( U_{inm} \), of any of the alternatives available to a household is

\[
U_{inm} = V_{inm} + \epsilon_{inm}. \tag{1}
\]

\( V_{inm} \) is a (linear-in-parameters, additive) function of all the measured, observable characteristics, and \( \epsilon_{inm} \) represents the residual for the impact of unobserved, "unmeasured variables, personal idiosyncracies, imperfections in perception and maximization" (Maddala, 1996, p. 68). If the \( \epsilon_{inm} \) are i.i.d. with the extreme-value (Weibull) distribution, the joint probability that a household (m) will choose a dwelling (i) and neighborhood (n) from the feasible alternatives (\( S_m \)) is given by the multinomial logit model,

\[
P(i, n \in S_m) = e^{V_{inm}} / \sum_{j \in S_m} e^{V_{jm}}. \tag{2}
\]

where \( e \) is the exponential function.

Given its own needs and characteristics, a household’s perception of a dwelling relative to the alternatives is based on two sets of attributes. One set consists of the socio-economic characteristics of the neighborhood (\( Z_n \)) where a dwelling is located. The other consists of the attributes (\( X_i \)) directly associated with the dwelling itself. These dwelling-specific variables include the structural attributes of the dwelling, its accessibility to employment centers, and the local public services enjoyed by the dwelling vis-à-vis the “tax cost” implied by owning it. As a result, equation 2 above can be expressed as:
\[ P(i, n \in S_m) = \left( e^{x_i' \alpha + n \beta} \right) \left/ \left( \sum_{j \in S_m} e^{x_j' \alpha + n \beta} \right) \right. \]

We use maximum likelihood to estimate the parameter vectors \( \alpha \) and \( \beta \).

This model is based on the assumption of "independence of irrelevant alternatives" (i.i.a.). In other words, "the odds of choosing housing unit (i) relative to (j) are independent of the characteristics of all other alternatives available to consumers" (Quigley, 1985, p.43).

McFadden (1978) and Quigley (Ibid) have shown that i.i.a. may not be a realistic assumption in models of dwelling choice. Unfortunately, equation (3) itself cannot be used directly to test the validity of the i.i.a. assumption. The proper approach is the nested multinomial logit model, which is an extension of equation (3). As Chattopadhyay (2000, p. 24) states: "economic theory does not provide guidelines on the exact nature of appropriate nesting hierarchies," either. (Also see Quigley, Ibid.) As a result, the validity of the i.i.a. assumption and the proper nesting strategy in a given model have to be determined empirically and together.

For this study, we tested for numerous two- and three-level nesting strategies, using various "neighborhood" designations to define the choice sets for the households. They included geographic areas (census bloc-groups, census tracts), administrative areas (school "zones"), and a number of social and economic descriptors (percent white, percent poor, median income, school achievement scores, etc.). In no instance were we able to reject the null hypothesis that i.i.a. holds for our model. Therefore, i.i.a. is our maintained hypothesis.

IV. Data, Sampling, Variables, and Empirical Results
A. Data and Sampling

We have data for 710 dwellings sold during a two year period in a mid-size city in the upper Midwest. The city is a single taxing jurisdiction, coterminous with one school district. The sources of data include the city assessors' office\(^9\), Census Tapes, the State Tax Department, and the Office of the Assistant Superintendent of Elementary Education.

As recognized in the literature, computational considerations necessitate that the number of alternative dwellings faced by a household be small; therefore, we estimate equation (3) using a sample of dwellings taken according to McFadden's (1978) "uniform conditioning property" (see, e.g., Bayer, et al, (2002, pp. 28-30), Chattopadhyay (2000, pp. 28-29), Quigley (1985, pp. 45, 47-49)). In most of the literature, all dwellings that change hands throughout the entire study period are assumed to constitute the set of dwellings available to a household. Samples are then taken from this entire set, irrespective of when that household may actually be in the market. In reality, the length of time from when a household enters the housing market until it purchases a unit is usually a few months. The dwellings available outside a household’s "transaction window" are irrelevant for that household. By the same token, when an offer is made on a dwelling, it is essentially withdrawn from the choice set available to the rest of the households. As Lerman (1979, p. 85) states, "... the set of (feasible) alternatives \((S_m)\) can vary from decision maker to decision maker." Thus, in order to reflect the market conditions more realistically, we define the transaction window for a household to be three months. Therefore, we first identify all the houses that were sold anywhere in the city during the same month a household bought its dwelling as well as in the months before and after.\(^{10}\) Only these dwellings constitute the relevant set of alternatives \((S_m)\) for that household. We then pick three dwellings at random from \(S_m\), as the alternatives the household has "rejected." McFadden (1978) has shown that the uniform
conditioning property gives consistent estimates.

Some descriptive statistics for the chosen and the rejected dwellings resulting from the application of McFadden's sampling rule are presented in Table 1. The average dwelling chosen is 1,259.56 square foot and has 2.98 rooms. It is 36.8 years old and sells for $56,100. In addition, 2.1% of the chosen dwellings have less than one full bathroom, 81.80% have a basement, 17.30% a four-season porch, and 18.50% are located near the river. The average household has a (gross) income of $34,800. The average school test score in the chosen school zones is 7.00. In the chosen census block groups (CBG), on the average, 61.14% of the homes are owner-occupied, 3.04% of the residents are non-white, 9.41% are below the poverty line. The median age across the chosen block groups is 28.49, and slightly less than 50% of the residents who are 25 years old or older have at least 13 years of schooling. Table 1 shows that the descriptive statistics for the rejected dwellings are quite comparable to those for the chosen dwellings.

B. Empirical Results

Results are reported in Table 2. Variables 1-14 are for dwelling, household, and locational characteristics most often used in the literature. We have two variables for dwelling size, namely, the number of rooms (excluding the bathrooms and the kitchen) and the average size per room. Their coefficients are positive and significant. Households prefer houses with more rooms but they also want the rooms to be spacious. The "garage" variable accounts for the availability and the type of parking space. There are four categories, ranging from no parking on the premises (category 1) to built-in, attached stalls (category 4). The empirical results show that households prefer dwellings with "better" parking facilities. Dwellings that only have a three-fourths bath or where the shower and/or the tub is in a room separate from the lavatory, are classified as having "less than one full bath." As expected, such homes are less likely to be
chosen than those with at least one full bathroom. Having a four-season porch also increases the appeal of a dwelling for the households. Age is a proxy for depreciation and the need for possible upgrading that an older house is likely to require. The results clearly show that older houses are less likely to be preferred. Dwelling price per square foot of heated floor space is a proxy for dwelling quality, its style, and the various built-in features. As expected, households are willing to pay more for higher quality houses with more built-ins.

The next three variables (variables 8-10) need to be examined together. Houses that are “near (the) river” are those which the assessors’ office has coded to be located in the “flood zone.” Virtually all such dwellings are located within easy walking distance (a hundred to a hundred and fifty yards) of the river. While being in a flood zone may be of concern, there are also some obvious amenities associated with being near a river, such as the opportunities for sailing, fishing, picnicking and, for some dwellings, the view. Our empirical results indicate that the attraction of locational features outweighs households’ concerns regarding the threat of a flood. This is not at all surprising. After all, for most people flooding is only a remote possibility whereas environmental features are tangible and always there. Most homes in the city have basements and, by itself, whether a dwelling has a basement is not a statistically significant factor in the decision making process. When we interact the “basement” variable with “near (the) river,” however, the coefficient is significant and negative. In general, houses with basements are more vulnerable to even minor flooding through the basement and our results show that where houses near the river are concerned, households prefer units with no basements.

Net household income is the income left for non-housing expenditures after property taxes, home insurance premiums, principle, and finance charges are paid. Our results show that households prefer higher net income (that is, higher income or lower housing expenditures) but
as the sign of the squared net income variable shows, at a decreasing rate.

The “access” variable is a gravity-type accessibility index. We derive the access index for each dwelling by normalizing “the sum of (a dwelling’s) relative accessibility” over all three employment-shopping-entertainment centers in the city. The normalization factor is the sum of the taxable sales at these centers. All else equal, the index is inversely related to distance. Our results show that given that this is a rather small jurisdiction, households in general prefer dwellings that are on the average farther from the relative congestion of the employment-shopping-entertainment centers. However, there is also a trade-off with net income; households prefer homes closer to these centers if close proximity entails lower housing costs (and, therefore, higher discretionary income). These results are consistent with the development patterns in the city. Newer and better homes form a ring around the city. As a result, the congested inner circle has emerged as the home to dwellings that are in general older, smaller, and cheaper.

Variables 15-17 are our local public finance variables. We first test for the impact of school “quality” on dwelling choice. The city consists of a single school district. For administrative purposes, it is divided into ten school zones. Children are required to attend the school located in the zone where they reside. Since the city is the school district, school expenditures per pupil are the same across all schools and school zones. Our variable for school quality is the school test score. Table 1 shows that the variable is statistically insignificant. This is not unexpected. The municipality is rather homogeneous in its ethnic, socio-economic make-up. As can be seen from Table 1, the “disadvantaged” constitute a relatively small percentage of the population. Since the entire city is one school district, competition for resources (including students) is not the issue it might have been had there been several school districts. Perhaps as a
result, households do not consider "score" to be a significant factor in their location decisions.

The other two local public finance variables are the dwelling-specific variables. The effective property tax rate is the property tax paid per one hundred dollar of purchase price. As expected, with everything else the same, a higher effective property tax rate makes a dwelling less desirable. Obviously households are sensitive to the tax burden associated with each individual house in their choice set. The variable "streets" refers to the condition of the street on which a house is located. Perhaps the most tangible indicator of dwelling specific differences in the quality and delivery of public services in any neighborhood is the output of public works department, namely, the condition of the streets, curbs, gutters, and sidewalks. Table 2 shows that being on a paved street (with curb and gutter) makes a dwelling more desirable than dwellings located on other types of streets (not paved and/or without a curb or gutter). These results show that even though the city in question is a single taxing jurisdiction with the local nominal tax rates the same for everyone, households still respond to differences in effective tax rates across housing units. In addition, if households perceive property taxes they pay as their share of the "price" for municipal services, they may view the condition of their street as the most immediately apparent indicator of the "quality" of public services they are purchasing in return. These results underscore the importance of testing for the significance of such variables even at the level of a single taxing jurisdiction in discrete choice models.

We have also tested for the impact on the household location decision of a number of "neighborhood" variables at the level of census block groups and school zones, respectively. The variables included: the percentage of owner-occupied housing, the percentage of nonwhites, the percentage of people below the poverty level, median income, median age, and the percentage of people with at least one year of college education. None were statistically significant. Since this
is a rather small municipality, we were not able to find any crime statistics for individual
“neighborhoods” in the city; however, the city itself is rated as a “safe” one. There are more than
half-a-dozen parks (green areas) within the municipal boundaries, rendering proximity-to-parks
irrelevant as a determinant of dwelling choice. In addition, we also tested for “fixed”
neighborhood effects at the level of census block groups and school zones. They were not
statistically significant either. As an example, we include the results for the school zones in
Table 2. Variables 18-26 are the nine dummy variables for the fixed neighborhood affects
associated with the ten school zones.15

The coefficients in such models are not easy to interpret. For that reason, we also present
the “odds ratios” in Table 2. The odds ratios are the exponents of the original coefficients. For
example, the variable “four-season porch” assumes a value of 1 or 0 depending on whether a
dwelling has such a porch. Its odds ratio is 1.428. Thus, our model predicts that all else equal,
the odds that a house with a four-season porch will be chosen are 1.428 times the odds for a
house without one; in other words, the odds of it being selected are almost 43 percent higher.
The “bathroom” variable is assigned a value of 1 for a house with no full bathroom and 0
otherwise. Its odds ratio is 0.490. This implies that the odds that a house without a full bathroom
will be chosen are 51 percent lower than the odds that a house with at least one full bath will be
chosen. The best way to interpret the odds ratio for nonbinary variables is by subtracting 1 from
the odds ratio and multiplying the result by 100. “This tells us the percent change in the odds for
each unit increase in the independent variable.”16 For instance, we see from Table 2 that the odds
ratio for the variable “average size per room” is 1.936. This indicates that a one-unit (i.e., one
hundred square foot) increase in average room size is predicted to increase the odds that a
dwelling will be chosen by almost 94%. Our model also predicts that each one-year increment in
the age of a house will lower the odds it will be chosen by 1.6% (= (0.984-1)*100). By the same token, with all else the same, a one-unit (i.e., 100 dollar) difference in net income (equivalent to a hundred dollar difference in housing expenditures) is predicted to affect the odds that a dwelling will be chosen by slightly more than 27%. Given that the median net household income (not shown in Table 1) in our sample is approximately $25,500, a one-hundred dollar difference in income left over for non-housing expenses represents a substantial amount. The rest of the odds ratios can all be interpreted the same way.

Given the objectives of this study, the odds ratios for the two dwelling-specific local public finance variables are particularly informative. For the “effective property tax” variable, the odds ratio is 0.673. This indicates that a dollar difference in property tax paid per one-hundred dollar of house value affects the odds that a dwelling will be chosen by almost 33%. On the surface, this appears to be unrealistically high. However, the average value of a house in our sample is approximately $56,000 (see Table 1). With all else the same, one dollar difference in the effective tax rates would imply a difference of $560 in the annual property taxes of two average priced dwellings. Even though it is not the focus of our study, we can also look at the implications of such a difference in terms of “capitalization.” Suppose, with all else the same, two houses sell for $56,000. At a discount rate of 0.08 and assuming the average life of a dwelling to be 50 years, $560 difference in annual property taxes implies almost a $6,900 difference in the values of those two houses over their lifetimes. This is 12.32% of the average dwelling price. The odds ratio for the “streets” variable is 1.953, indicating that the odds that a house located on a paved street with curb and gutter will be chosen is 95% higher than a house located on a dirt or gravel road or one with no gutter or curb. Whether taken individually or together, these findings clearly underscore the importance of local public finance variables on
dwelling location decisions, even in a single taxing jurisdiction.

IV. Conclusion

The most important difference between our paper and other similar studies is that we focus on location choice decisions in a single taxing jurisdiction rather than across a number of cities or even counties. As a result, and using a very detailed (and confidential) data base compiled by the assessor's office, we are able to control for a number of important locational and fiscal variables in our model. Our most important contribution to the literature is to demonstrate the (statistical) significance in household decisions of dwelling-specific local public finance variables even within a single taxing jurisdiction. To our knowledge no discreet choice model of dwelling choice has accounted for such variables. As a matter of fact, the prevailing assumption in the literature has been to assume that local public finance variables (quality of public services and the tax rates) are the same across a city. The effective property tax rate is the single most important proxy for the average household's contribution to the "price" of local public goods within a jurisdiction. The condition of the streets is the most immediately apparent indicator of the quality of the services a household receives (or "purchases") from the local government in return. Our results show that both are significant determinants of the household location decisions and, therefore, have to be included in such discrete choice models. Omitting such variables will be a source of specification error leading to biased results.