The Vickrey Auction Motivation of a Spatial Hedonics

Model That Identifies Neighborhood Effects

By

Clifford A. Lipscomb

Georgia Institute of Technology

685 Cherry Street

Atlanta, GA 30332-0345

Phone: 404-603-3954

Fax: 404-385-0504

E-mail: clifflipscomb@hotmail.com

Table of Contents

Abstract

Developing "sustainable" neighborhoods within urban areas is one response to increased air pollution, increased traffic congestion, and increased noise caused by two major factors: 1) the increase in demand for more roads by all travelers and 2) the increase in "convenience" required by all people as family and personal obligations encroach more and more on people's time. The average suburban commuter, who lives outside the city and travels each day to the city via automobile so that he/she may take advantage of higher incomes, exemplifies these two factors. This desire to have "the best of both worlds" has created the vast suburban expansion emanating from large metropolitan areas such as Los Angeles, New York City, Chicago, Houston, and Atlanta.

This research argues that it is possible for urban residents to enjoy amenities similar to those found in the suburbs (less noise, access to parks, etc.), but with fewer commuting hassles and increased access to local *urban* cultural amenities. This is because time is purported to be the main limiting factor. Research has found that city dwellers have an advantage over their suburban counterparts of living in culture-rich neighborhoods that are proximal to the central business district (where a higher concentration of jobs exists) and other employment clusters. So, city workers who perceive new advantages of living in urban areas- i.e. less commuting time, access to public transportation, among others- will choose to move into the city if they are willing to pay for these urban characteristics and amenities. Using a novel statistical approach to estimate the effects of demographic, physical, and spatial characteristics on housing prices in an Atlanta neighborhood, a general urban housing model is created that provides insight into the implications of one neighborhood's economic, demographic, and spatial composition. From this research, one can conclude that now is the perfect time to ally urban planning and policy with

economic incentives to shape community master plans so they best achieve the desires of all urban residents.

Chapter 1: Urban Economics Models

1.1 Trends in Urban Reinvestment

1.1.1 Neighborhood Land Uses

Just as the exurban "white flight" movement of predominantly white people occurred in the 1960s and 1970s, the 1990s ushered in a new physical movement of residential and commercial infrastructure to the deep urban core. While still underdeveloped in many cases, urban areas are being reborn with new economic incentives that encourage intown developments. As these intown developments occur, the urban landscape changes, meaning the types of persons attracted to the area will also change. New households will move into urban areas if they prefer urban cultural amenities and relief from commuting hassles [Roback (1982), Cohen (1990)]. Current residents will stay or move depending on their level of satisfaction with these urban infrastructure changes and their degree of tolerance for new, often transient, neighbors. The model in this dissertation predicts the types of households (based on income and demographic characteristics) most likely to move into, say, a vacant house, in a particular neighborhood. Using this information, current residents can decide whether it is most beneficial for them to stay or to move to another neighborhood.

Once a new household moves into a particular neighborhood, it tends to follow some general rules. One is that a household usually does not purchase the most expensive house in a particular neighborhood if it (the household) is looking for the house to appreciate in value over time for resale purposes. A second is that the household should avoid housing "myopia" and consider fully any externalities that may affect its quality of life. If the land use particulars of nearby parcels negatively affect the prices of surrounding parcels, then these negative externalities (smog, foul odors from water treatment plants, excessive noise from highways, and other factors that make the parcel less attractive to buyers) lower the selling price of particular houses. Conversely, positive externalities (such as being close to open spaces, retail and commercial areas, improved access to public services, and environmental amenities) positively affect the selling price of houses.

The entry and exodus of households may also cause parcels to change from one land use designation to another. When neighborhood planners and economists try to create "ideal" neighborhoods out of current neighborhoods, incremental land use changes most likely will not accomplish the neighborhood's economic and livability goals (Farmer 2002). To effectively push a neighborhood toward its optimal "sustainable" end, several key investments often need to occur at once. Key first investments may include designating open space parcels or locating well-stocked groceries, so private owners will not insist upon constructing houses on these lots. First investors must have assurances (contractual or verbal agreements) that their neighbors will reinvest in their own parcels in conformity with the neighborhood's long-range master plan. Otherwise, first investors' actions will go unmatched by current residents, thus not creating the maximum benefits for the neighborhood. For example, if my next-door neighbor adds $10,000 of economic value to her house with the construction of an additional bedroom and full bath, the selling price of my house (and others) would go up due to the interdependencies of land use attributes across parcels. Although my neighbor adds economic value to her house, she also "loses" in the sense that her proximal and surrounding neighbors are reaping benefits from the added value of her house *without necessarily adding value themselves*.[1] This example, however, is not the best at explaining the role of externalities in housing. But, externality *intensive* land

[1] While many economists would agree that housing is not a "zero-sum game", the homeowner adding value to her dwelling still loses potential added value of her dwelling because her neighbors do not make changes to their

uses, such as open space or key commercial sites, may be “outbid” by less economically valuable uses if the owners cannot capture the residual rents attributed to their parcel neighborhood-wide.[2] Therefore, the coordination of possibly intransigent first investors (who locate groceries and open spaces where they are needed) is contingent upon assurances by neighbors that all will develop their parcels according to an agreed upon master plan, which accounts for “the spatial dimension of coordinated simultaneous investment” (Farmer 2002). Neighborhood associations in conjunction with urban planners and economists can address these two concerns and coordinate first investments to jump-start the envisioned neighborhood revitalization process. [3]

Two implications arise from this. First, any attempt to redevelop an existing urban area must consider the starting points (current land uses), current planning and development laws, and an efficient way to achieve planners’, economists’, and neighborhoods’ desired outcomes simultaneously. Second, *in situ* land uses cannot rise to their highest and “best” uses in isolation; the cross complementarities associated with various types of land uses are important factors that contribute to the overall value of the parcel of interest. Coordination no longer reinforces the land uses that impose negative externalities on neighboring parcels, but fulfills the goal to maximize total economic real estate value (aggregated selling prices) in an area by seizing gains from positive externalities associated with the correct mix of land uses.

---

dwellings. From the Home Park housing survey, one finds that renters believe their landlords are “out to get students’ money” and “do not care about upkeep at their rental properties.”

[2] The hedonic model in Chapter 3 will determine the marginal prices of being near these open spaces, brown industries, and commercial sites so that we can see if externality intensive land uses are indeed outbid by less intensive uses.

1.1.2 Reinvestment Obstacles

The biggest obstacles to reinvesting in the built city are the fixed costs of reinvestment (i.e. capital outlays), traffic and population congestion, air and noise pollution, other contributions to quality of life checking the benefits of urban agglomeration (Tolley 1974), the diverse characteristics of an area's residents (which also drives the hedonic specification problem), and investors' fears that over-improved islands of development are inconsistent with sustained growth planning schemes (Farmer 2002). These obstacles have the potential to dissuade residents and investors from "support[ing] the landscape features that a city may want to encourage" (Ibid.). A city may want to encourage more open space and reduce ambient particulates, but more monies consistently are attracted to other services such as reducing the commuting costs of congestion.[4] This occurs because politicians and transportation authorities continue to succumb to commuters' desires for more roads instead of using this money to make urban areas more livable. The decisions of these key policymakers have caused "pricing errors of the past [to be] cast in brick and asphalt, [resulting in policies that] are very expensive and have limited effectiveness" (Anas, Arnott, and Small 1998, p. 1457). Instead, if these key policymakers had used road monies to redevelop the inner city to include additional green space, parks, and other family-friendly infrastructure, suburban families would perceive an even greater advantage to living in the built city. Given these past decisions of policymakers, it seems that the use of federal and state transportation funds to revitalize urban areas other than roads is

[3] Overcoming investor intransigence is not the focus of this dissertation. But, it is a phenomenon that must be overcome for neighborhoods to be redeveloped according to their master plans.

[4] The 2001 Urban Mobility Study conducted by the Texas Transportation Institute concludes that metropolitan Atlanta commuters were stuck in traffic a total of 152.5 million hours in 1999, which costs businesses and commuters approximately $2.62 billion in lost wages, lost time, vehicle depreciation, and other commuting costs.

impossible, meaning that some other fundraising method must be considered to transform these key parcels.[5]

Another problem that complicates the issues presented here is that all urban residents are different. Tiebout (1956) suggested that different types of residents sort into different neighborhoods within the city in a "self-organization" process. While this is true, each resident's motivation for locating in a certain neighborhood is different. Some households may choose to live in a particular neighborhood because it has a nice view of the city skyline, or because it is close to the household members' workplaces. While not all residents choose particular neighborhoods for similar reasons, some characteristics are generally accepted. For example, Glaeser, Kahn, and Rappaport (1997) found that the rich and poor alike favor improvements in urban transportation, improvements that realize a direct and indirect benefit for environmental improvements in the region. The direct benefit is lower auto emissions as a result of smarter intra-city logistics planning (bus and rail route coordination); the indirect benefit is the attraction of higher income immigrants who, through taxes and support of local services, support the decline of urban manufacturing and the rise of environmentally friendly services (Kahn 1996). Since these intra-city logistics improvements are tied to the developing pattern of real estate over a landscape, one can argue that a "significant portion of congestion pressures in many cities can be eased at the margin by unleashing self-interested reinvestment activity rather than by sponsoring capital intensive projects to allay pollution and traffic pressures" (Farmer, Reiss, Ditto 2000). This is the key to neighborhood transformations- using economic incentives to foster reinvestment activity among investors, developers, and area residents. Even Richard Moe, president of the National Trust for Historic Preservation, and other Georgia historic preservation

[5] This is a key role that neighborhood associations could play- being a neighborhood "bank." Responsibilities could

speakers agree that revitalizing neighborhoods is key to curbing urban sprawl, improving quality of life, and reducing gridlocked highways (Minor 2002). These reinvestment activities will 1) attract new residents that most prefer to reside in these urban areas and 2) at the margin relieve traffic congestion, pollution, and support start-up revitalization efforts of former urban manufacturing areas.

1.2 Land Use Models

Revitalizing the urban landscape in accordance with consumers' preferences is a lofty goal. At the heart of this effort are the spatial relationships between parcels. Firms, which locate close to common labor pools in order to take advantage of scale economies from production, exemplify the minimization of costs associated with production. Farmer, Reiss, and Ditto (2001) say that these sorts of firm-level scale economies take various forms, from a skilled work force specializing in a given industry that serves as a common labor pool for several producers of similar goods, to "a joint, or congestible, set of recreation and cultural services [that satisfy] a growing population under declining or flat marginal costs" (p. 3). In a similar vein, *households* locate close to desired amenities and employment clusters to reduce the costs (travel costs, congestion costs, etc.) associated with accessing these amenities and job locations.

The preceding discussion of the role of space and externalities suggests a brief examination of the evolution of land use theories. One of the first land use models was that of von Thunen, who argued that an export-oriented economy drives efficient land use and causes land to cluster into different zones (or concentric rings) around a town. In his model, the value of agricultural land was determined by transportation costs from the particular farms to the

---

include having a revolving low-interest loan fund for façade improvements, landscaping, etc.

marketplace where agricultural goods were sold (Barlowe 1993). In the original model, all residents of an area were assumed to be farmers. Variations of the original von Thunen model have argued that a housing band was located between the city center and agricultural land (Asami and Isard 1989, p. 514). Taken another step further, high-end commercial activities would gravitate toward the city center while bulk services would locate within the housing band. Therefore, while von Thunen's model is not used explicitly today, it is worthwhile to see how it spurned other land use theories over time.

The urban planning model of Dixit adds to the theory of von Thunen by incorporating a second urban cluster that develops as pressure from the population in-migration to one city forces it and the suburban perimeter to expand until a closely related product center and its manufacturing suppliers support this second cluster. Mayer and Somerville (2000) support the Dixit model in their discussion of residential construction. They argue that if a city experiences a population influx, "the demand for new residences increases, land and house prices rise, new construction occurs, and the city increases in size to accommodate the new residents" (p. 87). The city is physically larger at the new equilibrium. In other words, Dixit thought that in-migration toward the city center would create a second layer of von Thunen characteristics.

Next, the Tiebout (1956) land use model, incorporated explicitly into this research, predicts local neighborhood diversity, in which distinct citizen types support distinct housing characteristic packages that prevail in a given neighborhood. Tiebout built upon previous theory by adding household characteristics to urban planning theory. Instead of the focus being on types of industry clusters, suburban expansion, etc., his model focused on demographic characteristics of households as driving housing purchase trends and in-migration toward the

CBD. Clusters, according to Tiebout, may be residential, commercial, manufacturing, or industrial.

A fourth model of land use is that suggested by Alonso (1964) and Muth (1969). These models do not consider socioeconomic status or neighborhood quality as determinants of residential location. They fundamentally argue that transportation costs to the central business district (CBD) determine the spatial distribution of the land and housing prices, land consumption, and spatial residents' arrangements by income (Coulson 1991, p. 299). While this seems to be a natural extension of the von Thunen model (which says that the value of agricultural land is determined solely by transportation costs), it actually was a remarkable addition to land use theory. Standard hypotheses of Alonso-Muth models are negative rent gradients and increased land consumption per household with increases in the distance from the CBD. One complication of the negative rent gradient hypothesis is that urban submarkets may have their own rent gradients, thus confounding (overlapping) the market negative rent gradient. Additionally, Muth assumes that households have identical incomes and preferences. While they simplify Muth's analysis, these assumptions do not accurately capture the differences in income of urban households that locate in neighborhoods with such high concentrations of renters. Therefore, assumptions of identical incomes and preferences will be relaxed in this research.

As demonstrated here, these land use theories have been modified over time. Most recently, Farmer (2002) integrated the Dixit-Krugman and Tiebout models into a coherent land use model that emphasized the following: 1) housing near commercial and amenity services increase in value compared to housing away from these areas; 2) multipurpose trips are more significant than single-purpose trips (due to time constraints); and 3) pockets of agricultural land accommodate independent centers of retail and/or amenity services *and* simultaneous convenience shopping and professional services, which may compromise opportunities for amenity and open space in the reinvestment process. This dissertation continues the work of Farmer (2002), by incorporating the following features into the current urban land use model:

1. Neighborhood diversity, or distinct citizen types that support distinct characteristic packages;
2. Endogenous groupings of households (defined by particular characteristics and amenities) that mitigate the hedonic specification problem;
3. Socio-economic status and neighborhood quality as locational determinants; and
4. Non-identical incomes of neighborhood residents.

In this dissertation, the central questions to be answered are "What is the best way to identify neighborhoods in hedonic pricing models?" and "Can the Vickrey auction concept motivate a hedonic regression model that is theoretically and practically superior to past hedonic models?" To answer these questions, one must consider past research on utility theoretic frameworks and neighborhood identification within hedonic pricing models. Also, the central questions mentioned above motivate new technical questions about consumer preferences. For example, which dwelling and neighborhood characteristics most influence households' decisions to reside in a particular urban area? Is it proximity to work, the number of rooms in the dwelling, or other factors? Most urban planning models assume that households are rational, e.g. that they can compare the costs and benefits associated with living near a park, for instance. For other households, it may seem rational to live in urban areas if they prefer the local urban cultural amenities and relief from commuting hassles [Roback (1982), Cohen (1990)], which would translate into a growing urban advantage for city dwellers over their suburban counterparts. If this change is truly underway, city dwellers will perceive new advantages to living and to working in urban areas. Now is the perfect time to ally *urban* planning and policy with economic incentives to shape community master plans so they best achieve the desires of new urban residents (Farmer 2002), as well as those who already live there.[6]

[6] Given that approximately 70% of Home Park dwellings are rental units, current residents and crafters of the Home Park Master Plan understand the need to specifically entice certain household "types" to the area because of the link between household preferences and demographic characteristics.

Chapter 2: Hedonics Models

2.1 The History of Hedonics Research

In the early 1900s, research that considered the selling price of a good as a function of its characteristics was novel. This technique is called the hedonic pricing method, treats the economic value of a good as the dependent variable and the characteristics of a good as the independent variables. Using regression equations, slope coefficients (which are interpreted as unobserved, implicit prices) on each independent variable are estimated that reflect the impact of a one-unit change in the independent variable on the dependent variable, holding all other variables constant. This method is commonly used with goods that do and do not have traditional economic markets. An automobile, water quality, trees, and houses are only a few of the goods that can be analyzed using this method of valuation.

Debates in the literature on the first use of this technique are common. Colwell and Dilmore (1999) suggest that an overlooked monograph by G.C. Haas of the Division of Agricultural Economics at the University of Minnesota Agricultural Experiment Station in 1922 was the first hedonic study. This conclusion defies those of Griliches (1961) and Goodman (forthcoming), who argue that A.T. Court conducted the first hedonic study on automobiles in 1939. Regardless of its exact origins, Lancaster (1966) and Rosen (1974), who developed early theories of consumer behavior, popularized the hedonic method as a useful and legitimate valuation exercise.

According to Raymond Palmquist, the hedonic pricing methods are based on "the realization that some goods or factors of production are not homogeneous and can differ in numerous characteristics" (Braden and Kolstad 1991). Consumers purchase different bundles of characteristics each time a buying decision is made. When purchasing an automobile, for example, a consumer buys a specific type of engine, steering column, body style, color, and other characteristics. In this market, the manufacturer is willing to sell the automobile at a specific price based on the labor, parts, and shipping costs of the automobile, whereas the consumer is willing to pay a certain price for the characteristics of the automobile in question. When this offer and bid are in equilibrium, a buying/selling decision is made. Using the envelope theorem, the intersection of multiple bid and offer curves forms the hedonic price equation.[7]

The hedonic price method can be best illustrated through contrasting examples of goods that do and do not have traditional economic markets. First, an example of a good that does have a traditional economic market is Nike shoes. Economists observe the quantities of shoes bought by consumers at particular prices. From here, the estimation of the demand for Nike shoes is straightforward- plot the prices and quantities on a graph. In contrast, the estimation of the demand for a good that does not have a traditional economic market is not as simple. In the case of housing, which is a heterogeneous good, researchers must use the hedonic pricing method. Houses are listed at a price determined by the owner. This list price is based on the characteristics of the house, its nearby amenities, the actual selling price of similar houses in the same neighborhood, and the types of land use designations surrounding the particular house for sale. Then, the actual sales price of the house is determined by the equality of the purchaser's willingness to pay for the characteristics and amenities with the seller's willingness to accept a certain level of compensation for the house. This produces a buying/selling decision, similar to that in the automobile example. The difference is that in the case of the automobile, each part has an explicit cost- a tire costs $80, a paint job costs $300, etc. In the case of the house, one does not observe a separate price for the fireplace in the living room, for the bay window in the

[7] Please see Freeman (1993) for a nice summary of the hedonic pricing method and its limitations (p. 124-131).

kitchen, or for the number of bedrooms in the house. The motivation for using the hedonic pricing method is to separate the contributions to total selling price of each of these characteristics and amenities. What is the contribution to the total selling price (marginal price), holding all other characteristics and amenities fixed, of that spare bedroom? What is the marginal price of an extra foot of living space? Then, once these marginal implicit prices have been calculated, researchers can estimate the demand for certain characteristics and amenities by a class of demanders (i.e. the residents of a particular neighborhood, city, region, or nation). Obviously, the derivation of marginal implicit prices differs from that for goods with true economic markets, but hedonic marginal prices play the same role as do direct observations on prices in standard demand theory (Freeman 1993).

2.2 Problems Inherent to the Hedonic Method

At the core of hedonics research is the hedonic *specification* problem, which occurs when unique consumers (households in this case) with unique preferences purchase unique bundles of a single composite good (housing). Referred to by others as the "identification problem that dominates discussion in the applied [hedonics] literature" (Ekeland, Heckman, and Nesheim 2002, p. 304), the *specification* problem is that households' unique preferences for unique bundles of goods cannot be measured "uniquely"; bedrooms in one house are assumed to have the same marginal "value" as bedrooms in another house, regardless of size or quality. Similarly, each additional square foot of living space in houses of *all* sizes in the study area is assumed to contribute the same amount to the selling price of the house.

In the extreme case, each household, if treated as a unique buying and selling decision, would require its own hedonic regression equation to exactly measure its true marginal prices.

This means that a neighborhood with 900 households (like Home Park) would require a system of 900 different regression equations to be estimated simultaneously to completely capture the uniqueness of each household. In this situation, the econometric investigator learns nothing about the demand for housing *in this neighborhood*. To remedy this, we assume a Tiebout-style neighborhood in which household "types" can be grouped in some way, but most likely not by geography. By sorting households into "types", 900 different regression equations are no longer required. If household-level data can be used to distinguish households (i.e. a class of households chose to move to a particular area because of its proximity to a major research university), then the number of regression equations sufficient to describe a particular neighborhood may be dropped to between three and five.

As one can see, specification is an important policy concern because basic regression models require households with unique preferences for unique bundles to be poured into the mold of regression analysis, in which researchers estimate coefficients on independent variables. Mitigation of the hedonic specification problem, while not an impossible task, does pose some concern for policy analysts in that their analyses must be "correct" when results and implications are reported to their supervisors. Failure to consider the hedonic specification problem in valuation exercises (determining the value for non-market goods) can lead to a disconnect between a researcher's theory and applied statistics. In this research, a novel theoretical model is derived that mitigates the impact of the specification problem in the applied statistics.

A second and related problem with hedonics is the "incidental parameters" problem, which says that attributes are sampled only once. First analyzed by Neyman and Scott (1948) and later applied to congressional voting by Heckman and Snyder (1997), the incidental parameters problem involves the violation of the classical regression assumption of "drawing repeated samples from the same population", which *can* be a problem in hedonics research as the "population" of houses and the attributes of households changes with each new renter or homeowner. So, analyzing a cross-sectioned sample (one time period) means that the population is held identical by the econometric investigator for analyses of that period of time. This assumption (holding the Home Park neighborhood population constant) means that no rule of how the demographic and economic composition of this neighborhood change over time can be devised here.

Researchers further assume that each household purchases the single house that best fits the unique quality of life desired by its members. In choosing a particular house[8], households pay (through the selling price) an unobserved amount of money for each characteristic of the house and amenities in the neighborhood. For example, if a household narrowed its search to two identical (in structure and location) houses, one with a fireplace and the other without, it would choose the house with the fireplace if it (the household) is willing to pay the additional amount over and beyond the selling price of the house without a fireplace. In other words, the household's purchase of the house with a fireplace tells researchers that this household's preference for fireplaces can be measured (precisely we hope) through the difference in selling prices between the otherwise identical houses.[9] Extending this logic to the other house characteristics, a household is willing to pay a certain amount of money for each feature and

[8] As Rosen (1974) stated, households cannot "re-package" characteristics; they cannot buy one characteristic from one house (i.e. garden size) and combine it with another characteristic from a different house (i.e. number of rooms) (Hanley and Spash 1993). If this were the case, then the first-stage hedonic price function (the selling price of a house regressed on a set of independent variables) would be linear, which means that households would have similar marginal implicit prices for a particular good.

[9] Of course, this research does not consider the extensive literature on "place-based" values (B. Norton, C.S. Holling, etc.).

amenity related to that house.[10] Therefore, researchers use regression analysis to estimate these unobserved marginal prices for house features and amenities.

Other issues that complicate the specification problem include functional forms of the hedonic pricing function, the introduction of new policy variables, and different methods of identifying neighborhood effects. Box and Cox (1964); Cropper, Leland, and McConnell (1988); Halstead, Bouvier, and Hansen (1997); and Lipscomb (2001) have employed alternative Box-Cox functional form variations to get the "best fit" of the model. Sivitanidou (1995); Helmuth, Obata, & Kassabaum et al. (1997); Morrell and Lu (2000); and Lipscomb (2001) have used new and interesting policy variables like noise and the distance to an airport in the hedonic price function. Other statistical techniques such as method of moments (Bell and Bockstael 2000), principal components analysis (Bourassa et al. 1999), simultaneous equations (Irwin and Bockstael 2001), and latent variable approaches (Arguea and Hsiao 2000) are recent additions to the hedonics literature.

The two main concerns of past hedonics research that will be addressed here are 1) the uses of first-stage hedonic equations without a coherent theoretical motivation and 2) the way in which neighborhood effects have been modeled in previous studies. First, several recent studies (Halstead, Bouvier, and Hansen 1997; Bolitzer and Netusil 2000; Tyrvainen and Miettinen 2000, Luttik 2000) have not used a utility theoretic framework to derive the first-stage hedonic regression equation; put another way, these researchers assumed away the identification and specification problems.[11] Second, previous studies have employed a variety of methods for

---

[10] Researchers differ widely on what variables should be included in housing hedonic models. The recent incorporation of spatial variables (distances to shopping opportunities, etc.), for example, has further complicated the normative issues involved with hedonic models (i.e. do households really take into account the tree cover around their dwelling when choosing where to live?).

[11] Here, the identification problem refers to the recovery of structural parameter estimates from reduced form approaches.

defining neighborhoods (Hughes, Jr. and Turnbull 1996; Rapaport 1997; Bourassa et al. 1999; Immergluck 1999; Bolitzer and Netusil 2000; Sieg et al. 2000), using dummy variables to control for neighborhood or jurisdictional effects (Thorsnes 2000), and allowing the error terms to absorb neighborhood effects (Bockstael and Irwin 1999). This paper improves upon these two problems by 1) endogenously modeling neighborhood effects by dividing neighborhoods into distinguishable similar types of households and 2) using the Vickrey (1961) auction as a tool for motivating the reduced form first-stage analysis common in hedonic studies. First, the advantage of modeling *endogenous* neighborhood effects is that the researcher does not decide how many groupings fit into each neighborhood, nor does he know *a priori* the criteria that distinguish one grouping from another. In this instance, we can, according to Luc Anselin, "let the data speak" because the spatial theory is developed well in this research (Boyce, Nijkamp, and Shefer 1991). In addition, previous research has focused on estimating the probability of living in a *particular house* using the nested multinomial logit (NMNL) model (Chattopadhyay 2000). I argue in this paper that estimates of the probability of living in a particular household *type* within a given neighborhood are more important to planners, economists, investors, and other neighborhood residents attempting to maximize their return on investment.

Second, the Vickrey auction says that the highest bidder of a good wins the auction, but only pays the amount bid by the second highest bidder. The advantage of the Vickrey auction is that it motivates the econometric analysis *and* the random utility frameworks in this study. *The Vickrey auction is used as an independent proof that suggests the conditions under which the hedonic specification problem is diminished*. This paper will show how one theoretical assumption, that the highest bidder for a particular house pays only the price offered by the second highest bidder, can lead to a derivation of the hedonic regression model. This parallels the idea embedded within the Vickrey auction motivation of the econometric model, that 1) houses with similar attributes can be grouped into types and 2) houses with "above-average" attributes relative to the other households in a particular type have above-average selling prices if those attributes are valued positively by households, and vice versa.

2.3 The Hedonic Pricing Method Applied to Housing Markets

As we mentioned earlier, houses are differentiated goods comprised of various styles, sizes, structural characteristics, and amenities. House selling prices reflect the unique combination of house features (age of the structure, living space square footage, number of bedrooms, etc.); neighborhood characteristics (proximity to public transportation, noise levels from traffic, level of tree cover, etc.); and recreational amenities (parks, other forms of open space, presence of quality sidewalks, etc.). One of the earliest attempts to model the housing market was Muth (1960), who introduced the concept of "housing services", thereby encouraging economists to treat housing as *homogeneous*. Put another way, Muth's contribution was to use tools developed for markets with homogeneous goods to econometrically analyze housing markets.[12] However, the concept of housing services makes difficult the recovery of the marginal prices of particular housing attributes, such as a bedroom or a fireplace. Researchers after Muth treated houses as *differentiated* goods (having different characteristics and amenities/disamenities), as Lancaster (1966) first proposed and Rosen (1974) then popularized. This is called the hedonic pricing method. Traditionally, the first stage of analysis has the selling price of a house regressed on its structural characteristics (number of rooms, baths, square

[12] To deal with the difficulty of treating housing units of different technological and legal characteristics as homogeneous, Muth suggests acceptance of the market's judgment "to treat as identical those units of 'housing' which command identical prices" (p. 32).

footage, and others), parcel size (in acres), and nearby amenities (parks or shopping opportunities) and disamenities (landfills or industrial parks). More recently, economists have devised models that do not explicitly incorporate spatial distance variables into the hedonic pricing model. Instead, researchers typically allow that spatial information to be absorbed into the error terms so that spatial autocorrelation techniques can be employed. These biased estimates (resulting from variable omission) can be corrected by having a model that is consistently built around theory that includes explicit spatial considerations. The theoretical and empirical models are derived in the next chapter.

Chapter 3: Model to Mitigate Specification Limitations

3.1 Theoretical Model

Hedonics research postulates that consumers (households in this case) seek to maximize the usefulness and happiness associated with a series of choices. If a household receives more "happiness" from spending a sunny afternoon at a park than at the local art museum, it will spend the day at the park, all else held constant. This same phenomenon, choosing the one option from the set of available alternatives that maximizes satisfaction, usefulness, or "utility", occurs repeatedly. For example, when a household decides where to reside, it chooses a location that 1) is convenient to an "expected array of possible future jobs rather than just their current job" (Anas, Arnott, and Small 1998), 2) has an adequate amount of housing space to accommodate the household's current or expected size, and 3) is located "near" food sources, cultural amenities desired by the household, workplaces, entertainment opportunities, and others. The proximity or distances to these amenities and opportunities will be determined by the household's choice of residence, which balances the costs of living in a particular dwelling with the benefits of living there. Some of the costs include travel costs to work, relatively higher taxes in the city than outside the city, costs of consumption goods (food, clothing, and shelter), entertainment costs, and others. Some of the benefits of living in the city may include being near cultural entertainment hotbeds (professional sports opportunities, opera and musical performances, museums), relatively shorter drives to work, more public transportation riding opportunities, and generally higher wages. The goal of the household, then, is to maximize the net benefits of living in a particular dwelling. Therefore, one decision (where a household chooses to live) reveals certain household behaviors to economists and planners.

So, what does it mean to maximize "net benefits"? Simply maximizing benefits does not imply that costs are minimized. Firms, for example, seek to maximize profit, which is revenue minus costs, or net revenue. Similarly, households want to enjoy the most amenities associated with a particular location at the lowest possible costs. To accomplish this, households must understand what "constrains" their attainment of maximum "happiness" or "satisfaction". In this research, a general model is set up that says households receive certain levels of satisfaction from four things: goods consumed, housing space, local amenities, and leisure time. Then, constraints are imposed that limit the amount of these four things that can be enjoyed by households. These constraints are household income (endogenous in the system) and time (exogenous in the system). By choosing how their time is allocated, households determine their income and thus how much they can consume, how much money can be spent on a dwelling, and how much money can be spent on travel costs to work, shopping, entertainment, etc. This means that income, the consumption of goods and amenities, and travel costs are determined endogenously in the model. Time, on the other hand, is the only true exogenous variable in this model, meaning that households react to the time constraint by choosing to work a certain number of hours for a certain wage to afford a certain quality of lifestyle.

According to Tiebout (1956), households choose the jurisdiction in which to live based on the local public goods and taxes found there. If there are a large number of jurisdictions from which to choose, then a household's choice of a particular jurisdiction reveals its true preferences for local public goods. Similarly, that same "voting with their feet" causes households to choose jurisdictions in an efficient manner- by choosing *the* jurisdiction that causes that particular household to equalize their marginal benefits from the local public goods with their marginal costs of acquiring that "level" of public goods (Hoyt and Rosenthal 1997). This is the basic Tiebout hypothesis.

Applied to the current study, the basic Tiebout hypothesis is extended in two important ways: 1) to include not only local public goods, but also local amenities; and 2) to treat one neighborhood as a "market" within which certain types of households choose to reside. First, Tiebout argued that for households to sort efficiently into jurisdictions, "the provision of local public goods [must] mirror that of an efficient private market" (Ibid.). By extension, households in a particular neighborhood choose to reside there after evaluating *all of the features* of alternative neighborhoods in a given area. This means that households do not sort efficiently based only on local public goods. Instead, households base their decisions of the jurisdiction in which to reside on the equalization of marginal costs with marginal benefits related to all of the features/amenities that it will consume while living in that particular area. So, in addition to local public goods, households also choose where to live based on distances and travel times to various amenities (recreational and cultural), accessibility to public transportation, proximity to one's workplace, proximity to school, proximity to one's place of worship, etc.

Second, in this research, the same dynamics that Tiebout hypothesized would happen across multiple jurisdictions ("voting with your feet" and sorting into jurisdictions that equalize a household's marginal costs and benefits) are postulated to occur at smaller scales within a single neighborhood. In particular, this research suggests that Tiebout's analysis of efficient household sorting across jurisdictions is comparable to the efficient sorting of certain *types* of households throughout a single neighborhood. Just as Tiebout hypothesized that certain distinct citizen-types would locate in certain neighborhoods, we argue that within each neighborhood there is another layer of household types that emerges. The following discussion illustrates how one can elicit these household types within one neighborhood.

Following the preceding discussion on utility maximization, various constraints on households, and the equalization of marginal costs and marginal benefits of residing in a particular area, a random utility[13] maximization problem with income and time constraints is developed. This utility maximization problem (Equation 1) is the mathematical expression (with a semi-log utility specification) of the theoretical discussion and is consistent with a Tiebout-style neighborhood.

(1)

$$\begin{aligned}
&MaxU(\mathbf{x}^c, \mathbf{A}, s_H, L) = \ln \mathbf{x}^c + \ln \mathbf{A} + \ln s_H + \ln L \\
&st \\
&w_{sl} I_{sl} + w_{usl} I_{usl} = \mathbf{p}^c \mathbf{x}^c + R_H s_H + c_1 d_1 + c_2 d_2 + c_3 d_3 + c_4 d_4 + \mathbf{k}_i \mathbf{A}_i \\
&T = L + I + t_1 d_1 + t_2 d_2 + t_3 d_3 + t_4 d_4
\end{aligned}$$

Here, we assume that the utility function is transitive, complete, and continuous. We also assume that $U'(\mathbf{x}^c) > 0$, $U'(\mathbf{A}) > 0$, $U'(s_H) > 0$, and $U'(L) > 0$; and $U''(\mathbf{x}^c) < 0$, $U''(\mathbf{A}) < 0$, $U''(s_H) < 0$, and $U''(L) < 0$. We also assume negative semidefiniteness in U, which means that all indifference curves are strictly convex and do not touch any axes.

[13] Random utility (according to Hanemann 1984) means that while the consumer's utility function is deterministic for him, it has components that are unobservable to the econometric investigator; these unobserved components are therefore treated as random variables.

In words, this model says that households maximize utility (satisfaction and happiness) through the consumption of four items: 1) consumption other than housing space and amenities [$\mathbf{x^c}$]; 2) household amenities, cultural and recreational opportunities, and neighborhood attributes (sidewalk quality, proximity to open space, etc.) [**A**]; 3) housing space [s_H] from which households receive services that command a rental/selling price R_H per unit of space; and 4) leisure time [L][14].

The two main constraints on household's consumption and thus enjoyment of these four things are income and time. Skilled [sl] and unskilled [usl] households work a certain amount of time [**I**] for a certain wage rate [**W**]. This income [**WI**] is used to purchase a certain amount of housing space, amenities, consumables, and travel-related goods (car, gasoline, bus tickets, etc.). Also, each household has only 24 hours a day [T is time] in which to work; commute between work, home, and shopping trips; and enjoy leisure time. Households also pay a certain amount **k** for amenities **A** specific to each dwelling.[15] Finally, t_i are the times required to travel distances $\mathbf{d_i}$ at costs of $\mathbf{c_i}$ per unit of distance. $\mathbf{t_i}$ and $\mathbf{d_i}$ are broken down as the following: t_1 (d_1) is the round trip travel time from home to work; t_2 (d_2) is the round trip travel time to consume all goods other than housing, and includes trips to consume multiple consumable goods; t_3 (d_3) is the round trip travel time from home to amenities, and includes trips to consume multiple amenities; and t_4 (d_4) is the round trip travel time required to buy consumption goods and consume amenities in one trip.[16]

---

[14] Anas, Arnott, and Small (1998), in their synthesis of the urban economics literature, argue that more realistic models of urban areas require the derivation of the shadow value of time endogenously by "adding leisure and a time budget to the model" (p. 1436). This is consistent with the model presented here.
[15] **A** includes locational amenities as well as local public goods.
[16] For simplicity, this paper assumes that trips to consume goods other than housing and/or amenities *on the way to or from work* are negligible and will not be included in either constraint in the econometric model.

Next, the Lagrangian of the utility maximization model is solved, yielding the following first-order conditions:

(2)

$$
\begin{aligned}
\mathbf{x}^{c}* &= \left(\frac{\mathbf{WI} - c_1 d_1 + c_2 d_2 + c_3 d_3 + c_4 d_4}{3 p^{c}} \right) \\
\mathbf{A}* &= \left(\frac{\mathbf{WI} - c_1 d_1 + c_2 d_2 + c_3 d_3 + c_4 d_4}{3 \mathbf{k}} \right) \\
s_H * &= \left(\frac{\mathbf{WI} - c_1 d_1 + c_2 d_2 + c_3 d_3 + c_4 d_4}{3 R_H} \right) \\
L* &= T - \mathbf{I} - t_1 d_1 + t_2 d_2 + t_3 d_3 + t_4 d_4
\end{aligned}
$$

Then, the first order conditions are used (along with other relevant substitutions) to generate the indirect utility function (IUF):

(3)

$$
V = \ln \left[\frac{M - \mathbf{cd}}{3 p^{c}} \right] + \ln \left[\frac{M - \mathbf{cd}}{3 \mathbf{k}} \right] + \ln \left[\frac{M - \mathbf{cd}}{3 R_H} \right] + \ln \left[\frac{M - \mathbf{cd}}{3 \mathbf{W}} \right],
$$

where income M = **WI** and the total cost of travel (**cd**) equals $c_1d_1 + c_2d_2 + c_3d_3 + c_4d_4$.

Previous housing studies that have used specified forms of the indirect utility function (IUF) to estimate logit or multinomial logit models have included variables such as prices of a unit of housing services, statutory property tax rates[17], prices of composite goods (Rapaport 1997), income (Ibid., Haab and Hicks 1997, Sieg et al. 2000), household and community characteristics (Rapaport 1997, Chattopadhyay 2000), public and private goods (Rapaport 1997,

[17] Property tax rates, for example, are not warranted here because all dwellings in the study area (Home Park) are located within the City of Atlanta, which means that the property tax structures do not vary between dwellings.

Sieg et al. 2000), as well as race and the number of children in the household (Chattopadhyay 2000). Here, the indirect utility function includes variables such as wages, distances, travel costs, rental price of housing space, the prices of amenities, the prices of consumable goods, and time.

Housing demand, theoretically, can be derived in two ways: 1) through the expenditure function or 2) through the indirect utility function. The expenditure function e(**p**,*u*), which is the inverse of the indirect utility function, says that given any level of utility *u*, one can find the minimal amount of income necessary to achieve that utility level *u* at a certain level of prices **p**. The indirect utility function, on the other hand, says that maximum utility is a function of prices **p** and income *m* (Varian 1999, p. 100-102). We choose to use the indirect utility function to derive housing demand because of its direct importance in the mixed logit model to be estimated. In using the indirect utility function, we also must use an identity that ties the indirect utility function to Marshallian demands- that identity is Roy's Identity. This identity states that the partial derivative of the IUF with respect to prices, divided by the partial derivative of the IUF with respect to income, equals the Marshallian demand function for each argument in the utility function. So, using Roy's Identity, housing demand can be estimated from Equation 3. With all relevant substitutions, the Marshallian demand for housing is[18]:

(4)

$$s_H^{D_M} = -\frac{9}{4}\left[\frac{\mathbf{W}(T - L - t_1 d_1 - t_2 d_2 - t_3 d_3 - t_4 d_4) - c(d_1 + d_2 + d_3 + d_4)}{R_H}\right]$$

[18] If we assume that the cost per mile traveled to purchase any good, to travel to work, or to recreate is the same, then the cost per mile **c** can be the same for any distance traveled.

Equation (4) is consistent with demand theory. An increase in the rental price of housing space will cause the demand for housing space to decrease, *ceteris paribus*. Also, we see that households consider driving time, leisure time, and an array of distances when choosing where to reside. To that end, one must identify the Hicksian demand for housing to measure the WTP or WTA compensation for particular changes in house characteristics or household income. In this model, Hicksian demand is:

(5)

$$s_H{}^{D_H} = -\frac{3}{4R_H} \bullet \exp\left[\frac{\ln \mathbf{x^c} + \ln \mathbf{A}_i + \ln s_H + \ln L + 4\ln \mathbf{cd} + 3\ln \mathbf{p^c} + 3\ln \mathbf{k}_i + 3\ln R_H + 3\ln \mathbf{W}}{4}\right]$$

The introduction of time constraints into utility maximization models occurred in the seminal work of Becker (1965). In that work, Becker uses the same variable in each of the budget and time constraints, which permits him to substitute one constraint into the other. The result was one constraint that contained elements of the budget *and time* factors that shape how households maximize utility. When rewritten slightly as Varian (1999) does, Roy's Identity becomes $[-\lambda\, x_i\, (\mathbf{p}, m)]/\lambda$, where lambda can be interpreted as the marginal utility of income and time, but is widely interpreted simply as the MU of income. As one can see, when one constraint is used in utility maximization models, two things happen: 1) time costs are already built into the prices of all goods; and 2) the corresponding lambda in this version of Roy's Identity is the same in the numerator and denominator.

However, when income and time are not combined into one constraint, a slight problem arises. Traditionally, the lambda used in Roy's Identity holds *for individuals* and is interpreted as the marginal utility of income. Using this original form of the identity ($[-\lambda_m x_i(\mathbf{p}, m)]/\lambda_m$) still calculates the Marshallian demand for a good for individuals, but does not 1) *explicitly* include the marginal utility of time, or the lambda from the time constraint first used by Becker, 2) nor does it mitigate having a MU of income and MU of time for each individual household. In other words, the effects of travel times to consume various goods and amenities, leisure time, and time at work on the demand for particular types of houses are not treated explicitly nor separately by Roy's Identity. *These problems suggest that Roy's Identity, in its original form, fails to distinguish households with different marginal utility ratios into "types" adequately for our purposes here*. Therefore, one needs to sort households into types to avoid having a single-line regression equation for each household. For example, suppose that a large number of households in a neighborhood has identical marginal utilities of income (i.e. additional income, maybe from a tax break, gives different households the same level of "satisfaction" or utility). In this case, these households cannot be distinguished from each other because some change in income causes them all to "react" similarly, or receive the same amount of utility. Clearly in this case, the econometric investigator has no idea which households benefit "more" or "less" when utility increases are similar across a large number of households in a neighborhood because the marginal utility of *time* has not been considered separately. However, if the investigator has a measure of the marginal utility that each household receives from different allocations of time (time at work, consuming leisure, etc.), then he/she would have a second measure on which households can be distinguished. Having two measures on which households differ reduces the chance that households would have identical marginal utility ratios of income *to* time.[19]

[19] Essentially, this MU ratio measures the degree of "boundedness" of a household's income and time, meaning the degree to which one substitutes between activities that involve changes in income and changes in time spent in that activity.

Therefore, the *theoretical* separation of households in one neighborhood into "types", based on their marginal utility ratios, reduces the hedonic specification problem.

This marginal utility ratio can be estimated from the utility maximization problem. With some manipulation, we see from the first order conditions that the marginal utility ratio equals the wage rate ($\lambda_T / \lambda_M = \mathbf{W}$). This means that household wages are a good approximation of the marginal utility ratio. In other words, a household's wage captures elements of the income and time constraints. Then, given that each household earns different wages (because each household chooses how to allocate their time to different activities, including work), this marginal utility ratio can be used as a theoretical measure to sort households into types. This means that households with similar wage rates and time allocations will most likely exhibit similar levels of family size (approximated by the number of children under 18 years of age living in the dwelling), work experience (full-time employees will have higher incomes than students and part-time employees), education (persons in households with at least an undergraduate degree tend to have more income than households without undergraduate degrees), and desired amenities (higher income households can afford to live in the city and consume generally more expensive city-specific amenities such as operas, musicals, and sporting events). Therefore, in the household sorting process (3.2.1), these factors and others will be used to sort households into "types."

The preceding discussion illustrates to policy analysts the importance of the link between the theoretical separation of dwellings based on this marginal utility ratio and the empirical testability of the model in applied policy analysis. The mitigation of the hedonic specification problem in this manner is important in urban policy analysis for several reasons. First, with a budget constraint only, households' preferences are not as easily distinguishable from other households; households have fewer criteria (observed by the econometric investigator) to separate their preferences from others. Second, all of the independent variables required in this analysis can be reduced, theoretically, to these estimated marginal utility ratios for the purposes of sorting households into similar types. This verifies our use of principal components analysis (PCA) in the sorting process and prevents us from regressing the dependent variable on independent variables that were used to create the dependent variable. Third, households' responses to identical income and time *constraints* can be distinguished and one can relax the assumption of identical income common to previous housing hedonic studies (Muth 1969; Anas, Arnott, and Small 2000). Fourth, sorting households into endogenous groupings lessens the hedonic specification problem in two important ways: 1) the econometric investigator does not have to specify the groupings *a priori*, and 2) one avoids the impossibility of having one regression equation for each household in the extreme case to perfectly account for the heterogeneous nature of composite goods (houses).

3.2 Empirical Model

3.2.1 The Household Sorting Process

The theoretical point derived above, that the MU ratio can be used to sort households so that the hedonic specification problem can be mitigated, can be translated into an empirical estimation process. The consistent and efficient estimates of coefficients on the independent variables can be obtained via a sorting exercise. First, principal components analysis (PCA) is used to elicit factors that can be used to sort households into distinguishable types.[20] PCA

[20] PCA will be conducted similar to that in Bourassa et al. (1999) and Bingham (2001), in which it was used to extract coherent subsets of the explanatory variables for housing submarkets and central-city neighborhoods, respectively.

extracts linear combinations of the independent variables (called factors) that are used to distinguish households into different types. PCA is conducted using the demographic and attitudinal variables (see Chapter 4, Table 1) obtained from the housing survey to see if coherent subsets of the independent variables emerge. What we see is that these variables create nine factors with eigenvalues greater than one. These nine factors, each of which is more highly correlated with certain of the independent variables, are used to distinguish households into different types. *Therefore, PCA is the empirical estimation of differences among households suggested by the marginal utility ratio described in the previous section*. For example, if one notices a high concentration of students that lives in a particular neighborhood, he/she might hypothesize that at least one of the factors created by PCA would be highly correlated with whether a household is comprised of students or not.

Once households are sorted into types initially via PCA, a seemingly unrelated regression (SUR) model is used to determine the baseline beta coefficient vectors ($\mathbf{B}^1, \mathbf{B}^2, \ldots, \mathbf{B}^N$) for the independent variables within each type. The SUR model is used to account for the possibility that, on any given day with any other information, a household might choose a different combination of amenities that caused it to purchase/rent a different dwelling. In the SUR, the selling prices of houses (from the housing survey) in a particular type (predicted by PCA) are regressed on the same set of independent variables, which includes structural characteristics of the house as well as the distances to open spaces, local schools, Georgia Tech, strip commercial areas, and local grocery stores. This particular model is chosen because of the likelihood that the error terms from the system of equations (one equation per household type estimated from the PCA) are correlated (i.e. a demand shift would affect all residents, not only those of one particular type). Otherwise, one might have chosen to simply run an OLS regression model on each type separately.

Then, once the initial beta coefficient vectors have been estimated, the SUR model is iterated using a do-loop process. This process re-sorts each observation into the household type category whose beta coefficient vector best approximates that beta vector of the individual observation. For example, say a household is initially sorted into type A based on the principal components analysis. Then, after the SUR model is run, say that same household is re-sorted into type B. This occurs because all of the information on this particular household is not used in the PCA. Only in the updated SUR model are the remaining variables used to distinguish households. In fact, once the remaining variables (distance variables and structural characteristics) are used as regressors in the SUR model, we obtain initial coefficient estimates that are used to further sort households into the most appropriate type. After obtaining initial estimates from the SUR model, the criterion used for sorting households into types is the minimization of the difference in the predicted value of the dependent variable from the SUR model, minus the actual selling price of the house and parcel for that household, normalized by the standard error of the linear prediction. Mathematically, this is expressed as:

(5) $\text{TYPE} = i \text{ if } [(\text{yhat} - \text{saleprice})/\sigma]^{i} < [(\text{yhat} - \text{saleprice})/\sigma]^{\mathbf{j}}$

At this point, we can see in tabular form the initial sorting of households into types via PCA, then the first re-sort via the SUR model, and finally the do-loop re-sort process via SUR (please see Tables ? and ?- put in after updating dist vars). Here we see that the SUR model narrows the PCA-determined household types down to three household types. In fact, the SUR do-loop process causes no households to change types. This shows that the initial SUR re-sort would have sufficiently obtained the "correct" sorting of households; but the verification of that re-sort is an integral part of the process to obtain efficient beta coefficient estimates in the end. In this way, the hedonic specification problem is mitigated tremendously.

3.2.2 The Role of the Vickrey Auction in Housing Hedonics Models

The previous sections have shown that PCA and the SUR model are used to sort households into types that most closely approximate the marginal utility ratio developed earlier. Next, the Vickrey auction is used to devise a regression model that is theoretically superior to ordinary least squares (OLS) and that consistently and efficiently estimates the marginal implicit prices of the independent variables in this study.

The Vickrey auction concept, applied to housing, says that the highest bidder for a particular house purchases the house, but only pays the amount determined by the *second highest bidder* for that house. One might think that using an ascending-bid (English) auction would be most appropriate since it provides the seller with the highest price. While it is true that bidders are more informed about others' preferences and subsequently modify their bids as circumstances dictate in an English auction, bidders in a Vickrey auction have an incentive to bid upward; no one is deterred that he/she will pay a price that is too high. Aggressive bidders are more certain to win the auction, but by design know that they will pay a lower price that is closer to the actual market price if they win the auction. Vickrey (1961) demonstrates how this auction elicits a person's true WTP and how its efficiency properties are better than those of other auction types.

The importance of the Vickrey auction concept is that it accounts for differentiation among households and similarities within the housing stock. Each household has its own demand for housing. Since the bidders choose to bid on a particular house with a specific set of characteristics and amenities, these bidders must "prefer" the same type of house. But, each bidder has a certain willingness to pay for that combination of amenities C that is beyond the average characteristics and amenities of the dwelling and neighborhood, respectively. The bidder that is willing to pay the most for C will purchase the dwelling, but only at the willingness to pay of the second highest bidder. So, given the relatively similar housing stock in Home Park, it is reasonable to assume that the second highest and lower bidders can find combinations of amenities C in other houses in the same neighborhood in which they are the highest bidders, as they will prefer those combinations more (have the highest WTP) than any other household. Therefore, amplifying our conclusions from earlier discussions of the marginal utility ratio, households with similar characteristics will locate in the same neighborhood, meaning that they can be sorted into types. This means that each type of household should prefer particular amenities. For example, one might expect a type of mostly homeowners to prefer detached single family dwellings in relatively quiet areas that are close to their workplace, place of worship, etc. If this is proven true in the regression models, then via the Vickrey auction we expect other household types to prefer different sets of amenities that are specific to the dwellings for which they were the highest bidders. What we hope to say is that each type of household prefers certain amenities that are not preferred by the other types, and so on, for the purpose of mitigating the hedonic specification problem.

As I have explained previously, modeling these differences among household types is made difficult by the hedonic specification problem. Only through mitigation of the specification problem (via distinguishing households into types) can these taste differences (in terms of utility differences) be modeled. Therefore, if a core of housing characteristics in a particular type is similar with unique differences in several dimensions, then a wide group of demanders may exist, similar to the demand for other differentiated goods like high-rise apartments. Certain households may not necessarily want particular house characteristics that are important to other households. Each of these households is willing to pay different premiums for the unique set of characteristics and amenities for their house above and beyond the group "average" in a particular type.

While multiple neighborhoods can be analyzed with this approach, this work only tests the model empirically in one neighborhood because of the heavy data requirements. The approach assumes that households in a neighborhood can be sorted into types (not based on geography), each of which contains, say, between 90 and 150 dwellings based on demographic and attitudinal variables, as well as dwelling-specific structural characteristics and other features. Each household in a particular type differs on more than one element from the others in the same type, thus making each house unique. For example, in a particular household type, one house may have a nice kitchen with bay windows whereas another may have a large yard that sets the house away from the road frontage (decreasing road noise that reaches the house), while all other house features are very similar. Only within types can one compare the different WTP changes due to changes in structural characteristics or other features. Across-type comparisons are not appropriate according to Tiebout, as this is like comparing willingnesses-to-pay between different neighborhoods. Despite the uniqueness of households and their dwelling features, the aggregability of characteristics (both household- and dwelling-specific) to an aggregable group of demanders within the same type allows the regression coefficient estimates on all aspects to be consistent and efficient.

Most likely, a group of households, K, will purchase similar houses if they have similar preferences and incomes. However, the one household, *m*, of this otherwise uniform group that values a particular combination, C, of amenities A the highest of all amenities, purchases house H, specializing in that unique combination of amenities.[21] Yet, given standard pricing among group K bidders, household *m* buys house H for the same price paid by all other households in K (because of the similarities in the housing stock), but pays a small premium to acquire the desired levels of amenities represented in C. Yet, household *m*, while it values the combination of amenities (C) more than any other household, only pays the premium for C set by the *second highest bidder* in group K.[22] As a result, that household knows that it is paying an efficient premium for the levels of C that it desires, as one knows from the efficiency properties described by Vickrey (1961).

Using the aforementioned example, assume that house *m* is a member of type 1 (T^1). Further assume that households in this type have identical preferences over housing characteristics and amenities except for that amenity combination C in which the household chooses to "specialize." Regardless of whether C refers to one amenity (i.e. bay windows) or multiple amenities (bay windows, large lot, and high-quality sidewalks) in which the household chooses to specialize, the statistical outcome is essentially the same. The composition of C (as a single amenity or a vector of amenities) differs among the various households that choose to

[21] By specializing in a certain amenity or class of amenities, a household reveals its preferences for those amenities. This suggests that households choose a particular dwelling based on the utility "received" above a baseline, or reservation utility, level. This restriction that motivates the regression model is echoed by Ekeland, Heckman, and Nesheim (2002, p. 305).

[22] Similarly, the second highest bidder for this particular house will become the highest bidder for a similar house where he/she will pay the premium set by the second highest bidder for that dwelling.

locate in a particular neighborhood, which again emphasizes the fact that this treatment of housing is a restatement of the hedonic specification problem. Therefore, the reduced form equation (6a) and the household demand for housing for house *m* in type 1 (6b and 6c) are:

House i

(6a)

$$SP_m^1 = f(\mathbf{X}, \mathbf{Y}, \mathbf{Z} : b, d, g)$$

(6b)

$$SP_m - \overline{WTP^{T1}} = D_m^{2ndhighest}(\overline{SC}, C^{2ndhighest}) - \overline{D}^{T1}(\overline{SC}, \overline{C})$$

(6c)

$$WTP_m^{highest} - \overline{WTP^{T1}} = D_m^{highest}(\overline{SC}, C^{highest}) - \overline{D}^{T1}(\overline{SC}, \overline{C})$$

where

(7)

$$D^{2ndhighest} = D^{actual} \qquad D^{highest} \geq D^{actual}$$

For simplicity, this model assumes that only independent variables **X** (demographic and attitudinal variables), **Y** (spatial variables), and **Z** (dwelling characteristics) determine the selling price (SP) of house *m* in type 1. Equation 6a represents the first-stage OLS equation commonly used in hedonics. Here, households can specialize in some combination, C, of the independent variables. Equation 6b demonstrates how the Vickrey auction concept can be used to distinguish between the actual selling/rental price for a house and the average WTP for a house in a particular type. Finally, Equation 6c models the highest bid (or the WTP of the highest bidder) minus the average WTP for a particular house in type 1. One expects the premium paid by the highest bidder (SP_m – average WTP^{T1}) to be small if group K has well-defined preferences and coefficients for all other regressors are efficient.

3.2.3 Endogenous Types within Neighborhoods

The challenge to endogenize the definition of a neighborhood into household types flows from the hedonic specification problem itself. Rosen (1974) holds that in the limit, households cluster or organize into distinct entities of one element only. Even if many households have similar preferences and choose to purchase relatively similar houses, the vector of characteristics that induce the unique household to finally purchase its individual dwelling is unique to that household. Unlike uniform market goods, each house is distinct and will, if sold, go to the household willing to offer the singular highest bid for the particular bundle of characteristics possessed by that dwelling. If a class of buyers that shares many common preferences pursues an array of similar houses, then sorting household preferences (to the particular houses best suited to those preferences) becomes a restatement of the hedonic specification problem itself, as *similar* households with *similar* preferences pursue *similar* bundles of housing characteristics. Houses cannot vary along one element only; for the impact of the specification problem to be lessened asymptotically, houses in a neighborhood must vary along different dimensions. But, this does not preclude the use of techniques such as principal components analysis (PCA) to view over what space these similar preferences and houses tend to cluster. In this sense, PCA and other clustering techniques are used to mitigate the impact of the hedonic specification problem at the margin.

Next, we impose structure on the econometrics to avoid the identification problem when measuring within-neighborhood effects.[23] So, treating type endogenously, one can model the selling price of an individual house as it differs from the average WTP for a house in type 1 (from Equation 6b) as follows:

(8)

$$SP_m - \overline{WTP}^{T1} = \left[b^{T1} X_m^{T1} + d^{T1} Y_m^{T1} + g^{T1} Z_m^{T1} + a_m TYPE + e_{1m} \right] - \overline{WTP}^{T1}$$

α_m in Equation 8 models random type effects that are unobserved. The random effects model permits each type to have different effects on the selling price and average WTP, and adds generalizability to our model. One nice result of using the Vickrey auction concept is that the random type effect on the selling price and average WTP falls out in Equation 8, leaving one with the difference in independent variables and error terms from their respective means. Taking the expected value of the difference for each type gives us the general model (using notation from equation 6a):

(9)

$$E\left[SP_m^T - \overline{WTP}^T \right] = \beta^T X_m^T + \delta^T Y_m^T + \gamma^T Z_m^T + \varepsilon_{1m} - \overline{WTP}^T$$

where T is the TYPE being analyzed. Notice that alpha falls out when the selling price from (8) is conditioned on TYPE, leaving the house characteristics that differ from the TYPE's average characteristics as the driving components of the difference in selling price from average WTP.

The importance of Equation 9 is that it gives us the expected value of the premium paid for the combination of amenities (C) in which a particular household chooses to specialize.

[23] The City of Atlanta defines neighborhoods *a priori*.

Now, whether the calculation of this premium provides us with more information than can be obtained from traditional OLS regression remains to be seen. In the worst case, equation 9 will give us similar results to the OLS regression, which means that I have theoretically derived a model, using the Vickrey auction concept, that performs as well as OLS.

Chapter 4: Data Requirements

Existing secondary data sources [including the 2000 Census and Metropolitan Atlanta Multiple Listing Service (MLS)] do not provide all of the information required to adequately complete the aforementioned hedonic exercise. Data acquired from the MLS are tax parcel identification numbers; house values used for taxing purposes (assessed values); house square footage; number of acres; whether the house is owner-occupied, rented, etc.; date of construction; the selling price; and the date of the most recent sale. To complete the exercise, however, additional data were collected by 1) administering a survey to the residents of Home Park (please see Appendix A) and 2) constructing spatial variables using ArcView GIS (geographic information system). Using the data obtained from the MLS and Home Park survey, the hedonics exercise can be completed adequately. However, since we assume that space (measured through proximity to various features such as parks and public transportation) plays an important role in hedonics, the incorporation of additional spatial variables will allow the job to be done more completely. This follows a current trend in the literature (McLeod 1984; Kulshreshtha and Gillies 1993; Benson et al. 1998; Irwin and Bockstael 1999 and 2001; Paterson and Boyle 2002) to incorporate more GIS data into hedonic property value models.

This study addresses owner-occupied and rental housing in Home Park, a neighborhood adjacent to the north part of the Georgia Tech campus. Home Park has a large percentage of rental properties (approximately 70%) that accommodate mostly college students, but also younger couples and older single men. Nearby neighborhoods were redeveloped for the 1996 Summer Olympics, when radical changes occurred in neighborhood appearances as millions of dollars were poured into these formerly dilapidated neighborhoods. Public housing and other subsidized housing areas were rebuilt to accommodate households of all income levels. Now, in these nearby neighborhoods, a household paying $1,000 per month for an apartment may be a neighbor to a household paying $300 for the same quality and size apartment (i.e. Techwood Homes). These changes have been minimal in Home Park, as redevelopment monies were not directed at this particular neighborhood.

The variables used for this study can be grouped into dwelling features, demographic and attitudinal variables, spatial variables, and neighborhood features. Table 1 shows all of the variables to be used in this study.

Table 1: Dwelling features

Rental/Selling price of house (DV); continuous in dollars
    Source: Home Park survey (compared to MLS data for accuracy) [24]
Square footage of the house (IV); continuous in square feet
    Source: Multiple Listing Service of Metro Atlanta
Number of bedrooms (IV); polychotomous; D1 = 1 for 1-bedroom house, D2 = 1 for 2-bedroom houses, D3 = 1 for 3 bedroom houses, and D4 =1 for those with more than 3 bedrooms
    Source: Multiple Listing Service of Metro Atlanta
Number of baths (IV); discrete
    Source: Multiple Listing Service of Metro Atlanta
Year of last sale (IV); discrete; Y1997 = 1 for houses sold in 1997, etc.
    Source: Multiple Listing Service of Metro Atlanta
Age of the structure (IV); continuous in years; also include a quadratic form of the variable
    Source: Multiple Listing Service of Metro Atlanta

Spatial features:

Distance to nearest park or playground (IV); continuous in miles
    Source: GIS Clearinghouse, constructed by Muthu
Distance to nearest school (IV); continuous in miles
    Source: GIS Clearinghouse, constructed by Muthu
Road network distance to nearest grocery store (IV); continuous in miles
    Source: GIS Clearinghouse, constructed by Muthu

[24] It is important to make sure that household's perceived market value of their dwellings closely matches those from previous sales. Using a logistic growth curve model described in Konrad and Clark (1987), owner-occupied house sales prices from dwellings that sold before 1997 were forecast up to the year 2001. Using this method, we compared the selling price estimates from the forecast to those reported by households in the housing survey. We found a +- 3.6% difference in the estimates. Therefore, we conclude that households' reported current market values of their homes are accurate, particularly given that we asked them to estimate the market price of their homes within ranges of values, not one single value.

Road network distance to nearest retail opportunity (IV); continuous in miles
Source: GIS Clearinghouse, constructed by Muthu
Road network distance to nearest commercial opportunity (IV); continuous in miles
Source: GIS Clearinghouse, constructed by Muthu
Road network distance to nearest highway interchange (quadratic term) (IV); continuous in miles;
Source: GIS Clearinghouse, constructed by Muthu
Road network distance to nearest public transportation bus stop (IV); continuous in miles
Source: GIS Clearinghouse, constructed by Muthu
Road network distance to nearest public transportation rail stop (IV); continuous in miles
Source: GIS Clearinghouse, constructed by Muthu
Pure distance to nearest highway (to account for potential noise pollution) (operationalized as 1/pure distance) (IV); continuous in miles
Source: GIS Clearinghouse, constructed by Muthu
Amount of tree cover (IV); continuous (in percentage terms)
Source: GIS Clearinghouse coverages
Total linear length of sidewalk (IV);
Source: GIS Clearinghouse, constructed by Muthu
Viewshed (by parcel) (IV);
Source: GIS Clearinghouse, constructed by Muthu

Neighborhood features:
Sales Density (the percentage of dwellings that turns over each year in Home Park); (IV); continuous
Source: Created from LASTSALE variable, Multiple Listing Service of Metro Atlanta; and from Questions 7 and 18 of the Home Park survey

Demographic and attitudinal variables:
Total Income (IV);
Source: Home Park survey
Race of the respondent (IV); multinomial
Source: Home Park survey
Household size (IV); interval
Source: Home Park survey
Number of children in the household (IV); interval
Source: Home Park survey
Education level of the respondent (IV); multinomial
Source: Home Park survey
Age of the survey respondent (IV); continuous
Source: Home Park survey
Sex of the survey respondent (IV); dichotomous (0=female, 1=male)
Source: Home Park survey
Is the house owner-occupied? (IV); dichotomous (0=no, 1=yes)
Source: Home Park survey
Is some part of the house rented? (IV); dichotomous (0=no, 1=yes)
Source: Home Park survey

"What particular features attracted you to Home Park?"

Source: Home Park survey

"Do you want to remain in your current residence, or move either in Home Park or outside Home Park?"[25]

Source: Home Park survey

[25] This variable was suggested by Van Wissen and Rima (1988).

Chapter 5: Results

The response rate for this study was 53.4% (418/781). Of those who responded, 64.7% were renters and 35.3% were owners. The descriptive statistics (Table 1) show that the average dwelling in Home Park has 2.6 adults and approximately zero children. The average survey respondent is 33 years old. 64% of respondents to the survey were male. The average resident has lived in Home Park slightly longer than five years, is white, has at least an undergraduate degree, and makes between $25K and $35K per year. Approximately 34%, 26%, 31%, and 8% of Home Park residents feel that the most important issue besides national security is crime, the environment, education, and Social Security, respectively. Overwhelmingly, Home Park residents (57.3% of them) chose to live in the area because of its proximity to Georgia Tech. Also, more residents chose their particular dwellings based on the number of bedrooms (38%) than any other factor. Finally, 51.7% of all homeowners have made at least $10,000 in improvements to their homes over the last three years. This in part accounts for the average market price of homeowners' dwellings ($226,619), which is higher than the average market price for metropolitan Atlanta owner-occupied homes.

PCA on demographic variables created factors (Table 2) that were used to sort households into types. These initial, baseline types were used as the dependent variable (Type = 1, 2, 3, and 4) in the first run of the mixed logit model. Then, after the mixed logit/do-loop process, which continuously updates the household sorting process, households sorted according to Tables 3a, 3b, and 3c. Here, we see that only 5 households were sorted into the original Type 3 predicted by PCA. After re-sorting households with only three types, I show how the different procedures (PCA, mixed logit only, mixed logit in a do-loop process) produce different predicted types of households. Since the demographic variables were previously used to determine the *initial* sorting of households into types via PCA, only the attitudinal variables are used as independent variables in the mixed logit model.

The do-loop process had two iterations, indicating that the initial household sort via PCA was fairly accurate. However, the mixed logit/do-loop sort yielded only 5 households into Type 3, whereas the initial PCA sort allocated 61 households into Type 3. [what can I say about this?] After re-sorting the observations into *three* types only, we run OLS regressions and report the coefficients on the independent variables for types 1, 2, and 3 in Table 4. Originally, four types were chosen because of the small numbers of observations (418 total or approximately 104 per type) and the fact that the four highest scoring PCA-generated factors chosen to sort households into types had eigenvalues greater than 1.0. However, after the do-loop process, we find that a large majority of households (approximately 98.7%) are sorted into three types only.

The three types of households predicted from the model are distinct, as we would expect from a Tiebout self-organization of households in a particular neighborhood. Households that sort into Type 1 are generally homeowners who have made improvements to their homes, and who live in Home Park because of its investment potential. These households are comprised of mostly single families that have at least one family member employed full-time and that earn high incomes. Type 2 households are generally politically conservative student households who live in Home Park because of its proximity to Georgia Tech. These students have lower incomes and are currently pursuing degrees. They have lived in Home Park longer than other young Home Park residents, suggesting that "yuppies" (young residents with higher-than-average incomes for being recent college graduates) may be moving into the neighborhood. Finally, Type 3 households are also students who wanted to live close to Georgia Tech. However, these households are politically moderate to liberal, are younger in age, and have not lived in Home

Park as long as Type 2 households. The students in these households are likely putting themselves through school, as evidenced by the same approximate wages as Type 2. But, Type 2 households have a positive correlation with tenure and a slightly negative correlation with age, whereas Type 3 households have a relatively stronger negative correlation with tenure and age. This means that Type 3 households are relatively new to the neighborhood and relatively younger in age, suggesting that Type 2 households reflect older students close to completion of their degrees and Type 3 households reflect younger students new to the neighborhood. Another interesting conclusion is that both Type 2 and 3 households have negative correlations with income, suggesting that the younger students characterized in Type 3 households are putting themselves through college financially.

[Start reporting statistics from models described earlier]

Policy Implications and Further Research

1. Use the education levels among residents as “human capital externalities” in the hedonic model itself. I got this idea from Rauch (1991), cited in Zhang (2002), page 14. He used rent gradients to explain how living near educated people can enhance productivity. Therefore, wages in high human capital cities should be relatively higher. Can these externality effects also be separated out through the type concept?
2. Use network analysis to analyze the impacts of certain attributes of near neighbors, similar to the human capital externality approach mentioned above. Does the type of dwelling (rental or owner-occupied) of near neighbors influence the selling price of a particular house?
3. What are the policy implications of my research?
   - Surveys results show that Home Park residents are predominantly white, either students or full-time employees, in their middle 20s to middle 30s, politically moderate to liberal, and live in Home Park primarily because of its proximity to Georgia Tech, entertainment centers, and workplaces. Home Park residents in general chose their particular dwellings (whether rental or owner-occupied) based on the number of bedrooms and the fact that recent renovations were made to the dwelling. Also, the average Home Park resident wants to move to another dwelling inside Home Park (with many renters desiring to become owners of dwellings in Home Park).
   - Two neighborhood associations prevail in Home Park. First, the Home Park Community Improvement Association (HPCIA), comprised of a majority of absentee homeowners, is the City of Atlanta’s officially designated metropolitan planning organization (MPO) for the Home Park neighborhood. The other main group is the North Home Park Coalition (NHPC), a group whose focus is to maintain Home Park as a purely “residential”

community. NHPC believes that new construction projects such as Atlantic Station (currently under construction) pose great threats to the Home Park community. In particular, this group believes that a south entrance to Atlantic Station through the Home Park community (via State St., Atlantic Dr., Holly St., and/or Francis St.) will cause an unbearable amount of noise pollution and greater escape access for criminals, thus disrupting the current quiet residential setting. NHPC favors cul-de-sacs being placed at the proposed entrances to the Atlantic Station site, so that areas in Home Park north of 14^{th} Street retain their residential flavor. HPCIA, in contrast, opposes these cul-de-sacs because they limit access to Atlantic Station from the south. Easy access to Atlantic Station, argues HPCIA, will offset potential increases in crime with higher home values and higher rental fees that encourage higher-income households, willing to pay for the local urban amenities, to locate in Home Park. In the language of economists, HPCIA desires to maximize rents by eliminating cul-de-sacs in hopes of driving up the home values in Home Park, which happen to be owned by a significant number of HPCIA members. However, the problem with higher rental fees is that the current population of students that resides in Home Park is likely to be displaced. As a result, other neighborhoods near Home Park (i.e. Berkeley Park, Collier Hills, and Deering Road) are likely to accommodate more students in the event of higher rental fees due to Atlantic Station construction.

- Another policy implication of my research is “What should HPCIA do to vacant lots?” Is there a general rule that can be used by HPCIA (and agreed to by the landowners) to maximize the total home values of the neighborhood? For example, as mentioned in the literature review, I suggested that a particular type of land use for a particular vacant lot would maximize the total home values of surrounding homes/apartments. So, what land use type would be "best"? I believe there are multiple answers, contingent on the scenario. What follows are a few scenarios where results from this research can inform local decision-makers as to what to do.

1. Scenario 1: An 80 year-old house becomes vacant when its owner-occupier dies. The daughter of the former owner inherits the house and must choose between selling it to the highest bidder or selling it to the community, knowing that the community would most likely tear down the house to create a green space or park. Now, if the daughter sells the house to the highest bidder, that person either will become an owner-occupier or an absentee landlord (describe by schematic diagram). However, if the home and land are sold to the Home Park community, HPCIA has a great opportunity to alter the current land use to one that increases the home values of surrounding homes. This research tells us that Home Park residents prefer to be near parks, etc…. If the total increase in home values of houses surrounding the 80 year-old house (purchased from the daughter) is greater than or equal to the price actually paid to the daughter, then we have a Pareto-optimal scenario where the neighborhood as a whole receives more monetized "social surplus" than it costs to purchase the 80 year-old house.
2. Scenario 2: An absentee homeowner becomes tired of his house being trashed by his renters. Similarly, local residents do not like the appearance of the absentee homeowner's rental house. The absentee homeowner decides to screen renters more closely, opting to select older renters rather than the college students to who he has rented previously. Other absentee homeowners with property in Home Park, who

have similar problems with young renters, choose to rent to older people as well. The general results are many: a) local university students have a lower supply of rental housing from which to choose; b) the demographic composition of Home Park changes rapidly as young university students are replaced with employed or retired older people who are more likely to have children; c) rental prices are likely to change (the direction of change is dependent upon the degree of change in age- if the average age of renters shifts from ages 20-30 to 40-50, rental prices are likely to increase as people in the 40-50 age range most likely work full-time, have children, and are willing to pay higher prices for access to higher quality schools; however, if the average age of renters shifts from ages 20-30 to 60-70 over time, then rental prices are likely to remain the same or decrease as older renters on fixed or retirement income cannot afford to pay very high rental prices. Owners may perceive that lower rental fees for older renters are worth the fewer headaches of student renters.)

3. Scenario 3: Residential parcel zoned commercial or residential- local commercial sales used as a threshold to be met by residential property zoned commercial.

- The policy relevant material inherent in this investigation is abundant. For example, this research concludes that households within neighborhoods are not of a single type. Individual neighborhoods cannot accurately be described by one set of factors; many different types of households exist within ONE neighborhood. Many studies assume that households within particular neighborhoods are homogeneous. This study proves otherwise: neighborhoods should be broken up into distinguishable types based on theory developed in this paper. Therefore, any study of neighborhood trends should account for the heterogeneity of households within particular neighborhoods and attempt to aggregate individuals using some technique similar to the theoretical marginal utility ratios. Would the aggregation of types ACROSS neighborhoods work theoretically?

- Their discussion (Ekeland, Heckman, and Nesheim 2002) is consistent with our assertions made here. This article adds nothing to the hedonics literature that has not been articulated in the hedonics literature over the past seven years. Ekeland et al.'s discussion of "reservation utility" levels is analogous to our "second-highest bidder" concept pulled from the Vickrey auction discussion.
- Even though this current research focuses on one neighborhood, the econometric analysis can be applied to multiple neighborhoods in future studies that discern differences between neighborhoods in the same metropolitan area. [In particular, using Home Park and the next neighborhood to the north (Berkeley Park), one can also test other urban economic assumptions about monocentric models that radiate out from the CBD in one direction and/or the differences between two similar neighborhoods.]

Works Cited

Alonso, William. 1964. *Location and Land Use*. Cambridge: Harvard University Press.

Anas, Alex, Richard J. Arnott, and Kenneth A. Small. 2000. "The Panexponential Monocentric Model." *Journal of Urban Economics* 47: 165-179.

Anas, Alex, Richard J. Arnott, and Kenneth A. Small. 1998. "Urban Spatial Structure." *Journal of Economic Literature* XXXVI (3): 1426-1464.

Arguea, Nestor M. and Cheng Hsiao. 2000. "Market Values of Environmental Amenities: A Latent Variable Approach." *Journal of Housing Economics* 9, 104-126.

Becker, Gary. 1965. "A Theory of Allocation of Time." *Economic Journal* 75, 493-517.

Benson, Earl D., Julia L. Hansen, Arthur L. Schwartz, Jr., and Greg T. Smersh. 1998. "Pricing Residential Amenities: The Value of a View." *Journal of Real Estate Economics and Finance* 16(Jan.): 55-73.

Bolitzer, B. and N.R. Netusil. 2000. "The impact of open spaces on property values in Portland, Oregon." *Journal of Environmental Management* 59: 185-193.

Bourassa, Steven C., Foort Hamelink, Martin Hoesli, and Bryan D. MacGregor. 1999. "Defining Housing Submarkets." *Journal of Housing Economics* 8: 160-183.

Box, G.E.P. and D.R. Cox. 1964. "An analysis of transformations." *Journal of the Royal Statistical Society,* Series B. 211-252.

Boyce, David, Peter Nijkamp, and Daniel Shefer (Eds.). 1991. Regional Science: Retrospect and Prospect. Springer-Verlag: Berlin. p. 412-413.

Brock, W. and S. Durlauf. 2001. "Interactions-Based Models." *The Handbook of Econometrics 5,* James J. Heckman and Edward E. Leamer, eds. Elsevier Science.

Chattopadhyay, Sudip. 2000. "The effectiveness of McFadden's nested logit model in valuing amenity improvement." *Regional Science and Urban Economics* 30: 23-43.

Cohen, Michael. 1990. "A note on the cost of crime to victims." *Urban Studies* 27(1): 139-46.

Colwell, Peter F. and Gene Dilmore. 1999. "Who was first? An examination of an early hedonic study." *Land Economics* 75(4): 620-626.

Coulson, N. Edward. 1991. "Really Useful Tests of the Monocentric Model." *Land Economics* 67(3): 299-307.

Cropper, Maureen L., B.D. Leland, and Kenneth E. McConnell. 1988. "On The Choice of Functional Form for Hedonic Price Functions." *Review of Economics and Statistics* 70: 668-675.

Ekeland, Ivar, James J. Heckman, and Lars Nesheim. 2002. "Identifying Hedonic Models." *American Economic Review* 92(2): 304-309.

Epple, Dennis. 1987. "Hedonic Prices in Implicit Markets: Estimating Demand and Supply Functions for Differentiated Products." *Journal of Political Economy* 95 (1): 59-80.

Farmer, Michael C. 2002. "Re-Investing in the Built Environment: A Spatial Network Approach." *European Planning Studies*, forthcoming.

Farmer, Michael C., Joshua Reiss, and William Ditto. 2000. " Re-Investing in the Built Environment." *European Economic Review*, forthcoming.

Freeman, A. Myrick. 1993. The Measurement of Environmental and Resource Values: Theory and Methods. Resources for the Future: Washington, D.C., 104-105.

Glaeser, Edward. 1998. "Are Cities Dying?" *Journal of Economic Perspectives* 12(2): 139-160.

Glaeser, E., Kahn, M., and Rappaport, J. 1997. "Why do poor people live in cities." Working Paper. Harvard University Department of Economics.

Haab, Timothy C. and Robert L. Hicks. 1997. "Accounting for Choice Set Endogeneity in Random Utility Models of Recreation Demand." *Journal of Environmental Economics and Management* 34: 127-147.

Halstead, John M., Rachel A. Bouvier, and Bruce E. Hansen. 1997. "On the Issue of Functional Form Choice in Hedonic Price Functions: Further Evidence." *Environmental Management* 21(5): 759-765.

Hanemann, W. Michael. 1984. "Discrete/Continuous Models of Consumer Demand." *Econometrica* 52(3): 541-562.

Hanley, Nick and Clive L. Spash. 1993. Cost-Benefit Analysis and the Environment. Edward Elgar: Northampton, MA, USA, 74-76.

Heckman, James J. and James M. Snyder, Jr. 1997. "Linear probability models of the demand for attributes with an empirical application to estimating the preferences of legislators." *RAND Journal of Economics* 28(0): S142-S189.

Helmuth, Obata, & Kassabaum, Inc., and Raytheon Infrastructure Services, Inc. 1997.

Sea-Tac International Airport Impact Mitigation Study. Washington Department of Community, Trade and Economic Development. [Cited March 13, 2000]. <http://www.rcaanews.org/rcaa/hoksec9.html>.

Hoyt, William H. and Stuart S. Rosenthal. 1997. "Household Location and Tiebout: Do Families Sort According to Preferences for Locational Amenities?" *Journal of Urban Economics* 42, 159-178.

Hughes, William T., Jr. and Geoffrey K. Turnbull. 1996. "Uncertain Neighborhood Effects and Restrictive Covenants." *Journal of Urban Economics* 39: 160-172.

Immergluck, Daniel. 1999. "Neighborhoods, race, and capital: The effects of residential change on commercial investment patterns." *Urban Affairs Review* 34(3): 397-411.

Irwin, Elena G. and Nancy E. Bockstael. 1999. "Interacting Agents, Spatial Externalities and the Evolution of Residential Land Use Patterns." Presented at Western Economics Association meeting.

Irwin, Elena G. and Nancy E. Bockstael. 2001. "The Problem of Identifying Land Use Spillovers: Measuring the Effects of Open Space on Residential Property Values." *American Journal of Agricultural Economics* 83 (Aug.): 698-704.

Kahn, M. 1996. "The Silver lining in Rust Belt decline: Killing off pollution Externalities." Working Paper.

Krugman, Paul. 1998. "Space: the final frontier." *Journal of Economic Perspectives* 12(2): 161-174.

Kulshreshtha, Suren N. and Jon A. Gillies. 1993. "Economic Evaluation of Aesthetic Amenities: A Case Study of River View." *Water Resources Bulletin* 29 (April): 257-266.

Lancaster, Kelvin. 1966. "A New Approach to Consumer Theory." *The Journal of Political Economy* 74(2): 132-157.

Lipscomb, Clifford A. 2001. "The Capitalization of Amenities and Disamenities into Local Housing Markets: The Case of College Park, Georgia." *Colloqui: Cornell Journal of Urban Planning*. Ithaca, NY: Cornell University, 2001.

Luttik, Joke. 2000. "The value of trees, water and open space as reflected by house prices in the Netherlands." *Landscape and Urban Planning* 48: 161-167.

McFadden, Daniel. 1978. "Modelling the Choice of Residential Location." In Karlqvist, A., L. Lundqvist, F. Snickars, and J. Weibull (eds.) Spatial Interaction Theory and Planning Models. North Holland: Amsterdam, 75-96. Reprinted in J. Quigley (ed.), The Economics of Housing, volume 1. 1997. Edward Elgar: London.

McLeod, Paul B. 1984. "The Demand for Local Amenity: An Hedonic Price Analysis." *Environment and Planning A* 16 (Mar.): 389-400.

Minor, Elliott. "Preservation key to improving quality of life." The Daily Tribune News March 1, 2002, pg. 5A.

Morrell, Peter and Cherie H.-Y. Lu. 2000. "Aircraft noise social cost and charge mechanisms- a case study of Amsterdam Airport Schiphol." *Transportation Research Part D* 5: 305-320.

Muth, Richard F. 1960. "The Demand for Non-Farm Housing," in The Demand for Durable Goods. A.C. Harberger, Ed. Chicago: University of Chicago Press, 29-96.

--------------------. 1969. Cities and Housing. Chicago: University of Chicago Press.

Neyman, J. and Scott, E.L. 1948. "Consistent Estimates Based on Partially Consistent Observations." *Econometrica* 16: 1-32.

Palmquist, Raymond B. 1991. "Chapter IV: Hedonic Methods" in Measuring the Demand for Environmental Quality, Braden, John B. and Charles D. Kolstad, Eds. Elsevier Science Publishers B.V. (North-Holland).

Papageorgiou, Y.Y. and T.R. Smith. 1983. "Agglomeration as Local Instability of Spatially Uniform Steady-States." *Econometrica* 51(4): 1109-1120.

Parsons, George R. 1986. "An Almost Ideal Demand System for Housing Attributes." *Southern Economic Journal* 53(2): 347-363.

Paterson, Robert W. and Kevin J. Boyle. 2002. "Out of Sight, Out of Mind? Using GIS to Incorporate Visibility in Hedonic Property Value Models." *Land Economics* 78(3): 417-425.

Rapaport, Carol. 1997. "Housing Demand and Community Choice: An Empirical Analysis." *Journal of Urban Economics* 42: 243-260.

Roback, Jennifer. 1982. "Wages, Rents and the Quality of Life." *Journal of Political Economy* 90(6): 1257-1278.

Rosen, Sherwin. 1974. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *Journal of Political Economy* 82: 34-55.

Sieg, Holger, V. Kerry Smith, H. Spencer Banzhaf, and Randy Walsh. 2000. "Estimating the general equilibrium benefits of large policy changes: the Clean Air Act revisited." National Bureau of Economic Research, Working Paper 7744.

Smith, V.K. and Huang, Ju-Chin. 1995. "Can Markets Value Air Quality? A Metaanalysis of Hedonic Property Value Models." *Journal of Political Economy* 103: 209-227.

Texas Transportation Institute. 2001. "2001 Urban Mobility Report." College Station, Texas: Texas A&M University.

Thorsnes, Paul. 2000. "Internalizing Neighborhood Externalities: The Effect of Subdivision Size and Zoning on Residential Lot Prices." *Journal of Urban Economics* 48: 397-418.

Tiebout, Charles. 1956. "A Pure Theory of Local Expenditures." *Journal of Political Economy* 64: 416-424.

Tolley, George. 1974. "The Welfare Economics of City Bigness." *Journal of Urban Economics* 1(3): 325-345.

Tyrvainen, Liisa, and Antti Miettinen. 2000. "Property Prices and Urban Forest Amenities." *Journal of Environmental Economics and Management* 39: 205-223.

Wissen, Leo Van and Annemarie Rima. 1988. Modelling Urban Housing Market Dynamics: Evolutionary Patterns of Households and Housing in Amsterdam in Studies in Regional Science and Urban Economics, Ake E. Anderson, Walter Isard, and Peter Nijkamp, eds. Volume 18, North Holland Publishing Co.: Amsterdam.

APPENDIX A: HOME PARK HOUSING SURVEY

Dear Home Park Resident:

You have been randomly selected to complete a survey that will be used to implement the Home Park Master Plan. If you are a renter, please complete the "**I AM A RENTER"** survey **only**. If you own your home, please complete the "**I AM A HOMEOWNER"** survey **only**.

Timothy State, President of the Home Park Community Improvement Association, Inc., approved this survey. You will not be paid and there is no cost to you to participate. As our way of saying thank you, please find an enclosed stick of gum that will last longer than this five-minute survey. There is no direct benefit or foreseeable risk to you to participate in this survey. If you have questions about your rights as a research subject please contact the Office of Research Compliance at 404-894-6944.

After completing the survey, please return it to me using the self-addressed stamped envelope enclosed.

We need your help. All information that identifies you and your dwelling is confidential and will be purged upon completion of this study. Your answers will not be provided to any companies for any reason. If you have questions about the survey please contact Dr. Michael Farmer at 404-894-6458 or Cliff Lipscomb at 770-387-2518.

The Home Park Community Improvement Association will receive a summary report from this research. Your contribution is very useful to us, but no information on individual households will be shared with outside sources.

Your participation is completely voluntary. There are no right or wrong answers; we only want your opinion if you want to provide it to us.

Thank you in advance for your time in completing this survey- the Home Park Community Improvement Association and I very much appreciate your help.

Cliff Lipscomb, Ph.D. Candidate
Georgia Tech School of Public Policy

I AM A HOMEOWNER

1. How many adults (18 years old or older) live in your dwelling? ______
2. How many children (under 18 years of age) live in your dwelling? _____
3. How many adults in your dwelling are employed (including self-employed adults)? _____
4. How old are you? _________ years
5. What is your gender? ___ Female ___ Male
6. Which best describes your living situation:
   ___ I own the house, live in it, and do not rent any of it.
   ___ I own the house, live in it, and rent part of it.
7. Approximately how long have you lived in your current dwelling?
   ________ years
8. Which best describes your race?
   ___ African-American ___ White ___ Other
   ___ Hispanic ___ Asian
9. Check the ONE statement that best describes YOU. I am:
   ___ unemployed. ___ a student.
   ___ a homemaker. ___ retired.
   ___ employed full-time. ___ employed part-time (non-student).
10. If you are currently employed (self-employment is included here), which statement that best describes YOU:
    ___ I am the highest wage earner in the dwelling.
    ___ Another household resident is the highest wage earner.
    ___ All residents who work make approximately the same wages.
11. Which of these best describes YOU (*please check only one*):
    ___ I did not complete high school.
    ___ I am a high school graduate.
    ___ I am currently an undergraduate student.
    ___ I have an undergraduate degree.
    ___ I am currently a graduate student.
    ___ I have a graduate degree.
12. Which category best describes *your* total annual income before taxes (include all sources of income, including fellowships, alimony, retirement income, etc.)?
    ___ Less than $15,000 ___ $50,000 to $69,999
    ___ $15,000 to $24,999 ___ $70,000 to $89,999
    ___ $25,000 to $34,999 ___ $90,000 or more
    ___ $35,000 to $49,999
13. Which *one* issue besides national security is more important to you?
    ___ Crime ___ Education
    ___ Environment ___ Social Security
14. Politically speaking, do you generally consider yourself (*check one only)*:
    ___ Conservative ___ Liberal ___ Moderate

(over)

15. What is the approximate market value of your house today?
(*Check only one.*)

___ $90,000 to $149,999	___ $225,000 to $249,999
___ $150,000 to $174,999	___ $250,000 to $274,999
___ $175,000 to $199,999	___ $275,000 to $299,999
___ $200,000 to $224,999	___ More than $300,000

16. From the list below, please check the ***two*** most important factors in your decision to live in the Home Park *neighborhood*.

___ Close to religious facilities	___ Tree cover
___ Close to Georgia Tech	___ Crime rate
___ A feeling of community	___ Noise levels
___ Diversity of residents	___ Close to parks
___ Investment potential	___ Close to your workplace
___ Close to entertainment	___ Close to public transportation

17. From the list below, please check the ***two*** most important factors in your decision to live in *your particular house.*

___ Kitchen	___ Lots of windows
___ Number of bathrooms	___ Hardwood floors
___ Views of the neighborhood	___ Internet connection
___ Recent renovations to the house	___ Other _______________
___ Number of bedrooms	

18. To your knowledge, have total improvements to your home over the last three years exceeded $10,000? ___ Yes ___ No

19. Which statement best describes you: "In the next two years…"
___ I do not wish to move.
___ I want to move inside Home Park.
___ I want to move outside Home Park.

20. (optional) Feel free to add any of your own comments concerning what you like or do not like about the Home Park neighborhood and/or your house.
____
____

Thank you for your help!

I AM A RENTER

1. How many adults (18 years old or older) live in your dwelling? ______
2. How many children (under 18 years of age) live in your dwelling? _____
3. How many adults in your dwelling are employed (including self-employed adults)? _____
4. How old are you? ____________ years
5. What is your gender? ___ Female ___ Male
6. Which best describes your living situation:
   ___ I rent an entire house or apartment.
   ___ I rent a unit in an apartment complex.
   ___ I rent a room in a house owned by someone else.
7. Approximately how long have you lived in your current dwelling?
   ________ years
8. Which best describes your race?
   ___ African-American ___ White ___ Other
   ___ Hispanic ___ Asian
9. Check the ONE statement that best describes YOU. I am:
   ___ unemployed. ___ a student.
   ___ a homemaker. ___ retired.
   ___ employed full-time. ___ employed part-time (non-student).
10. If you are currently employed (self-employment is included here), which statement that best describes YOU:
    ___ I am the highest wage earner in the dwelling.
    ___ Another roommate is the highest wage earner.
    ___ All roommates who work make approximately the same wages.
11. Which of these best describes YOU (*please check only one*):
    ___ I did not complete high school.
    ___ I am a high school graduate.
    ___ I am currently an undergraduate student.
    ___ I have an undergraduate degree.
    ___ I am currently a graduate student.
    ___ I have a graduate degree.
12. Which category best describes *your* total annual income before taxes (include all sources of income such as fellowships, retirement income, etc.)?
    ___ Less than $15,000 ___ $50,000 to $69,999
    ___ $15,000 to $24,999 ___ $70,000 to $89,999
    ___ $25,000 to $34,999 ___ $90,000 or more
    ___ $35,000 to $49,999
13. Which *one* issue besides national security is more important to you?
    ___ Crime ___ Education
    ___ Environment ___ Social Security
14. Politically speaking, do you generally consider yourself (*check one only)*:
    ___ Conservative ___ Liberal ___ Moderate

(over)

15. How much do you and your roommates pay *total* for your rented dwelling each month?

___ $400 to $499 ___ $800 to $899
___ $500 to $599 ___ $900 to $999
___ $600 to $699 ___ More than $1,000
___ $700 to $799

16. From the list below, please check the ***two*** most important factors in your decision to live in the Home Park *neighborhood*.

___ Close to religious facilities ___ Tree cover
___ Close to Georgia Tech ___ Crime rate
___ A feeling of community ___ Noise levels
___ Diversity of residents ___ Close to parks
___ Investment potential ___ Close to your workplace
___ Close to entertainment ___ Close to public transportation

17. From the list below, please check the ***two*** most important factors in your decision to live in *your particular rental unit*.

___ Kitchen ___ Lots of windows
___ Number of bathrooms ___ Hardwood floors
___ Views of the neighborhood ___ Internet connection
___ Recent renovations to the house ___ Other _______________
___ Number of bedrooms

18. Which ONE statement best describes you: "In the next two years…

___ I do not wish to move.
___ I want to move inside Home Park.
___ I want to move outside Home Park.

19. (optional) Feel free to add any of your own comments concerning what you like or do not like about the Home Park neighborhood and/or your rental unit.

____
____

Thank you for your help!

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
adults	418	2.595694	1.501935	1	12
children	418	.1578947	.6108118	0	6
adultwk	417	1.841727	1.374173	0	11
age	412	33.56311	14.64165	17	98
gender	410	.6487805	.4779346	0	1
tenure	411	5.021022	10.18732	.01	70
race	415	2.214458	.6406391	0	4
employ	418	2.617225	.840743	0	5
relwage	418	.8923445	.8568465	0	2
educ	415	3.238554	1.399951	0	5
income	407	2.046683	1.924763	0	6
crime	415	.339759	.474199	0	1
envir	415	.2626506	.4406053	0	1
educiss	415	.313253	.4643761	0	1
socsec	415	.0795181	.2708722	0	1
politics	408	1.259804	.7875892	0	2
nearrelg	415	.0457831	.2092667	0	1
close_gt	415	.573494	.4951661	0	1
feelcomm	415	.1277108	.3341704	0	1
diverse	415	.0674699	.2511368	0	1
invespot	415	.1590361	.3661512	0	1
entertan	415	.2072289	.4058102	0	1
tree_cov	415	.1084337	.3113027	0	1
crimerat	415	.0457831	.2092667	0	1
noise	415	.0289157	.1677718	0	1
nearpark	415	.026506	.1608284	0	1
nearwork	415	.3325301	.4716884	0	1
nearmart	415	.1084337	.3113027	0	1
kitchen	415	.1373494	.3446313	0	1
no_baths	415	.139759	.3471554	0	1
hoodview	415	.1253012	.3314597	0	1
renovate	415	.2289157	.4206419	0	1
no_beds	415	.3807229	.4861507	0	1
windows	415	.1493976	.3569102	0	1
hwfloors	415	.1180723	.3230832	0	1
internet	415	.0409639	.1984457	0	1
wantmove	414	.910628	.9537656	0	2
rentsit	271	.7343173	.866818	0	2
yard	415	.0843373	.2782285	0	1
humancon	415	.0433735	.2039423	0	1
own_sit	147	.2312925	.4231005	0	1
montrent	269	4.30855	2.081717	0	6
homeimpr	145	.5172414	.5014347	0	1
rent_own	418	.353222	.4785423	0	1
newrent	269	99536.62	23523.4	50850	118650
newhomev	142	226619.7	58359.82	120000	312500
finalval	411	143443.7	72068.8	50850	312500
homeimp2	418	.1789976	.3838086	0	1

Table 2: Principal Components Analysis

Demographic Variables (420 observations used)		
Factors	Eigenvalues	High Correlations[26]
Factor 1	4.469	Rent_own, adults, age, ftemploy, student, income
Factor 2	2.058	Age, tenure, ftemploy, retired, educ, income
Factor 3	1.299	Adults, adultwk, gender

Note: 402 observations out of the sample of 418 have complete demographic data with no missing values.

Table 3a: Household Sort According to Principal Components Analysis[27]

Table 3b: Household Sort According to SUR Do-Loop Process

PCA PREDICTED TYPES	DO-LOOP PREDICTED TYPES 1	2	3	Total
1	154	0	0	154
2	0	93	0	93
3	1	3	1	5
4	0	0	150	150
Total	155	96	151	402

[26] Variables here have a correlation of +- .30 or higher.
[27] Number of observations used in the sorting process is 372 because 46 observations have some missing values that have not been imputed yet.

Table 3c: Comparison of Initial Sort via PCA to Final Sort after the SUR Do-Loop

Table 4: OLS Coefficient Estimates Using Do-Loop Predicted Types (With robust standard errors in parentheses)

	TYPE 1	TYPE 2	TYPE 3
Observations	155	96	151
R-squared	.667	.805	.888
	Coefficient Estimates		
Rent_own	**86577.25*** (15600.49)**	**129955.1*** (31655.39)**	**170997.9*** (13280.57)**
Adults	13977.44 (10113.45)	**9180.81*** (2593.07)**	**14017.3*** (2799.24)**
Children	12389.9 (9695.3)	14229.45 (16650.43)	6184.65 (4869.76)
Adultwk	7900.5 (12560.1)	1061.74 (3147.36)	-322.03 (2185.29)
Age	**1556.51** (633.95)**	1485.75 (1227.92)	146.22 (359.49)
Gender	14962.07 (12908.31)	-5503.11 (7293.08)	**12763.52** (6135.76)**
Tenure	-479.71 (707.86)	1105.49 (3080.45)	**-874.87* (493.79)**
Race	4417.24 (13599)	**-11133.94** (4291.20)**	-234.56 (3979.44)
Employ	5262.46 (8225.86)	5228.80 (7036.58)	**-8992.21* (5134.07)**
Educ	2052.33 (4882.41)	-5273.47 (4288.37)	**-5256.95** (2380.18)**
Income	**11652.98** (5385.23)**	-2432.1 (3044)	3002.23 (2813.2)
Crime	8546.49 (33011.3)	-53015.86 (40883.6)	**-14944.24* (8688.72)**
Envir	15304.54 (28027.77)	-57095.22 (36465.12)	Dropped
Educiss	-6370.27 (33846.25)	**-71592.96** (32029.95)**	-14986.71 (10878.85)
Socsec	Dropped	Dropped	1841.75 (18985.65)
Politics	**-20976.07** (9787.34)**	-870.97 (3980.71)	**8531.11** (3736.86)**
Close_gt	-14607.4 (36156.8)	6878.64 (11811.31)	13810.93 (11432.56)
Invespot	**-22240.35* (12836.27)**	1926.28 (22671.42)	-25676.55 (23558.21)
Tree_cov	-37592.84 (23914.91)	-9004.49 (7069)	Dropped
Crimerat	**40238.69* (22534.88)**	Dropped	-3100.31 (9404.31)
Nearmart	**-38215.46* (22314.01)**	-2770.32 (22057.89)	**12595.27* (7499.69)**
Renovate	**31358.44** (13730.96)**	983.87 (6319.82)	**11422.07* (6036.85)**
No_beds	19385.61 (17187.83)	-7580.15 (6920.52)	**16486.89** (6738.39)**
Wantmove	-3566.43	-3798.99	2693.59

	(7391.87)	(4019.25)	(3223.78)
Homeimp2	**31840.07* (14034.26)**	-12579.54 (33295.27)	525.78 (16456.09)
Constant	-35073.55	148189.8	60503.31

- * indicates significance at the .10 level
- ** indicates significance at the .05 level
- *** indicates significance at the .01 level