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An Hedonic Estimation of the Effect of Federally Subsidized Housing on Nearby Residential Property Values

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ABSTRACT

Does subsidized housing lower neighboring property values? People often voice this concern when projects are planned for their neighborhoods. Yet the few studies of this question tend to find little support for this "not in my back yard" mentality. In a time when demographics, the economy and government policy are limiting poor people's access to safe, affordable housing, the foundation of this rationale deserves closer attention. This paper estimates what property owners are willing to pay to have more or less subsidized housing near them. Hedonic prices are also estimated for differing spatial, tenant, and value distributions of this subsidized housing.

A major finding is that the number of subsidized units near a residential property has a small, statistically significant negative effect on its value, which diminishes with greater distance. A second important finding is that lumpy increments of additional affordable housing in a neighborhood (i.e., major housing developemnts) are more likely to have noticeable impacts on housing values than are single unit increments. Thus, policies that ecnourage dispersal of affordable housing within a community are less likely to meet with local resistance than are multi-family projects.

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Chapter 1: The Nature of the Problem

Introduction

This paper investigates the effects of federally subsidized rental housing on neighboring property values using an hedonic technique. While this question is hotly debated within communities where such housing exists or is scheduled to be developed, relatively little empirical research is available to verify or reject the claim which lies at the base of the not-in-my-back-yard (NIMBY) mentality: that subsidized housing reduces the value of nearby properties. This is an important policy question in a time when access to decent and affordable housing for poor, elderly and handicapped people is being limited by a number of economic, demographic and policy factors. Surprisingly few studies in the expansive literature on urban land use are devoted to the issue. These few studies use diverse methods and come to somewhat conflicting conclusions. A weak consensus does emerge, however, indicating little support for the negative externality hypothesis. This consensus is weak because most of the studies use very small samples and fail to frame the issue within any kind of theoretical set of expectations.

The primary objective of this research is to determine if there is any evidence to support a negative externality hypothesis that is *also* consistent with economic theory. After describing the significance of the affordable housing problem, the rest of Chapter 1 reviews the literature on the effects of subsidized housing on property values. Chapter 2 then develops a set of hypotheses about the likely factors related to the presence, size, spatial pattern and quality of subsidized housing which may affect neighborhood property values. Chapter 3 describes the hedonic model used and how it is operationalized in order to test these hypotheses. Chapters 4 and 5 present the results of the analysis and the paper's conclusions.

A hedonic model was chosen for three reasons. First, it is appealing on theoretic grounds. While a straightforward regression model could isolate important property value covariates, the interpretation of the coefficients would have unclear theoretical foundation. This has been a major limitation of the literature reviewed in the next chapter. Most studies have approached this question from a purely empirical viewpoint: do effects exist or not? However, given the complex array of factors that interact to determine equilibrium prices in local housing markets, most of these studies were unable to uncover any significant effects. A strong theoretical foundation may provide guidance in these circumstances. The hedonic model presented here is well founded in utility theory.

A second reason to prefer the hedonic model is that if subsidized housing is shown to have significant effects on nearby property values, some specific, if tentative, statements can be made regarding welfare implications. This aspect of the results will not be heavily developed in this paper; however it sets the path for further analysis. A third reason for using the hedonic method is that the technique has yet to be applied to this problem.

Subsidized Housing and Property Values

What is it about subsidized housing that makes communities fear for their property values? Is it an objectively measurable characteristic of the subsidized units or a more subjective interaction between different social classes? How property owners perceive subsidized housing and the people who live in it is an important contributor to the NIMBY phenomenon. Are community fears racist or classist? Are they really concerned with their property values or is it a fear of social contagion which motivates them to eschew subsidized units in their communities?

These are important, if unpleasant, questions. While economic research can not provide direct answers to them, it can uncover how these normative perceptions are translated into market behavior. Further it can provide guidance to policy makers as to what "objective" characteristics of subsidized housing may have lesser or greater impacts on property values by answering questions like: do elderly tenants have less negative effect than families; does the spatial distribution of subsidized units within a neighborhood effect property values; do different types of subsidy programs engender differential effects? Such information is crucial, especially for local governments and private agencies who are attempting to ameliorate urban housing problems.

The Problem of Affordable Housing

The National Housing Act of 1949 established the primary goal of modern national housing policy: "a decent home and suitable living environment for every American family." The 1989 Congressional National Housing Task Force, found what they termed "the paradox of housing in America. For most, housing is a dream fulfilled; but for too many others, housing is unavailable, unaffordable or unfit." (National Housing Task Force, 1988, p. 2) This cleavage between the housing "haves" and "have-nots" is less a paradox than the result of explicit policies, as well economic and demographic trends, which have translated during the past decade into more poor people seeking less affordable housing.[1]

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[1]The double *entendre* is intended.

In 1988, less than one third of those people qualifying for housing assistance received it (Apgar and Brown 1988; Zarembka 1990). One reason for this state of affairs is the basic structure of federal housing assistance (Keyes and DiPasquale 1990). Housing subsidies for poor people are provided through discretionary funding, which explicitly enters the budget each year. On the other hand, housing assistance for middle and upper income home owners is provided primarily through the home owner tax deduction. Anyone who owns a home can claim these deductions. While this basic policy structure is important in maintaining the quality of the national housing stock in general, it offers less assistance to people with lower incomes than to people with higher incomes. In 1988, the federal government spent roughly $14 million on housing assistance for the poor, while foregoing close to $54 million in taxes from home owners (Keyes and DiPasquale 1990).

In addition to this fundamental policy structure, the recent retrenchment of the federal role in stimulating housing production has endangered the future of the existing stock of affordable housing. The 1960s saw an enormous federal involvement in the production of housing. A large portion of existing subsidized rental housing was built during this period through federal incentives to private developers in the form of loans and tax deductions. In return for these inducements, investors were obliged, through so called "use control" contracts, to preserve these units for low income family use. These controls are now expiring. Recent studies on a large sample of these units (645,000 of 2 million) have reported that if the federal government does nothing to preserve this stock of housing for low income tenants, "only 19 percent of the 645,000 units are predicted to remain in the subsidized housing stock. . . 43 percent are predicted to default and 38 percent to prepay (their mortgages)" by the end of this decade (Clay and Wallace 1990, p. 329; National Low Income Housing Preservation Commission 1988).

Federal policy since 1974, and even more sharply, since 1980, has shifted away from direct government intervention to stimulate affordable housing production. The Reagan Administration eliminated the major remaining production-oriented program, Section 8 New Construction and Rehabilitation (NCR), in 1983. Federal policy since 1980 has emphasized a demand based approach, using direct payments to tenants instead of incentives to private investors, in an attempt to make more effective use of the existing private rental market. While this policy was supposed to indirectly stimulate housing production, the statistics presented here indicate this effect has not been substantial. There are a number of reasons for this failure.

A major problem with the demand-based approach is that rising housing costs have increased pressure on the rental market, reducing the ability of the market to absorb even those who can get federal subsidies (Clay and Wallace 1990). Due to high interest rates of the 1980s and historical ratcheting from the inflation of the 1960s and 70s, the real cost of home ownership has risen over the past two decades. The median price of a representative first home in 1988 was $66,000, up 22 percent in real terms from 1967 (Apgar 1990). This has made it harder for young, potential first time buyers to purchase homes. From 1981 to 1986, home ownership rates fell for every age group under 65 years old, with the most significant decline in the under 35 population: about a 17 percent decline for those under 25, 12 percent for 25-29 year olds, and 10 percent for the 30-34 year old cohort (Zarembka 1990). This means that more people, who would have been home owners in the past, are staying in the rental market. Whether this trend will continue given recent reductions in interest rates is unclear.

The number of poor households in the rental market has also increased. In 1980 the number of poverty level renters was 5.8 million. By 1988 it had risen to 7.7 million (Apgar 1990). This larger group of poor renters is also indicated by the decline in median income for renters, from $18,000 (1986 dollars) in 1972 to $15,300 in 1986, or about half the median income of home owners (National Housing Task Force 1988; Regional Housing Task Force 1991). Some of this income deterioration is due to the changing demographics of the renter population, as a growing proportion are composed of minorities and single parent female headed families.

This pressure on the rental market has bid rents up. The number of units renting for under $300 per month dropped by 1.6 million from 1974 to 1985 (Apgar and Brown 1988; Apgar 1990; National Housing Task Force 1988). Rising housing costs and declining incomes translate into an increased housing cost burden for the poor. In 1988 half of all renters, about 16 million households, are paying over 30 percent of their income for housing (Apgar 1990). Coincidentally, a 30 percent housing cost-to-income ratio is the standard rent burden used in most federal assistance programs beyond which renters are eligible for subsidies.

In addition to rising housing costs and changing demographics, two explicit federal policies during the 1980s have frustrated the demand-side approach. These are deregulation of the savings and loans and the Tax Reform Act of 1986, both of which greatly reduced incentives for private investors to provide housing for low income families.

The deregulation of the savings and loan industry by the Reagan Administration in 1981 made investment in affordable housing substantially less interesting for private investors than placing their monies in other forms of real estate ventures offered through S&L institutions. While these ventures were associated with substantial risk (as were affordable housing projects), they provided more attractive short run returns for investors. The S&L crisis has limited the importance of this diversion of resources from affordable housing investment. However, a second and even more devastating policy shift occurred in 1986, which further discouraged private investment in affordable housing projects.

Almost overnight, the Tax Reform Act of 1986 wiped out most of the tax benefits associated with investment in affordable housing. Over the 1970s and early 1980s, Congress had created a complex set of tax incentives to encourage investment in affordable housing. This incentive structure was probably as significant in the development of the affordable housing stock as any of the direct subsidy programs described in the next section. As one private investor commented:

> The recent elimination of tax advantages (for low-income housing investors) has, for us, at least, guaranteed its conversion. To forestall our decisions, Congress would have to do something pretty spectacular to again make owning and managing such ventures attractive to anyone. (National Low Income Housing Preservation Commission 1988, p. 3)

Congress' response, the Low Income Housing Tax Credit, has been relatively unsuccessful in stimulating private investors to return to affordable housing (National Council of State Housing Agencies 1987; National Low Income Housing Preservation Commission 1988).

Many analysts have blamed this so called "affordable housing crisis" on the shift in federal policy from a supply- to a demand-oriented approach over the past 20 years (for an excellent presentation of this argument, see DiPasquale and Keyes (1990), especially the chapter by Clay and Wallace). They argue that the federal government no longer provides adequate incentives for private investors to allocate resources to the production of affordable housing units. At a time when fiscal stress, slow overall economic growth and housing cost and demographic trends combine to frustrate demand based solutions, federal policy has only exacerbated the affordable housing problem.

Chickens and Eggs

While its clear that more affordable housing needs to be provided, many communities facing the choice of where to put these units have been reluctant to locate them in middle and upper income neighborhoods for fear of lower neighborhood property values. The result of this community fear, historically, has been a clustering of subsidized housing in low income areas (Warren 1986). Thus there is a chicken and egg dilemma: does subsidized housing lower neighboring property values or do cities simply locate subsidized housing in poor neighborhoods? This problem poses serious concerns for a researcher interested in separating the chicken from the egg. This problem is confronted in chapter two.

The Evolution of Federal Housing Subsidy Programs

In this section, we briefly summarize the major federal housing subsidy programs. There have been at least 12 major pieces of federal legislation since 1934 that have shaped the programmatic evolution of housing subsidies. A full description of this history is beyond the scope of this thesis. For a fuller treatment, see Jacobs et al. (1986)

to which much of our discussion is indebted. Table 1.1 summarizes the major federal subsidy programs.

Rental Subsidy Programs

There are three basic types of rental subsidy programs, corresponding to the three major subdivisions shown in table 1.1: public housing, private market incentives and direct transfer payments to individual tenants.

Public Housing

Major federal involvement in the provision of affordable housing began with the public housing program, authorized by the National Housing Act of 1937. Under this program, local public housing authorities (PHAs) issue tax-exempt bonds, for which the federal government pays debt service. Once the bonds mature, ownership of the units reverts to the PHA. This financing scheme allows a PHA to rent its units to low-income tenants at reduced rates. As operating costs rose in the 1960s, PHAs found it increasingly difficult to maintain adequate housing quality for their poorer clientele without increasing rents.

In 1969 the first of the Brooke Amendments was authorized by Congress, limiting rents in public housing projects to 25 percent of tenant income. (The limit was increased to 30 percent in 1981.) While easing the burden of tenants, this exacerbated the gap between rents and operating costs. While limited operating subsidies had been provided by the government to PHAs since 1961, the Brooke Amendment led Congress to authorize HUD to provide extensive operating subsidies to allow for needed rehabilitation of the public housing stock. In 1981, increasing costs and concerns over managerial inefficiencies resulting from the extensive subsidies induced HUD to institute a performance-based operating subsidy program. HUD determines a reasonable level of operating costs for each public housing project based upon a complex formula. It then pays the project a subsidy equal to the difference between this figure and the rent the project receives from tenants. This provides incentives for project management to meet HUD definitions of managerial efficiency, but does little to assist projects in legitimate financial difficulties.

Private Market Incentive Programs

A number of subsidy programs based on providing below market interest rates (BMIR) to private developers were created between 1959 and 1968. The basic idea of all of these programs is to provide private developers with low-cost loans to build housing specifically designed for needy people. The interest savings are then passed on in the form of lower rents to tenants. While these programs remove some of the inefficiencies of public management of properties inherent in the public housing system,

TABLE 1.1
MAJOR FEDERAL HOUSING SUBSIDY PROGRAMS

Rental Subsidy Programs

Public Housing	**Loan Based Incentives to Investors**	**Direct Transfer Payments to Tenants**
	Section 202: for elderly tenant projects only; still active.	Section 8/NCR: (New Construction and Rehabilitation) subsidies given to individual tenants, but are tied to the building they are living in; canceled in 1983.
	Section 236: canceled in 1973.	
	Section 221d/MR: provides risk reduction terms for developers, although this is not strictly a subsidy program; still active.	Section 8/EV: (Existing/Voucher) people may take their subsidy with them anywhere in the jurisdiction of the local public housing authority; still active.
	Section 221d/BMIR: (below market interest rate); canceled in 1973.	
	Section 514: administered by Farmers Home Administration; primarily in rural areas; still active.	

Home Owner Programs

Section 235: still active.	Section 502: administered by Farmers Home Administration; primarily in rural areas; still active.

All programs administered by HUD (Housing and Urban Development), except where noted. Note that this list is not exhaustive, but only covers the major subsidy programs administered by the federal government. This research is only concerned with federal rental programs. While Section 235 and 502 are the major home owner programs, there are a variety of other programs not included here. For a full description of all federal housing programs see Jacobs et al. (1986).

they fall prey to a housing cost/income squeeze. Because rents in units built under these loan schemes are based on fixed interest rates, there is an effective floor to how low rents can go. In the face of rising housing costs, loan-based programs tend to disproportionately increase the rental burden on the poorest of the poor. Even fixed loan rates of one percent price some of the poorest people out of the housing rental market.

There are two varieties of loan programs: direct government loans and interest subsidies paid to private lenders.

Direct Loan Programs. Section 202 of the National Housing Act of 1959 provided housing assistance for the elderly and handicapped. Under this program, HUD directly finances project development at below market interest rates. Originally, the rate was set at three percent, however, it is now based on current market rates to prevent excessive burden on the federal treasury. All tenants of 202 buildings who meet income requirements are required by law to also have access to Section 8 rental subsidies, discussed below.

Section 221(d)(3) of the Housing Act of 1961 authorized the so-called BMIR loan program. Similar to the 202 loan instrument, the BMIR program provided low cost government loans to private developers for the purpose of building multi-family low-income housing. The BMIR program was superseded in 1968 by the Section 236 rent-subsidy program. Today 221(d)(3) market rate (MR) loans are still provided, which include significant risk-reduction terms for private developers.

Private-Loan Programs. After the National Housing Act of 1949, The Housing and Urban Development Act of 1968 is considered the second turning point in federal housing legislation. In contrast to the 202 and BMIR loan programs, the 1968 Act established two major programs which provided interest subsidies to lenders (instead of developers) which reduced the effective borrowing rate for developers to one percent. Section 236, a rental subsidy program, established a dual rent schedule. A tenant would pay either a "basic" rent, which was calculated based on a one percent interest rate for the developer, or 25 percent of their income, whichever was *greater*. This program was canceled in 1973 after it was realized that it also fell victim to the cost/income squeeze. For many tenants, the basic rent was the greater of the two rents, which meant many people were paying upwards of 40 to 50 percent of their income on housing.

Rural Housing Loan Programs. While HUD is largely responsible for urban housing subsidy programs, the Farmers Home Administration (FmHA) of the Department of Agriculture, oversees most rural housing programs.[2] The major rural rental subsidy

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[2]FmHA has a quite broad definition of "rural." It often provides loans to semi-urban areas.

program, Section 514, added in 1962 to Title V of the National Housing Act of 1949, authorizes FmHA to make loans to finance the construction of cooperative and rental housing projects for low and moderate income families and the elderly in rural areas. As with HUD's 236 program, tenants pay the greater of a basic rent, calculated on a one percent mortgage, and between ten to thirty percent of their income. Two differences with the HUD loan programs are notable. The term for the mortgage is 50 years, as opposed to the standard 40 for HUD programs. This further reduces the monthly rental burden for rural low-income tenants. Second, 514 loans are provided directly through the Rural Housing Insurance Fund (RHIF) of FmHA. Due to the revolving nature of this fund, the political vulnerability of these loans is less than the direct 202 and BMIR loans, since new appropriations are not required in each fiscal year.

Direct Subsidies to Tenants

The third watershed in housing legislation came with the passage of the Housing and Community Development Act of 1974. This law authorized Section 8, the largest and most flexible of rental subsidy programs still in operation. This legislation was seminal because it marked the beginning of a shift towards a demand-based strategy in federal housing policy. While still providing for new construction and rehabilitation of the affordable housing stock, Section 8 was an attempt to remedy the cost/income squeeze inherent in the loan-based programs of the 1960s. Section 8 was based on the idea that subsidies should be provided directly to individual tenants as opposed to using federal monies to stimulate investment in the housing stock directly.

Section 8 is essentially an income-subsidy program, where HUD pays the difference between 30 percent of a tenant's income and the market rent for the housing unit. This ensures that owners receive the market rent required to maintain the property while tenants pay no more than 30 percent of their income on housing. HUD has developed a set of "fair market" rents for each area where Section 8 is active. These rents in essence provided a ceiling above which properties are ineligible for Section 8 subsidies, which in combination with income limitations for tenant qualification, help ensure against excessive draw downs on treasury funds.

Two Section 8 programs were originally authorized: Section 8 New Construction and Rehabilitation (NCR) and Section 8 Existing. The first tied subsidies to specific buildings while the second allowed subsidies to "follow" tenants to any buildings within the Section 8 jurisdiction.[3]

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[3]A Section 8 jurisdiction is defined by the operating area of the local PHA which administers the program. Section 8 certificates for one PHA's jurisdication can only be used in another PHA area if the respective PHA's have a cooperative agreement.

Section 8 NCR provided no federal commitment for the financing of new or rehabilitated housing projects, but instead guaranteed market rents would be paid to the owners of such projects. Usually funds for the actual construction or rehabilitation were provided through tax-exempt financing or through existing federal loan programs such as Section 202. In 1983, under pressure from the Reagan Administration, Congress discontinued the NCR portion of Section 8 (except for those for the elderly financed through Section 202 loans).

The Section 8 Existing program continues to provide low-income people with certificates which they can take with them to any property in their Section 8 jurisdiction which (a) meets Section 8 income, rent and quality standards and (b) is operated by a landlord agreeable to having Section 8 tenants in his or her building.

As a further move towards a demand-based housing strategy, the Reagan Administration successfully lobbied Congress in 1983 to establish a Section 8 Voucher program. The voucher idea is similar to the Section 8 Existing program. However, instead of basing subsidies on the market rents of each unit, the subsidy is calculated against the fair market rent established by HUD in each Section 8 jurisdiction. Theoretically this increases the flexibility of the program, because a tenant can choose a unit with a lower (higher) rent than the area fair-market rental rate, thus pocketing (paying) the difference. While the Reagan Administration wanted to replace wholesale all Section 8/Existing certificates with the voucher variant, Congress only authorized a voucher demonstration program. Nevertheless, the voucher program still exists.

An important feature of the Section 8 programs is their ability to "piggy-back" onto other subsidy programs. Section 202 and 514 both allow tenants who meet income requirements to receive Section 8 rental subsidies. Piggy-backing is also allowed for eligible tenants in buildings developed under the now-defunct Section 236 and BMIR programs. The result has been to relieve much of the cost/income squeeze effects which these loan-based subsidy programs suffered prior to 1974.

Home Ownership Subsidy Programs

While most of the federal subsidy programs are rental based, two major programs for home owners are Section 235 and Section 502. Section 235, operated by HUD, is a home ownership subsidy program which provides interest subsidies to private lenders to effectively reduce the borrower's interest on market loans to one percent. Borrowers pay the one percent mortgage payment or 20 percent of their income, whichever is *greater*. Section 502 is similar to Section 235 except that it is turn by FmHA and focuses on rural areas. The present study only investigates the effects of federal rental subsidies. The next chapter reviews the literature on these effects.

Chapter 2: The External Effects of Subsidized Housing

Summary of the Literature[4]

While many people believe that low income housing has a negative effect on neighboring property values, surprisingly little serious research has focused on this question. Fifteen studies are reviewed in this chapter. Half of these have been published in academic journals,[5] the rest being part of the "fugitive literature" of working papers and agency reports.[6]

Eleven of the studies look explicitly at subsidized housing's effect on property values.[7] Two of these studies examine the hypothesis that subsidized housing units have a positive effect on neighboring properties in low-income neighborhoods (DeSalvo 1974; Nourse 1963). The rest focus on the existence of negative effects. Only one of these latter studies (Guy, Hysom, and Ruth 1985) found any evidence that there may be a statistically significant negative effect between property value and proximity to subsidized housing. Two of the studies found positive effects (DeSalvo 1974; Rabiega, Lin, and Robinson 1984), but could not adequately explain these results or confirm them with alternative test methods. The remaining eight studies found no significant positive or negative effects.

Neither of the two studies which examine the effects of group homes for the mentally handicapped on neighborhood property values (Farber 1986; Lauber 1986), nor the two which investigate such effects of manufactured homes (Gruber, Shelton, and Hiatt 1986; Nutt-Powell, Hoaglin, and Layzer 1986) found any significant evidence to support the negative (or positive) externality hypothesis.

The methodologies used in these studies are quite diverse. However, they are all variants of two broad methods: price trend comparisons between test and control sites

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[4]For a more detailed summary of the studies cited here see Lyons, 1992.

[5]Babb, Pol, and Guy 1984; DeSalvo 1974; Farber 1986; Guy, Hysom, and Ruth 1985; Nourse 1963; Rabiega, Lin, and Robinson 1984; Schafer 1972; Warren, Aduddell, and Tatalovich 1983.

[6]Baird 1980; Gruber, Shelton, and Hiatt 1986; Lauber 1986; Nutt-Powell, Hoaglin, and Layzer 1986; Lynn Sedway and Associates 1983; Saunders and Woodford 1979; Torrey and Torrey Inc. 1983.

[7]Babb, Pol, and Guy 1984; Baird 1980; DeSalvo 1974; Guy, Hysom, and Ruth 1985; Lynn Sedway and Associates 1983; Nourse, 1963; Rabiega, Lin, and Robinson 1984; Saunders and Woodford 1979; Schafer 1972; Torrey and Torrey Inc. 1983; Warren, Aduddell, and Tatalovich 1983.

and regression analysis. Five of the fifteen studies used some form of regression analysis (Farber 1986; Guy, Hysom, and Ruth 1985; Nutt-Powell, Hoaglin, and Layzer 1986; Rabiega, Lin, and Robinson 1984; Warren, Aduddell, and Tatalovich 1983). Only two of these (Guy, Hysom, and Ruth 1985; Rabiega, Lin, and Robinson 1984) used distance to subsidized or manufactured housing as a key variable, although many of the studies included some spatial dimension. None of these studies attempt a hedonic formulation, but only use regression techniques to control for covariates.

The balance of the fifteen studies use some variant of a test/control methodology. Price trends in a test neighborhood *with* subsidized, manufactured or group housing and a similar control neighborhood *without* such housing are compared over time. A statistically significant difference between the time trends indicates the existence of external effects. Most of these studies found no statistically significant divergences between test and control neighborhood price trends for subsidized, manufactured or group housing. However, many of these studies found occasional, unexpected, but statistically insignificant positive effects. There are a number of general limitations to these studies.

First, with the exception of Nourse (1963), Schafer (1972), and DeSalvo (1974), all of the studies use quite small samples, which significantly reduces the power of the statistical tests used (which in most cases is the paired t-test). Secondly, with the exception of DeSalvo, the geographic area covered by these studies is very limited, confined in many cases to two nearby neighborhoods. This makes it difficult to test the significance of different spatial patterns associated with different subsidy programs as well as different neighborhoods. Indeed, two of the studies (Lynn Sedway and Associates 1983; Torrey and Torrey Incorporated 1983) compare averages in a small geographic area (i.e., five or six observations) to county-wide averages. Such comparisons are extremely subject to neighborhood bias which arises from factors other than subsidized housing, which may be masked in the average but accentuated in the small sample thereby giving biased results. Thirdly, with the exception of Rabiega, Lin and Robinson (1984), these studies admit suffering from the difficulty inherent in this type of methodology — that of finding suitable control areas which maintain their comparability to the test site over space and time.

The literature is hardly conclusive on the existence or direction of externalities associated with subsidized housing. Given the complexity of urban housing markets, even when some links are found, statements as to causality are at best tentative. A few statistically significant results were reported, some negative and some positive, however, no real *substantively* significant results, in terms of dollar impact, have been found. This distinction between statistical significance and substantive significance is an important one. In a highly fractious, politically charged debate such as that over subsidized housing, careless statements about the results of "scientific" studies can be easily misinterpreted. Statistically significant results with insignificant dollar figures attached should not be given undue importance.

Still the literature indicates some kind of consensus, however weak, that no real negative effects appear to exist. Yet many communities are scratching and clawing to prevent subsidized housing from entering their neighborhoods in the name of protecting their property's value. Why? While the full answer to that question may lie in places better investigated by anthropologists and sociologists, this paper is about economics. In that context, a more useful question is what kinds of hypotheses can one develop about the variables of interest most likely to indicate external effects and how they might behave. The next sections explore some of these issues.

Presence and Distance

Certainly a major variable of interest in any characterization of subsidized housing externalities is that of presence. Does the presence of subsidized housing in a neighborhood, however defined, result in external effects on property values? There are a number of thorny issues associated with such a question. The first is causality. Recall that in chapter one the question was raised: which came first, subsidized housing or low property values? The chicken and egg nature of the NIMBY phenomenon makes any strong causal statements dependent on how well other neighborhood factors other than the existence of affordable housing are controlled. The primary covariate here is neighborhood property value. One would generally expect that if external effects exist and are not directly associated with the inhabitants of the property,[8] they are induced by quality differentials between the subsidized housing and neighboring housing units. While such an effect was not confirmed by DeSalvo (1974), his indicator, median borough rent, may not have been geographically specific enough to accurately measure "micro-neighborhood" quality differentials. Thus, any indicator of quality should be defined at the same neighborhood level as is the external effect in question. That is, if a researcher is examining the impact of a subsidized housing project over a span of three city blocks, some indicator of average housing quality in those three blocks should be used to control for quality differentials. Therefore, some of the indicators typically used, such as census tract level median family income or median gross rent, are probably too aggregated. However, such micro level data are often unavailable. Indeed, this study uses census tract level data since it was easily obtainable.

A second issue of concern is how to appropriately define the geographic meaning of neighborhood. Is it one block? Three blocks? Is it road distance or as the crow flies? As was shown most clearly by Rabiega, Lin and Robinson (1984) and Guy, Hysom, and

[8] Of course, as was mentioned in chapter one, race and class may play a major role in the NIMBY mentality. This research does not directly address such questions, only because the detailed data necessary to develop appropriate measures of race and class differences between property owners and subsidized housing inhabitants was not available in the study area.

Ruth (1985), effects may vary with distance. But it is unclear that *actual* distance is necessarily a very good estimate of peoples' *subjective perceptions* of distance. One incomplete but easy way to incorporate such subjective considerations into an objective study is to focus the unit of analysis at the decision maker's location instead of at the subsidized housing location. Patterns of externalities on property values, if they exist, are revealed precisely because of the pattern of locational decisions made by economic agents in the housing market. It is the preferences of buyers and sellers of housing which is revealed in the marketplace and thus any attempt to determine if those preferences are affected by subsidized housing should center attention on the behavior of those individuals. All of the studies reviewed above focus analysis on the subsidized housing sites — the neighborhood is defined so as to radiate outwards with subsidized housing at the center. From the standpoint of economic theory, it makes more sense to center areas around each individual non-subsidized housing unit, letting the neighborhood "move" with the home owner.

A second way to incorporate subjective consideration of distance is to weight "actual" distances between subsidized and non-subsidized units by characteristics of the subsidized properties. For instance, it may be that a 20-unit subsidized building which is only 300 feet away seems more distant to a homeowner than a 200-unit high rise which is 1000 feet away. Short of using survey techniques to elicit people's perceptions of distances to subsidized units, attribute weighting provides an imperfect solution for incorporating subjective considerations into variable concepts of neighborhood and distance.

Spatial Distributions of Subsidized Housing

In addition to simply knowing how "close" subsidized housing is to a non-subsidized unit, another spatial dimension is of concern: how are subsidized units arrayed around neighboring property? This is an important and contentious issue in community planning for subsidized housing — how should the units be located so as to minimize perceived negative impacts on neighboring properties? Despite its relevance to current policy debates, none of the studies reviewed here considered this variable, mainly because they focus on the subsidized units, which in some sense impedes consideration of the patterns of those units within a neighborhood.[9]

Figure 2.1 shows two different spatial patterns of three subsidized locations surrounding a non-subsidized unit. The distances between the non-subsidized unit and each of the three surrounding subsidized locations is the same in both panels. The spatial relationship between the subsidized locations, however, is not. If subsidized

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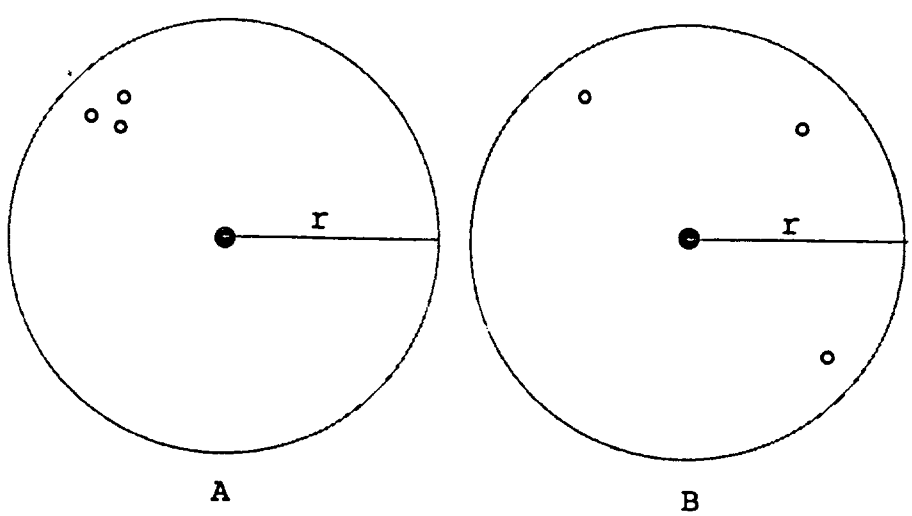
[9]A possible exception to this is Baird's study (1980) which expressly chose to compare neighborhoods with and without other subsidized housing nearby.

housing does have negative effects on property values, one could hypothesize that the more clustered set of units would have a stronger negative effect than the dispersed set. To capture these kinds of "micro-neighborhood" spatial variations, distance measures between subsidized units are necessary.

FIGURE 2.1

ILLUSTRATION OF DIFFERENT SPATIAL PATTERN OF THREE SUBSIDIZED UNITS AROUND A RESIDENTIAL PROPERTY



There is a second kind of spatial pattern which should be considered for its likely contribution to the external effects structure. Beyond spatial variations within a neighborhood, the overall spatial pattern of subsidized properties within a metropolitan area may have associated externalities. It is this spatial pattern which lies at the root of the chicken and egg issue. The urban riots of the 1960s and the conversion of public housing from transitional homes for the upwardly mobile into "vertical ghettos" for racial minorities motivated a reorientation of housing policy towards greater choice and deconcentration (Jacobs et al. 1986, Warren 1986), resulting in the Section 8 program, most specifically its Existing/Voucher variant. In theory, programs like Section 8 Existing/Voucher allow a broader set of housing choices for low income households: they can choose to live in the neighborhood of their choice. Whether this actually has occurred or not is unclear.

A recent study by Elizabeth Warren (1986) indicates that the Section 8 Existing program has been at least somewhat successful in achieving this end. Warren uses the Dissimilarity Index (D) to measure the degree of deconcentration achieved in public housing, Section 8 New Construction and Rehabilitation and Section 8 Existing subsidized housing programs in Chicago. The index takes on values between 0 and 100. The closer D is to 100, the more concentrated is the subsidized housing in a certain number of tracts, with most tracts having no subsidized housing whatsoever. If every tract had the city wide average of subsidized housing, then D would be zero.

Using this index for the census years 1960, 1970 and 1980, Warren shows only slight deconcentration has occurred in Chicago for subsidized housing programs on the whole over the two decades. However, the index for Section 8 Existing in 1980 is only 53.46, compared to 91.30 for public housing and 89.87 for Section 8 NCR. As Warren concludes, "the Section 8 Existing program stands out as by far the best vehicle for distributing housing assistance geographically." (Warren 1986, p. 492) Further, excluding Section 8 Existing programs, Warren found subsidized housing for families is highly concentrated in low-income, heavily black tracts.

It has been an explicit policy goal of the Twin Cities Metropolitan Council since 1971 to deconcentrate subsidized housing into the suburban areas. In 1971 ninety percent of all subsidized housing in the St. Paul metropolitan area was located within the city limits (Metropolitan Council 1985). Currently approximately eighty percent of the subsidized housing in Ramsey County is still located in the city.

The reason for concern, from an economic standpoint, is that if most subsidized housing tends to be located in neighborhoods where people already have low incomes and thus poor access to education, health care, and other social services, clustering even more subsidized housing in these areas places additional strains on public service provision and may generate external social costs. The "ghetto-ization" of inner city public housing projects during the 1960s is an example of this type of social cost. Recent urban violence in Los Angeles and elsewhere is another.

These external costs cannot be measured on the same metric as property effects. They tend to have a much broader effect over time and space than the direct property effects of subsidized housing. However, regression analysis does partially control for these clustering externalities by (a) including observations from neighborhoods with concentrations of subsidized housing and those without and (b) including a number of neighborhood level variables, such as median family income, percent black, percent hispanic, and educational level, which help to remove variation in housing prices due to clustering effects. To what extent this resolves the chicken and egg problem depends on how correlated these indicators are with the historical and social patterns of clustering.

Programmatic Patterns

Because spatial patterns may be affected by the types of subsidies under which affordable housing is provided, any theory of possible effects should consider the programmatic pattern of subsidized housing within a community. From an *a priori* standpoint, the major consideration here would seem to be mobility, i.e., the impact of project-based subsidies versus certificate and voucher programs, like Section 8 Existing/Voucher. However, one may find differential effects associated with other programmatic distinctions. Cautious interpretation of these effects is necessary, because it may be unclear if these effects are a result of programmatic variation or other unobserved variables which are highly correlated with program type. For instance, Section 202 serves only elderly tenants, thus a Section 202 effect may really be measuring the effect of elderly tenants on neighboring properties. Likewise, effects associated with older, now discontinued programs, such as Section 236 or BMIR, may really be capturing an age effect, since all of these projects were built prior to 1973. There is also little reason to suspect that type of subsidy *itself* is of concern to neighboring property owners.

There is some indication, or at least a belief, both in the literature as well as in community debates, that there is a difference between the property effects of elderly units and family units (Warren 1986). In addition to racial and class distinctions, this belief may exist because families have children, and some studies have shown a significant negative relationship between percent of young people (under 21) in a neighborhood and property values in that neighborhood (For example, see Kohlhase 1991; as will be shown, the current study also found this youth effect). The youth effect is probably related to a higher propensity to commit crimes among adolescents and young adults. Any theory of effects should therefore also include tenant level variables to isolate these kinds of effects.

Summary

A major shortcoming of the empirical research on the externalities imposed by subsidized housing on neighboring properties is their lack of *a priori* theories or *a posteriori* stories to explain their results. This omission is somewhat understandable given that the problem is so mired in issues of race and class, both of which pose intractable hurdles for empirical research methods. In this chapter, a number of possible explanatory variables have been described, including: presence; subjective distance between subsidized and non-subsidized housing; micro and macro level spatial patterns of subsidies; and programmatic and tenant distribution, all of which may isolate the effects of subsidized housing on neighboring properties. Defining all of these variables from the perspective of each homeowner allows a more theoretically appealing method for determining the effects of subsidized housing on the locational preferences of economic agents in the housing market.

How should these variables behave? The null hypothesis in all regressions reported in chapter four is that each of these variables has no significant effect on property value. Neither economic theory nor the experience of communities debating whether to introduce subsidized housing indicates any *a priori* reason to expect positive effects. On the other hand, if there is any effect at all, one would expect it to be negative, and diminish with distance. The next chapter describes why the hedonic method is an appropriate model to estimate these effects.

Chapter 3: The Hedonic Model

Basics of the Hedonic Technique

Following Lancaster (1966), preferences for consumption goods are determined by the utility people derive from a set of characteristics those goods possess. However, it is the goods themselves, not their individual attributes, which are traded in private markets. Hedonic models can be used to estimate how much people are willing to pay to obtain more or less of an individual characteristic. When the market price of a good is regressed onto measures of its attributes, the resulting coefficient for any attribute is an estimate of the implicit marginal price of that particular characteristic. This technique has been widely used in environmental quality studies to value (dis)amenities such as water quality, air quality, noise pollution, watershed preservation, toxic waste siting, and others (e.g., Can 1990; Kohlhase 1991; Li and Brown 1980; Lupi, Graham-Tomasi, and Taff 1991; Palmquist and Danielson 1987; Palmquist 1989; Wilman 1984). See Bartik and Smith (1987) for a comprehensive review of this literature.

When people shop for a house, they are not looking for a single, undifferentiated good. Rather, they are seeking a particular combination of housing attributes. Some of these are inherent in the structure of the housing unit: square feet of living area, lot size, number of bathrooms, etc. Other housing attributes are linked to the neighborhood in which the house is located. These locational characteristics fall into four broad categories (Goodman 1986): *environmental amenities*, such as water and air quality; *local public goods*, such as education, health care and waste disposal services; *socioeconomic characteristics* of neighbors, such as median family income, educational level, and employment status; and *proximity attributes*, such as distance to job location or shopping centers.

Based on this logic, the price of a house is a function of its structural characteristics as well as its locational characteristics. A general hedonic equation for housing can be expressed as:

$$P = \rho(S,L,\beta) \tag{3.1}$$

where P is a vector of housing prices, S is a matrix of structural attributes associated with each house, L is a matrix of each unit's locational attributes, and β is a vector of marginal prices associated with each attribute.

Theoretical Foundation of the Hedonic Technique

While the technique can be traced back to Court (1941; 1941b), it was Lancaster (1966) who first laid the most accessible theoretical foundation for hedonic price analysis. Lancaster's contribution lay less in the technical formulation of a new operational model of utility theory than a heuristic recognition that goods traded in markets are not the direct objects of utility. Rather preferences for market goods are determined by the set of attributes associated with those goods. Further, goods in combination will possess different sets of characteristics than if the goods are consumed separately, allowing for a much richer view of consumer behavior. It is richer, because it captures many *non-market* qualities which people value, but which traditional consumer utility theory ignores by design. For example, water quality is not typically traded in a market, yet it is something which people value. Presumably, then, their behavior should reflect this valuation. Traditional consumer theory is silent on the valuation of such non-market qualities because they do not possess market prices, which are the only kind of prices traditional utility theory knows about.

The hedonic approach allows recovery of *implicit* prices of non-market qualities based on observations of transactions in private markets where a good with weak complementarity to the attribute in question is traded. Because real estate is believed to capitalize many such implicit values, housing is often used in hedonic studies as the complementary good. Rosen (1974) provides the most succinct analysis of the theoretical foundations of a working hedonic model, which is closely followed here.

A consumer's bid function for a product, $\theta(z;m,u)$, is implicitly determined by

$$U(m - \theta, z) = u \tag{3.2}$$

where U is a strictly concave utility function, m is the consumer's fixed income, z is an n-vector of product attributes, and u is a fixed utility index. θ measures what a consumer is willing to pay for the vector of attributes, z, associated with the product at a fixed level of utility and income. Differentiating (3.2) with respect to any given attribute, z_i, gives the marginal rate of substitution, θ_{zi}, between the ith attribute and money. With all the normal assumptions of perfect competition and signs of the derivatives, θ_{zi} is the consumer's implicit marginal valuation of the ith attribute of the product at a given utility and income level. Different consumers will have different bid functions, as shown in figure 3.1.

In a similar fashion, a set of producer offer curves are established. An offer function, $\phi(z;\pi,\beta)$, is implicitly defined by

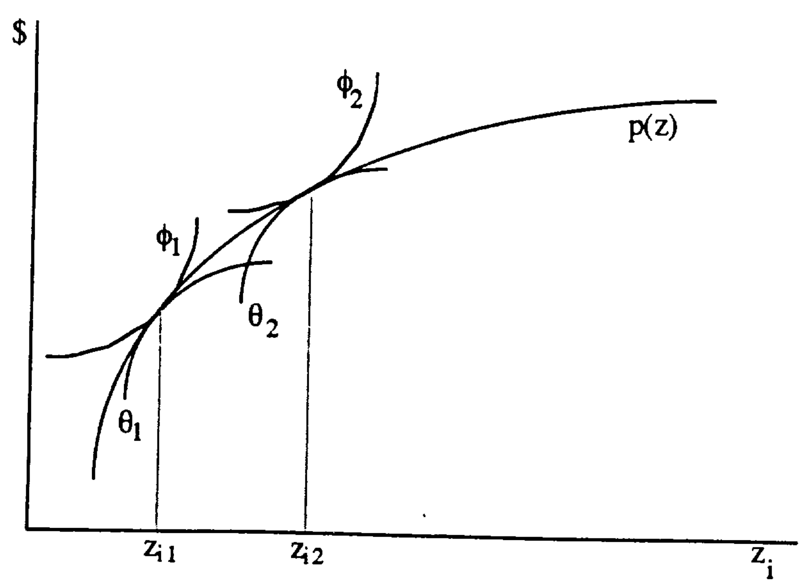
$$k\phi - C(k;z,\beta) = \pi \quad \text{and} \quad \frac{\partial C(k;z,\beta)}{\partial k} = \phi \tag{3.3}$$

where k is the number of units of the product to produce with attribute set z, C is the cost of producing k units of the product, $\partial C/\partial k$ is the marginal cost of production, β is a fixed vector of factor prices and production parameters, and π is a fixed level of profit.

With certain assumptions about the cost function, solving (3.3) for ϕ and differentiating with respect to z_i, gives the implicit minimum value the producer will accept to offer z_i units of the *i*th attribute in the product at a given profit level. Different producers facing different cost functions and production parameters will have different offer functions, as shown in figure 3.1.

FIGURE 3.1

THE RELATIONSHIP BETWEEN CONSUMER BID FUNCTIONS, PRODUCER OFFER FUNCTIONS AND THE HEDONIC PRICE FUNCTION



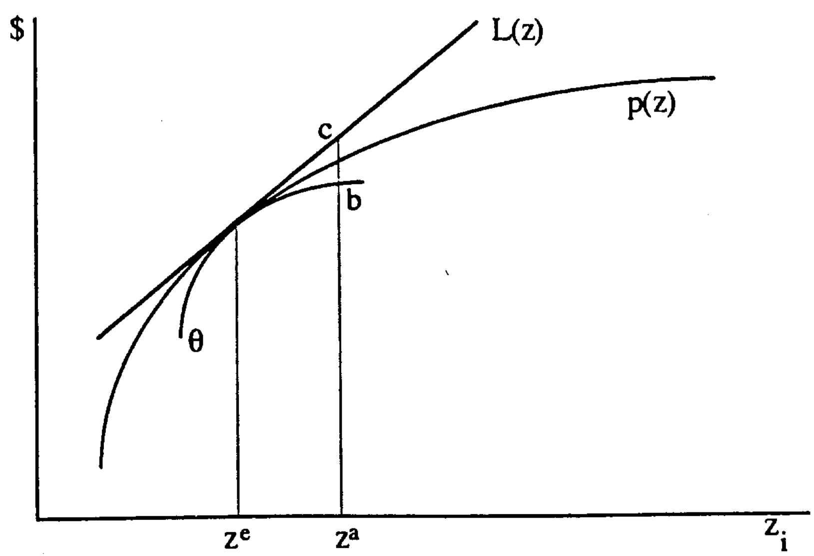
θ_i are consumer bid functions; ϕ_i are producer offer functions; p(z) is hedonic price function; and z_{ij} are equilibrium amounts of the attribute z_i for consumer and producer pair j.

Assuming competition prevails, both consumers and producers face a price for the product with attribute vector z in the market, p(z). Consumers maximize utility by choosing z* where $\theta(z^*;u^*,m) = p(z^*)$ and producers maximize profits such that $\phi(z^*;\pi^*,\beta) = p(z^*)$, where *'s imply optimal values of the variables. Figure 3.1 shows the graphical interpretation of this stylized equilibrium, where p(z) is the hedonic price function relating the market price of the product to various levels of its attribute vector, z. This function is the envelope of tangencies between consumer bid functions and producer offer functions.

To put this theoretical framework into perspective, let the market good be housing, which is comprised of a number of attributes, z, including structural and locational characteristics. Let the *i*th attribute, z_i, be mean distance in feet to nearby subsidized housing within some neighborhood of the house. Figure 3.2 shows the equilibrium point of tangency between our representative consumer's bid function, θ, and the hedonic price function, p, which occurs where the subsidized units average z^e feet away from the house. Unfortunately, the entire bid function is not revealed in the market. Only the market clearing points of tangency which define the hedonic price function are observed. Therefore, it is not possible to directly determine how much a person is willing to pay to change z^e to z^a, that is to be $(z^a - z^e)$ feet farther away from the subsidized units. That willingness to pay value corresponds to point b in figure 3.2 on the consumer's bid function. One way to estimate b is to evaluate, at z^a, a linear approximation of the bid function, $L(z;k)$, where k is simply the slope of the bid function (and thus the hedonic price function as well) at z^e. This estimate improves as z^a gets arbitrarily close to z^e. Thus, in equilibrium, the partial derivative, $\frac{\partial p(z^*1,...,z^ai,...z^*n)}{\partial z_i}$, , is a reasonable estimate of θ_{zi}.[10]

Figure 3.2

ESTIMATING WELFARE CHANGES USING THE HEDONIC PRICE FUNCTION



θ is consumer's bid function. p(z) is the hedonic price function. L(z) is a linear approximation of θ, tangent to the hedonic price function at ze. Point b represents the actual value of the bid function at z^a, which is approximated by point c on L(z).

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[10]The reader may ask, why not just use the value of p(z) at z^a, since according to figure 4.2, it seems a better estimate of b? However, this is not always the case, since there is no theoretical restriction on the shape of p(z). Here it is drawn as concave, however, it could also be drawn as convex, in which case L then provides the better estimate. This is one reason why welfare measures based on p(z) are only theoretically appropriate for marginal changes in the level of the attribute, where any such errors are likely to be very small.

Some Practical Problems with Hedonic Price Functions

Again, because the bid function is unobserved, there is no way to determine the magnitude of the error of using L(•) to estimate b. Thus, the hedonic technique is only accurate for marginal changes in the level of the attribute, z_i. This is a limitation of the technique, empirically, since policy usually considers much more substantial changes. In addition, the method assumes the housing market is characterized by the conditions of competitive equilibrium. This assumption is usually technically violated in most housing markets, due to the importance of housing stocks — the market for housing rarely clears. A housing market with a homeowner vacancy rate of one percent is usually considered to be in "equilibrium" in a growing area like the Twin Cities. Recent vacancy trends in the study area do not contradict a hypothesis of a market in equilibrium (US HUD 1990). There is also an identification problem when only a single market is considered.

A further caveat to literal interpretation of hedonic results is that a number of assumptions concerning the differentiability and shapes of the theoretical functions giving rise to the hedonic price function must be made which are unlikely to perfectly reflect reality. These reservations should be kept in mind when drawing conclusions about actual dollar figures associated with large changes in hedonic variables.

Using Regression to Estimate The Hedonic Price Function

Normal least squares regression methods can be used to estimate the parameters of the hedonic function. The regression problem becomes

$$P = \alpha + \beta z + e \tag{3.4}$$

where P is a vector of housing prices, z is a matrix of housing attributes, α is the regression intercept, β is the matrix of slope coefficients, and e is an independent, identically distributed error term. Following the theory outlined above, the partial derivative, $\partial P/\partial z_i$, is an estimate of the marginal implicit value, θ_{zi}, of the ith housing attribute — i.e., how much the consumer is willing to pay for varying levels of the attribute. Further, because utility is being held constant, $\partial P/\partial z_i$ can also be thought of as the inverse Hicksian compensated demand function for the ith attribute, meaning equivalent and compensating variation welfare measures for changes in the level of the attribute can be (theoretically, at least) recovered.

In order to give $\partial P/\partial z_i$ economic meaning, how z_i is entered into the regression equation is significant. If z_i is simply entered as a linear term, $\partial P/\partial z_i$ will be constant, indicating consumers' willingness to pay for the attribute has a constant relationship to the level of the attribute. This is not how economists generally model consumer preferences. It is generally expected that a consumer's marginal willingness to pay (accept) for more (less) of a good (bad) diminishes with larger quantities of the good, which is another way of saying $\partial^2P/\partial z^2 i$ should have the opposite sign of $\partial P/\partial zi$. This argument rests on a behavioral postulate which is of unclear verity: diminishing marginal disutility. It is entirely possible that greater and greater compensation is required to maintain a constant utility level in the face of greater amounts of something the consumer perceives as being bad. Therefore, z_i should enter the equation in a nonlinear way to allow determination of the first and second derivatives of P.

However, nothing in hedonic theory specifically restricts how variables enter the equation. There is a large literature on appropriate specifications for hedonic price equations (Bartik and Smith 1987; Cropper, Deck, and McConnell 1987). Most studies enter the variable(s) of interest in quadratic form, to easily capture first and second order effects, while entering all other variables as simple linear terms. Thus, the regression equation becomes

$$P = \alpha + \gamma_j z_j + \lambda_j z_j^2 + \sum_{k \neq j} \beta_k z_k + e \tag{3.5}$$

where the subscripts index the independent variables.

While this has obvious advantages in terms of interpreting the coefficients on the variables of interest, there is a disconcerting theoretical implication in this specification: that a consumer's marginal valuations of all attributes other than those entered as quadratic do not change appreciably over their relevant range of values. For many variables, such an assumption is reasonable. For instance, suppose the number of bathrooms per house in a sample may only range from 1 to 5. If significant second order effects do not begin to set in until more than 10 bathrooms are found in a house, then the linear term alone is likely to capture most of the variation in prices due to bathrooms. The theoretical consistency obtained by entering all variables in quadratic (or some other nonlinear) form comes at a cost: the parsimony of the specification. In addition, doubling the number of parameters to be estimated requires a much larger sample size (Judge et al. 1988). The tradeoff is then one of parsimony versus bias, which must be determined for each variable in each regression. No *a priori* guidelines can be established. For the purposes of parsimony and given that each regression model contains over 50 independent variables, only variables of interest will be entered as squared terms, while the structural and locational effects will only be measured with first order terms.

Returning to the parsimonious specification given in (3.5), how do we interpret the coefficients on the quadratic terms? In cases where consumers are willing to pay more for greater amounts of the attribute, γ should be positive and λ should be negative. In cases where consumers are willing to pay more for less of the good, λ should be negative. In this latter case, the sign of λ depends on whether diminishing marginal disutility is a valid assumption.

We now turn to operationalizing this hedonic regression problem to test hypotheses concerning the existence and magnitude of subsidized housing's external effects on neighboring property values.

The Study Area

The study area for this research is Ramsey County, Minnesota, part of a seven county metropolitan area surrounding the Twin Cities of Minneapolis and St. Paul. Table 3.1 provides some preliminary 1990 census population and housing statistics on Ramsey County. Figure 3.1 orients Ramsey County within Minnesota and shows base maps of the county by municipality and 1980 census tract boundaries.

TABLE 3.1

POPULATION AND HOUSING STATISTICS FOR RAMSEY COUNTY

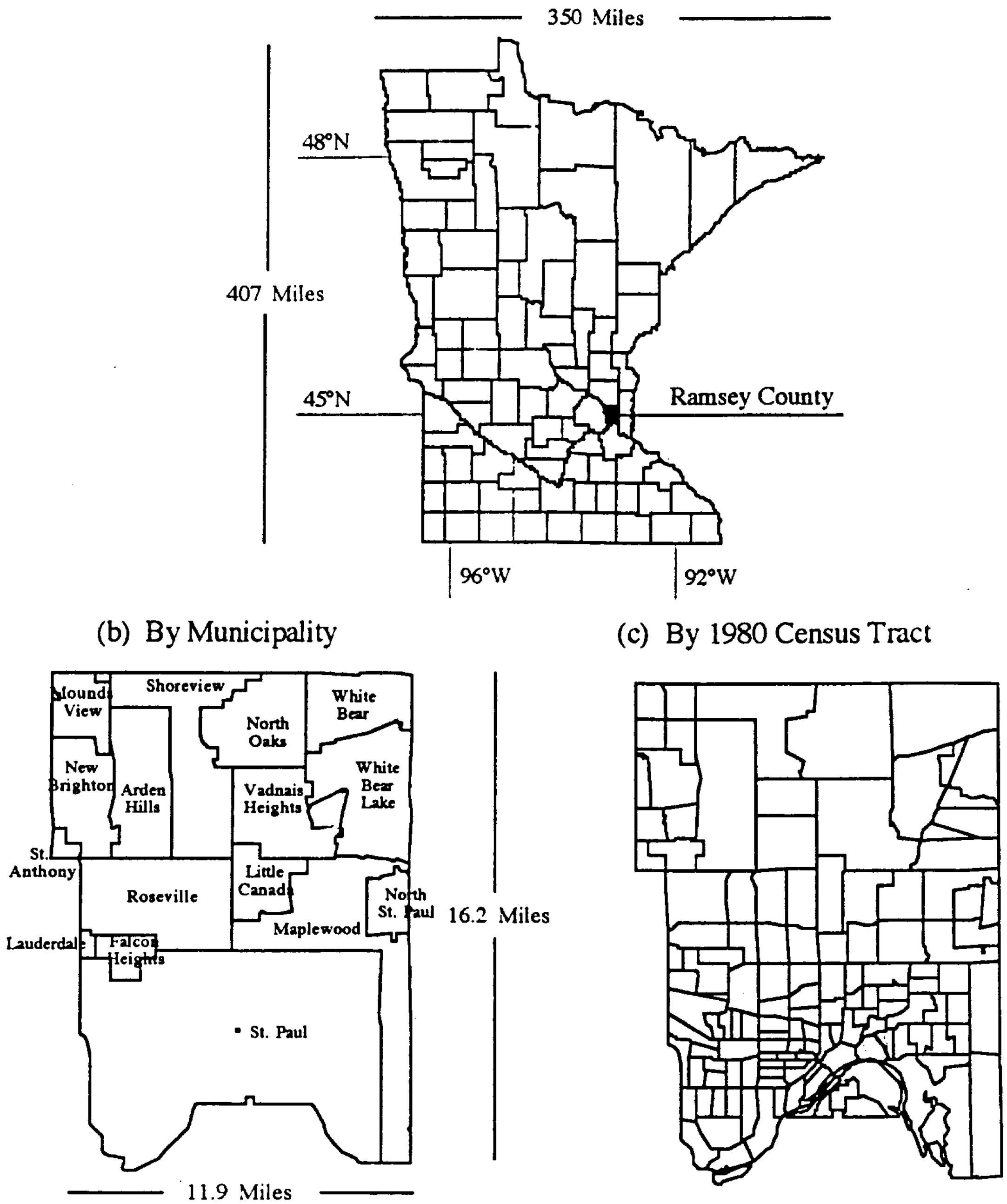
	Count	Percent		Count	Percent
Total Population	485,765	100.0	Total Housing Units	201,016	100.0
Under 18 years old	120,104	24.7	Occupied	190,500	94.8
Over 18 years old	365,661	75.3	Vacant	10,453	5.2
White	427,473	88.0	Owner	118,499	59.0
Black	22,831	4.7	Rental	72,001	35.8
Other Race	35,461	7.3			
Hispanic	13,890	2.9	Median Monthly Rent	$418	

Source: Metropolitan Council of the Twin Cities, 1990 Census Count publication numbers 320-91-055, 320-91-056.

FIGURE 3.3

BASE MAPS OF RAMSEY COUNTY

(a) Within Minnesota

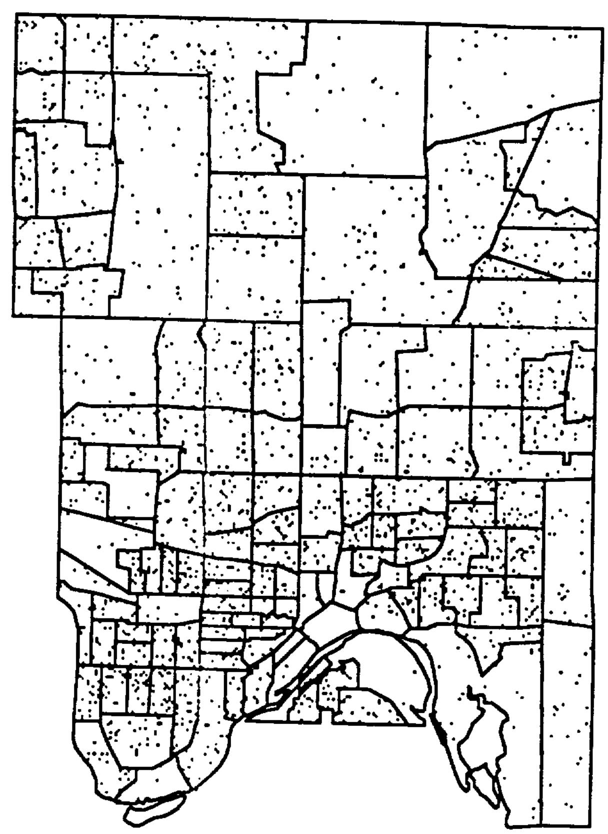


The Data Set for Housing Attributes

The unit of analysis for this study is a non-subsidized residential unit. Data were collected from the Ramsey County Department of Property Taxation and Records Administration on a large number of structural and locational attributes of each of the 128,010 residential non-subsidized housing units in Ramsey County. Figure 3.4 shows how these housing units are distributed spatially throughout the county.

FIGURE 3.4

RESIDENTIAL HOUSING DENSITY IN RAMSEY COUNTY BY CENSUS TRACT



Each dot represents 53 houses. Dots are placed randomly within tract boundaries.

Census tract level data for 1980 were collected for all tracts in Ramsey County.[11] Each residential unit was matched with its appropriate tract number to link these census variables to each housing unit. Table 3.2 and 3.3 list the structural and locational variables used in this study. The dependent variable in all regressions is the 1991 assessed value. Figure 3.5 shows the distribution of housing values by census tract.

TABLE 3.2

STRUCTURAL VARIABLES USED IN THE REGRESSIONS

LOTAREA	square feet of lot area	C
LIVRMS	number of rooms *not* including bedrooms or bathrooms	C
BEDRMS	number of bedrooms	C
BATHRMS	number of bathrooms	C
LIVAREA	square feet of living area	C
FIREPL	number of fireplaces	C
GARGAREA	square feet of garage space	C
GTATTACH	is garage attached	D
GTDETACH	is garage detached	D
CENTAIR	has central air conditioning	D
POOLAREA	square feet of pool area	C
DECKAREA	square feet of deck space	C
AGE	age of house	C
OSPAREA	square feet of open screened porch	C
EPAREA	square feet of enclosed porch	C
HOMESTD	is homesteaded or rental	D
EWBRSTON	exterior wall is brick or stone	D
EWMETAL	exterior wall is metal	D
EWSTUCCO	exterior wall is stucco	D
EWOTHRNW	exterior wall is other not wood	D
HTNOTFA	heating system is not forced air	D
LOCCORN	on corner lot	D
PTNOT1FM	multifamily dwelling or not	D

A 'C' in the last column denotes a continuous variable, while a 'D' indicates a dummy variable. All data for these variables come from the county assessor. For exterior wall dummies, the base case is wood. For the garage type dummies, the base case is no garage.

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[11]At the time the data were collected, 1990 census data were not available on a large portion of the variables selected for the analysis. While many of the variables may not have changed substantially since 1980, certainly the age distribution of neighborhoods has. In addition, one neighborhood in St. Paul where much of the county's subsidized housing is concentrated has experienced some gentrification over the past decade, which indicates some of the 1980 socioeconomic variables for this neighborhood may no longer reflect actual neighborhood conditions.

TABLE 3.3

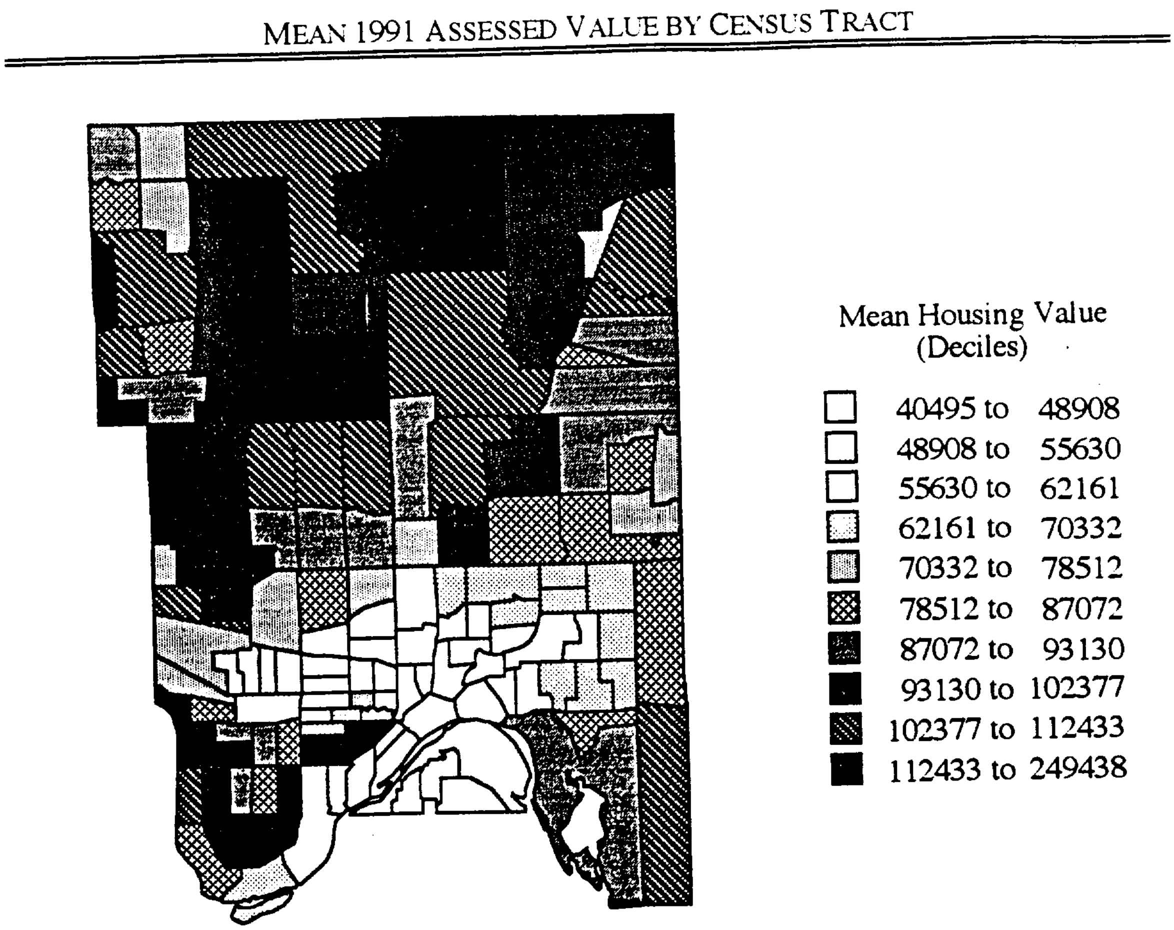
LOCATIONAL VARIABLES USED IN THE REGRESSIONS

SDNEWBR	New Brighton school district	D	A
SDSHOREV	Shoreview school district	D	A
SDMAPLEW	Maplewood school district	D	A
SDROSEV	Roseville school district	D	A
SDWBLAKE	White Bear Lake school district	D	A
TOPHILLY	hilly area	D	A
RIVER	on river	D	A
LAKE	lake view/access	D	A
ZONMF	area zoned for multifamily dwellings	D	A
MEDFAMIN	median family income	C	T
PHSGRAD	percent high school graduates	C	T
PCOLGRAD	percent college graduates	C	T
PWHITE	percent white	C	T
PBLACK	percent black	C	T
PSPAN	percent hispanic	C	T
PUNDER21	percent under 21	C	T
POVER65	percent over 65	C	T
PSPFFAM	percent single parent female-headed households	C	T
POWNOCC	percent owner occupied	C	T
MRENT	median rent	C	T
TTWORK	mean travel time to work (in minutes)	C	T
PBELOWPO	percent below poverty level	C	T

A 'C' in the second to last column denotes a continuous variable, while a 'D' indicates a dummy variable. An 'A' in the last column denotes data for this variable comes from county assessor's office. A 'T' indicates census tract data. For the school district dummies, the base case is St. Paul.

FIGURE 3.5

MEAN 1991 ASSESSED VALUE BY CENSUS TRACT

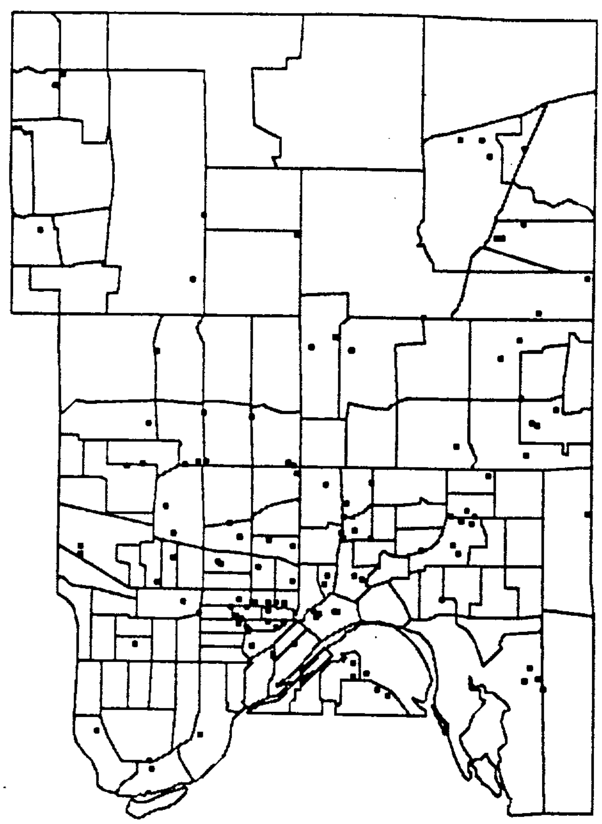


The Subsidized Housing Data Set

By combining data collected from the Twin Cities Metropolitan Council, a database compiled in Larson (1988), as well a personal investigation by one of the authors, 120 federally subsidized housing projects in Ramsey County were identified for this study.[12] In order to compare the spatial distribution of housing values given in figure 3.5 to the location of these 120 subsidized housing projects, figure 3.6 locates this housing within census tracts. A larger scale map in figure 3.7 relates these locations with subsidy type (i.e., Section 8, Section 202, etc.). Figure 3.8 and 3.9 replicate these maps by municipality instead of census tract. Table 3.4 provides descriptive statistics on this distribution of subsidized housing.

FIGURE 3.6

LOCATION OF SUBSIDIZED HOUSING BY CENSUS TRACT

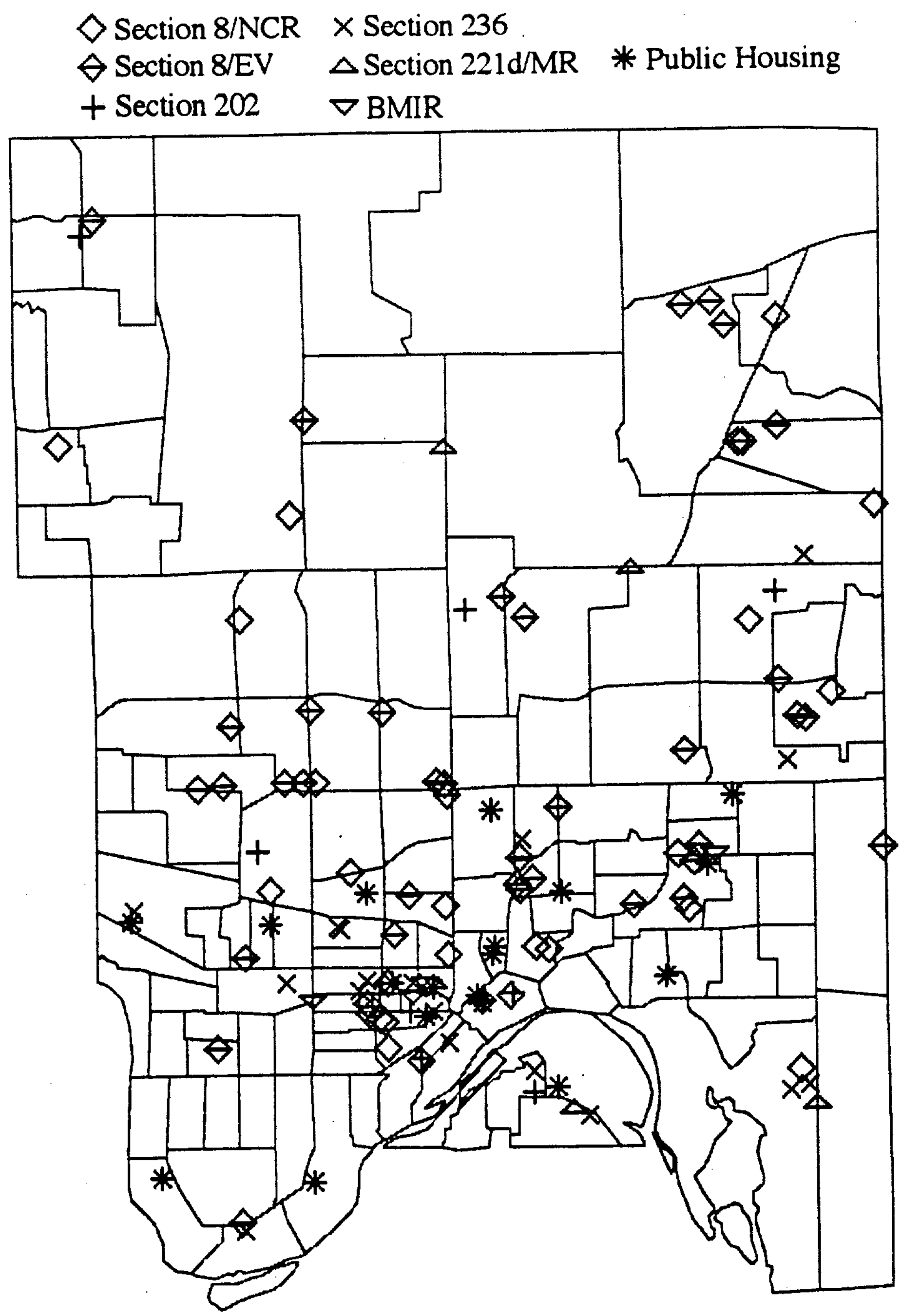


Each dot represents the actual location of a single housing project.

[12]The non-Section 8/EV projects in this data set are, to the best of the author's knowledge, a complete set of federally subsidized rental housing in the county as of September 1991. While the source for the Section 8/EV projects included is the same as the other projects, this aspect of the data set may be less than perfectly complete. However, 39 Section 8/EV projects are included in the study, which is still a large enough sample to invoke the central limit theorem for the purpose of hypothesis testing.

FIGURE 3.7

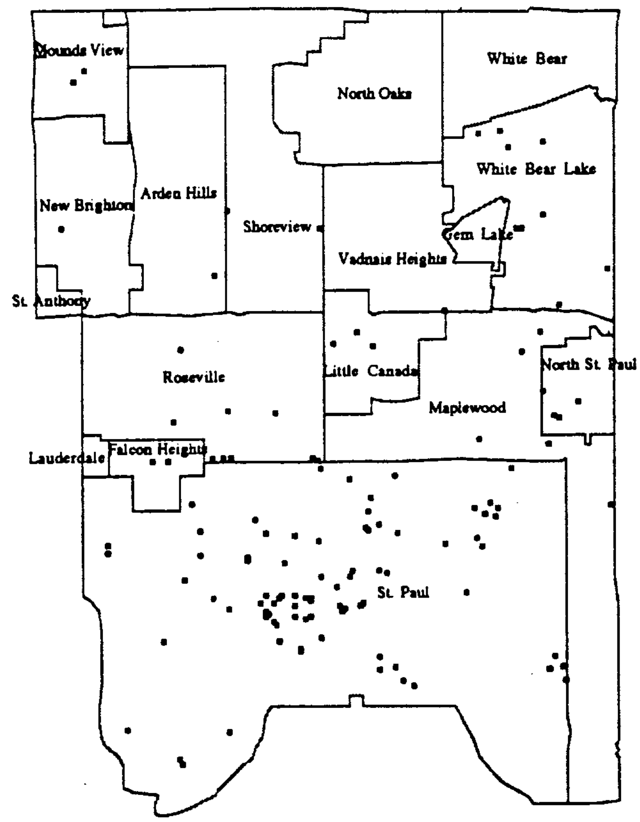
LOCATION OF SUBSIDIZED HOUSING BY SUBSIDY TYPE AND CENSUS TRACT



Each symbol represents the actual location of a single housing project.

FIGURE 3.8

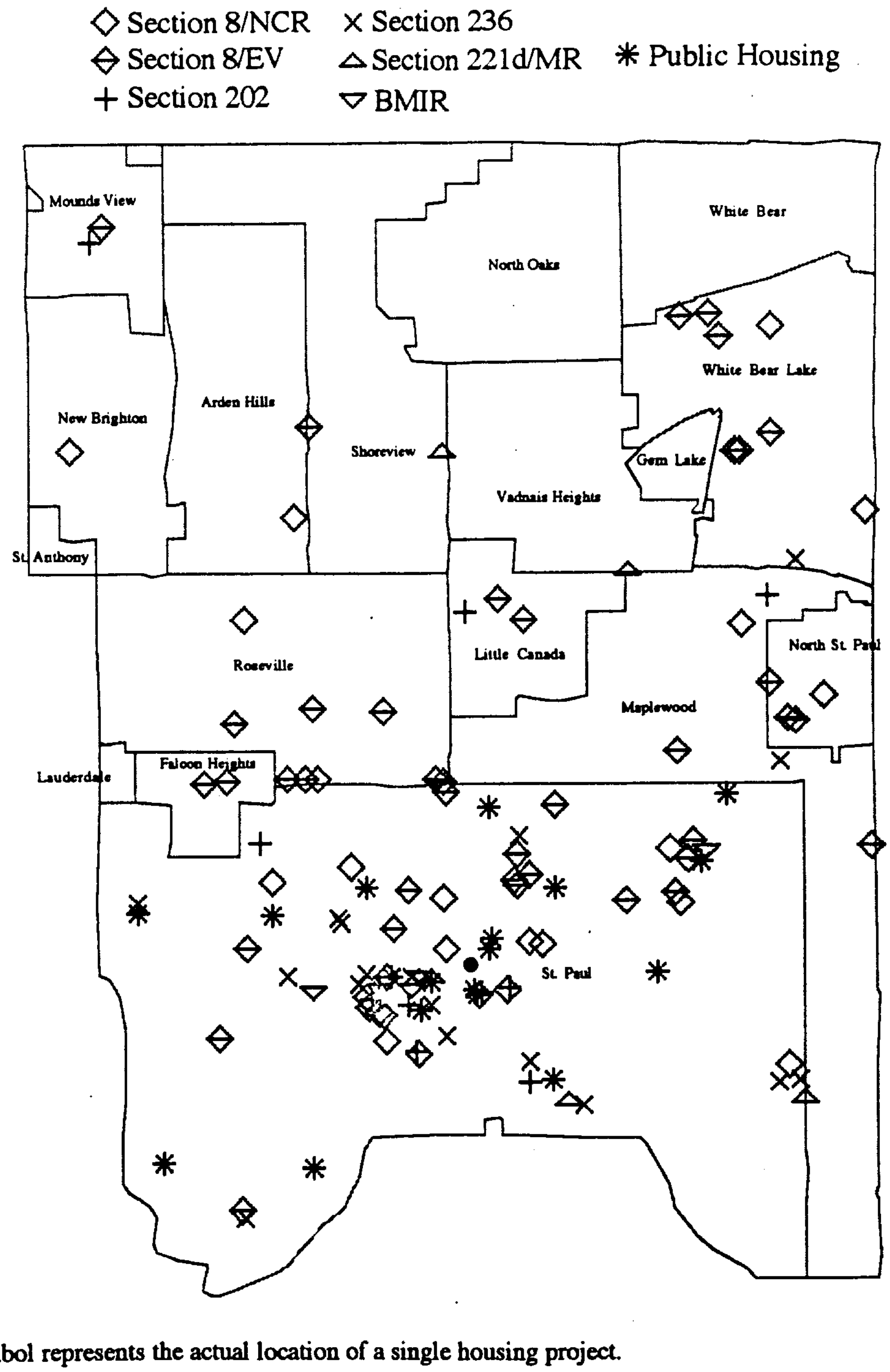
LOCATION OF SUBSIDIZED HOUSING BY MUNICIPALITY



Each dot represents the actual location of a single housing project.

FIGURE 3.9

LOCATION OF SUBSIDIZED HOUSING BY SUBSIDY TYPE AND MUNICIPALITY



Each symbol represents the actual location of a single housing project.

TABLE 3.4

DESCRIPTIVE STATISTICS ON THE SIZE AND VALUE OF THE SUBSIDIZED HOUSING LOCATIONS

	N	NUMBER OF SUBSIDIZED UNITS TOTAL	MEAN (PER LOC)	SD	MIN	MAX	PER UNIT VALUE MEAN	SD	MIN	MAX
TOTAL	*120*	*12864*	*96.11*	*89.79*	*7*	*506*	*25799*	*11097*	*7353*	*101438*
ELDERLY	33	4516	121.00	54.95	16	219	28558	16834	7353	101438
FAMILY	83	8184	88.90	99.99	7	506	24887	7811	7679	59501
SPECIAL	4	164	40.25	43.47	10	103	21965	8243	11013	30097
S8EV	39	2821	72.33	82.54	7	441	24792	7292	13750	59501
PROJECT-BASED	81	10043	107.56	91.36	10	506	26284	12538	7353	101438
S8NCR	26	2352	63.46	50.38	12	195	27941	8500	7679	39575
S202	11	983	67.27	40.85	10	124	33575	28399	7353	101438
S236	17	2398	141.00	110.96	31	506	20076	2893	14126	25273
S221D MR	5	243	34.80	5.97	29	44	25238	7721	14700	33211
BMIR	4	452	52.50	37.55	11	96	19469	2274	16828	21500
PUB HOUSING	18	3615	196.72	83.01	75	430	27105	6867	17692	44747
WITHIN ST. PAUL CITY LIMITS										
TOTAL	*80*	*9036*	*97.05*	*94.21*	*10*	*506*	*25227*	*12635*	*7353*	*101438*
ELDERLY	27	3985	128.30	55.61	16	219	28662	18627	7353	101438
FAMILY	49	4887	84.47	108.79	11	506	23600	7766	7679	44747
SPECIAL	4	164	40.25	43.47	10	103	21965	8243	11013	30097
S8EV	15	469	31.27	27.25	11	113	23814	6025	13750	36383
PROJECT-BASED	65	8567	192.23	97.70	10	506	25553	13731	7353	101438
S8NCR	18	1476	46.17	33.71	12	121	26114	9610	7679	39575
S202	8	777	67.00	41.37	10	120	36351	33425	7353	101438
S236	15	2112	140.73	118.24	31	506	19918	2832	14126	25273
S221D MR	2	135	33.00	4.24	30	36	17767	4337	14700	20833
BMIR	4	452	52.50	37.55	11	96	19469	2274	16828	21500
PUB HOUSING	18	3615	196.72	83.01	75	430	27105	6867	17692	44747
IN SUBURBS										
TOTAL	*40*	*3828*	*94.23*	*81.33*	*7*	*441*	*26944*	*7098*	*17263*	*59501*
ELDERLY	6	531	88.17	40.78	40	127	28090	3015	22840	31665
FAMILY	34	3297	95.29	86.93	7	441	26742	7608	17263	59501
SPECIAL	0	0								
S8EV	24	2352	98.00	94.95	7	441	25403	8046	17263	59501
PROJECT-BASED	16	1476	88.56	57.57	15	195	29255	4715	18220	35064
S8NCR	8	876	102.38	61.69	15	195	32049	2422	28641	35064
S202	3	206	68.00	48.50	40	124	26172	3057	22840	28847
S236	2	286	143.00	35.36	118	168	21259	4298	18220	24298
S221D MR	3	108	36.00	7.55	29	44	30219	4097	25549	33211
BMIR	0	0								
PUB HOUSING	0	0								

N is the number of subsidized locations (i.e., projects) within each category.

To operationalize the concepts discussed in chapter two, sixteen variables of interest related to subsidized housing were defined. These are listed in table 3.5.

TABLE 3.5

SUBSIDIZED HOUSING VARIABLES USED IN THE REGRESSIONS

Presence	NLOCS	number of subsidized locations, i.e., projects
	NSUNITS	number of subsidized units
Spatial Pattern	MAINDIS	mean distance between housing unit and subsidized units
	SUBDIS	mean distance between subsidized units
	SDSUBDIS	standard deviation of distances between subsidized units
Value	UNITVAL	average per unit value of subsidized units
Tenant Type	ELDERLY	number of elderly subsidized units
	FAMILY	number of family units
	SPECIAL	number of special (i.e., handicapped) units
Subsidy Type	S8NCR	number of Section 8 NCR units
	S8EV	number of Section 8 E/V units
	S202	number of Section 202 units
	S236	number of Section 236 units
	S221D	number of Section 221d units
	BMIR	number of BMIR units
	PUBH	number of public housing units

All variables are continuous and defined over a specific radius, as discussed in the text.

These sixteen variables can be broken down into five sets: presence, spatial pattern, value, tenant type, and subsidy type.

Presence

Two variables were computed to represent the concept of presence of subsidized housing in a neighborhood: the number of subsidized housing projects (NLOCS) and the number of subsidized units (NSUNITS) that fall near a non-subsidized house. How near is "near" is discussed in the next section on distance. The number of projects, NLOCS, is a cruder measure of presence than number of units, since projects are of variable size. However, since neighborhood concerns usually center around the development of a new project, rather than there are 100 or 101 units in the project, NLOCS may be a more useful policy variable.

Spatial Pattern

In order to test the hypothesis that any external effects associated with subsidized housing diminish with distance, all of the sixteen variables were calculated over five discrete radii around each non-subsidized unit. As was discussed in chapter two, this allows for a flexible definition of neighborhood in two senses. First, the neighborhood is constantly redefined for each housing unit, since each housing unit becomes the center of its own neighborhood for the calculation of each variable. Secondly, by defining five different radii around each house, various concepts of "neighborhood" are allowed.

The five radii are: 300 feet, quarter mile, half mile, one mile, and two miles. The Ramsey County Surveyor's office provided a database linking each property in Ramsey County with its locational coordinates, expressed in the National Geodetic Survey's county coordinate plane system. Since these coordinates are expressed in a two dimensional planar system, Euclidean distances between coordinate pairs could be computed. This is how all distance measures were calculated in this study. It should be noted that these distances measure feet between property centers. Some subsidized housing projects have multiple buildings. For these projects, a single pair of coordinates was computed which is the average of each building's coordinates, weighted by number of units in the building.

The 300 foot radius is designed to capture the effects of units immediately adjacent to the non-subsidized house. Given that many of the subsidized units are in multi-building complexes and that distance is measured between the centers of buildings, not their exterior walls, any radius smaller than 300 feet would probably miss some properties. The two mile radius was chosen to represent the outer limit of any possible effect. There is little empirical guidance in previous research as to where this limit should be set. Further, without some information as to the pattern of effects over various distances, an analytical solution to this problem is impossible. However, over 97 percent of all non-subsidized units in Ramsey County lie within two miles of at least one subsidized unit. It was therefore felt that two miles represented a reasonable outer limit.

Notice there are three distinct concepts of distance in the design. There is the overall definition of the inclusive neighborhood, from 300 feet to two miles. There is one variable, MAINDIS, which measures the average distance between the non-subsidized unit and all surrounding subsidized locations, weighting each distance by the number of units at each subsidized location. This is done to reflect the notion of *subjective* distance, as discussed in chapter three. The third type of distance measure, indicated by two variables, SUBDIS and SDSUBDIS, captures the spatial distribution of the subsidized units themselves within the radius.

Value of the Subsidized Housing

One variable, UNITVAL, measures the mean value per subsidized unit of all such units within the neighborhood radius. This variable is intended to capture differentials in quality between a subsidized unit and neighboring residential properties. This variable should be significantly negative if property effects are caused by the quality differentials between non-subsidized and subsidized units. UNITVAL is computed by dividing the 1991 assessed value for the subsidized property by the number of residential units in the project.

Tenant and Subsidy Distributions

To test the hypothesis that different types of tenants, i.e., elderly, family or handicapped, cause differential effects on neighboring properties, the number of units housing each type of tenant were computed. Similarly, the number of units in each radius were broken down by subsidy type, to capture possible differential effects of this sort.

The Sample

Since a computer was not readily available which could handle a regression with 128,010 observations, a 25 percent sample was taken (n=26,503). Tables A.1 to A.6 in the Appendix provide descriptive statistics on all variables entered into the regression models from this sample.

The Regression Models

Since there is a complex set of subsidized housing variables, it is useful to summarize how they are computed. For each non-subsidized house in the sample, distances are computed to each of the 120 subsidized locations in the county. Any distances which fall beyond two miles are discarded. The included subsidized locations are then separated into each of five radii, from 300 feet to 2 miles. Note that the quarter mile radius contains all of the subsidized housing which falls within the 300 foot radius. The half mile, correspondingly, contains all of those units which fall within the quarter mile and 300 foot radii, and so on. All sixteen variables of interest are then calculated for each radius. The magnitude of these effects is expected to diminish as the radii get larger, since the effect is distributed over a much wider area.

There is an incongruity inherent in the sample for those variables where smaller magnitudes are expected to have larger effects. This is the case with all the distance measures (MAINDIS, SUBDIS, SDSUBDIS) as well as the per unit value effect (UNITVAL). Closer units, and more clustered groups of units, are expected to have a stronger effect than units farther away and more widely dispersed. Similarly, units of lower value are hypothesized to have a greater effect than higher valued units. For houses with no subsidized units nearby, all distance and value variables are set to zero. However, it is conceivable that a house could have a subsidized unit right "on top of it", i.e., so close as to be almost zero feet away. Similarly, a unit could be of such low quality as to approach zero value. In the first case, zero values imply there should be no effect at all. In the second, zero values indicate the greatest hypothesized effect.

To solve this problem, all distance variables and the value variable are inverted in the regressions. Therefore, the farther away a unit is, or the more it is worth, the smaller will the regression variable be. Since none of the distance variables or value variables for houses with subsidized units nearby actually take on zero values, this solution solves the consistency problem. However, it creates a bias problem.

While the regression coefficients on the inverted variables are unbiased, their inverses are *biased* estimators of the original uninverted variables. This is due to the algebra of expectations. The expected value of a non-linear transformation of a variable is not equal to a non-linear transformation of the expected value of that variable. While there is no general analytical solution to remove this bias, it is possible to derive a less biased estimator by taking a Taylor series expansion around the expected value of the OLS estimator.[13] The resulting estimator is found by:

$$\frac{1}{\beta} \approx \frac{1}{\beta^{OLS}}\left(1 + \frac{1}{2}V\left(\beta^{OLS}\right)\right)^{-1} \qquad (3.6)$$

where $1/\beta$ is the less biased estimate of the effect of the original uninverted variable, β^{OLS} is the regression coefficient on the inverted variable, and $V(\beta^{OLS})$ is the variance of β^{OLS}, which can be estimated by the square of the standard error of β^{OLS}.

As is shown in chapter 4, this bias problem turns out to be of little practical importance. The coefficients and standard errors on the inverted variables are so large that reinverting them results in estimates so small as to be effectively zero, despite the fact that they may have significant t-values. For instance, the coefficient on UNITVAL at the two mile radius is -5.46×10^{8}. Simply inverting this gives the biased estimator for UNITVAL of -1.83×10^{-9}. Since the standard error on this variable is large (5.23×10^{7}), adjusting this estimate by using (5.1) reduces its value even closer to zero to -7.0×10^{-17}. This means that every dollar decline in per unit subsidized housing values within a two mile radius lowers property values by $0.0000000000000007. While the original coefficient is highly significant, with a t value of -10.445, the magnitude of the reinverted estimate is so small that it can be said that UNITVAL has no *real* effect on property values. This is the case with all four inverted variables at all five radii.

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[13]See Kennedy (1979, p. 69) for a complete derivation.

For this reason, when results are presented in the next chapter for these variables, they are given *only* in their original form — as coefficients on the inverted variables. Since these coefficients are all *effectively* zero when reinverted, there is little reason to present them in original, biased reinverted, and finally less biased reinverted form. Presenting them in original form provides more information as to the derivation of their t-values.

Model One: Testing Presence and Distance

In order to test the hypotheses developed in chapter two, four separate regression models are specified. Model one tests for presence and distance effects only and is of the form:

$$P = \alpha + \beta_S S + \beta_L L + \gamma_1 NLOCS + \lambda_1 NLOCS^2 + \gamma_2 MAINDIS + \lambda_2 MAINDIS^2 + e \qquad (3.7)$$

where S and L represent matrices of structural and locational characteristics respectively, NLOCS is number of subsidized locations within the radius, and MAINDIS is the weighted mean distance between the non-subsidized house and all surrounding subsidized locations weighted by the number of units at each location. Notice that the structural and locational attributes have been entered as linear terms.

Negative coefficients on the first order terms of NLOCS and MAINDIS would be consistent with the negative externality hypothesis. Positive coefficients on the second order terms are expected, implying a diminishing marginal effect, which is consistent with how most economic variables behave. (See the related discussion earlier in this chapter in the section entitled, "Using Regression to Estimate the Hedonic Price Function.")

Model Two: Presence and Distance Revisited

Model two replaces number of locations (NLOCS) with number of units (NSUNITS), with all other parameters remaining the same as in model one. The resulting model is:

$$P = \alpha + \beta_S S + \beta_L L + \gamma_1 NSUNITS + \lambda_1 NSUNITS^2 + \gamma_2 MAINDIS + \lambda_2 MAINDIS^2 + e \qquad (3.8)$$

Using NSUNITS to test for presence accounts for differences in the size of subsidized housing projects. All expectations as to the signs are the same as with model one, however, the magnitude of the coefficient on number of units should be smaller, reflecting the scale of that variable.

Model Three: Adding Quality, Spatial Variation and Tenant Type

Model three is substantially more complex than the first two models. This model includes average per unit value of subsidized housing (UNITVAL) to test for quality effects; mean (SUBDIS) and standard deviation (SDSUBDIS) of the distances between subsidized locations to test for differential effects associated with the spatial pattern of subsidized housing within a neighborhood; and the distribution of units by tenant type to test for differences between elderly (ELDERLY), family (FAMILY) and handicapped (SPECIAL) effects. Each of these variables is entered with first and second order terms. The resulting model is:

$$
\begin{aligned}
P = \alpha + \beta_S S + \beta_L L \; + \; & \gamma_1 MAINDIS + \lambda_1 MAINDIS^2 + \\
& \gamma_2 SUBDIS + \lambda_2 SUBDIS^2 + \\
& \gamma_3 SDSUBDIS + \lambda_3 SDSUBDIS^2 + \\
& \gamma_4 UNITVAL + \lambda_4 UNITVAL^2 + \\
& \gamma_5 ELDERLY + \lambda_5 ELDERLY^2 + \\
& \gamma_6 FAMILY + \lambda_6 FAMILY^2 + \\
& \gamma_7 SPECIAL + \lambda_7 SPECIAL^2 + e
\end{aligned}
\qquad (3.9)
$$

A significant positive coefficient on the first order unit value term would imply that subsidized housing quality affects neighboring property values, i.e., they vary in the same direction. A significant positive coefficient on the first order spatial pattern variables would recommend a policy of dispersing the subsidized units evenly throughout the neighborhood. Signs on the tenant type variables indicate the effect of that type of tenant on property values. For instance, an insignificant coefficient on number of elderly units and a significant negative coefficient on number of family units would be consistent with the belief that elderly housing is more acceptable to communities than family housing.

Model Four: Adding Subsidy Type

The last of the four models is similar to model three, but replaces tenant type variables with subsidy type variables:

$$
\begin{aligned}
P = \alpha + \beta_S S + \beta_L L \; + \; & \gamma_1 MAINDIS + \lambda_1 MAINDIS^2 + \\
& \gamma_2 SUBDIS + \lambda_2 SUBDIS^2 + \\
& \gamma_3 SDSUBDIS + \lambda_3 SDSUBDIS^2 + \\
& \gamma_4 UNITVAL + \lambda_4 UNITVAL^2 + \\
& \gamma_5 S8NCR + \lambda_5 S8NCR^2 + \\
& \gamma_6 S8EV + \lambda_6 S8EV^2 + \\
& \gamma_7 S202 + \lambda_7 S202^2 + \\
& \gamma_8 S236 + \lambda_8 S236^2 + \\
& \gamma_9 S221D + \lambda_9 S221D^2 + \\
& \gamma_{10} BMIR + \lambda_{10} BMIR^2 + \\
& \gamma_{11} PUBH + \lambda_{11} PUBH^2 + e
\end{aligned}
\tag{3.10}
$$

Each of these models is estimated for each of the five radii. Therefore twenty regressions in all are estimated. Results are presented in the next chapter.

Chapter 4: Regression Results

Goodness of Fit

For cross sectional data, the models exhibit quite good fits, with R^2 and adjusted-R^2 statistics for all models hovering near 0.80. Table 4.1 reports these statistics for each model at each of the five radii.

TABLE 4.1

R^2 AND ADJUSTED R^2 FOR EACH MODEL AT EACH RADIUS

MODEL 1	300 feet	1/4 mile	1/2 mile	1 mile	2 miles
R^2	0.7937	0.7942	0.7948	0.7954	0.7957
Adjusted R^2	0.7933	0.7938	0.7944	0.7950	0.7953
MODEL 2					
R^2	0.7937	0.7940	0.7946	0.7954	0.7951
Adjusted R^2	0.7934	0.7936	0.7942	0.7951	0.7947
MODEL 3					
R^2	0.7937	0.7942	0.7958	0.7968	0.7982
Adjusted R^2	0.7933	0.7937	0.7953	0.7963	0.7977
MODEL 4					
R^2	0.7938	0.7945	0.7961	0.7974	0.7986
Adjusted R^2	0.7933	0.7940	0.7956	0.7968	0.7980

The Structural Parameters

In order to gain some perspective on the hedonic results, table 4.2 provides the minimum and maximum coefficients observed across all five radii and all four models for the constant term and the structural attributes. According to these results, the marginal value of an extra square foot of living space (LIVAREA) is highly significant and ranged between \$43 and \$44 in all twenty regressions. It is useful to use this coefficient as a standard against which to judge the magnitude of the coefficients of the various subsidized housing variables.

TABLE 4.2

MINIMUM AND MAXIMUM COEFFICIENTS FOR
CONSTANT AND STRUCTURAL VARIABLES FROM ALL REGRESSIONS

n=26503	MINIMUM				MAXIMUM			
	BETA	SE	T	SIG	BETA	SE	T	SIG
Constant	37127.95	1451.66	25.576	0.0000	50904.13	1597.15	31.872	0.0000
AGE	-255.91	7.71	-33.162	0.0000	-231.76	7.87	-29.427	0.0000
BATHRMS	9310.48	385.75	24.136	0.0000	9535.76	385.68	24.725	0.0000
BEDRMS	-2964.60	206.62	-14.348	0.0000	-2614.82	205.13	-12.747	0.0000
CENTAIR	-35.55	314.17	-0.113	0.9099	275.50	313.51	0.879	0.3795
DECKAREA	9.34	1.40	6.638	0.0000	10.27	1.41	7.249	0.0000
EPAREA	15.91	1.67	9.490	0.0000	17.48	1.68	10.403	0.0000
EWBRSTON	10161.66	764.70	13.288	0.0000	10784.35	759.72	14.195	0.0000
EWMETAL	-141.65	348.89	-0.406	0.6847	204.10	345.89	0.590	0.5551
EWOTHRNW	-1296.06	509.72	-2.543	0.0110	-1015.25	507.22	-2.002	0.0453
EWSTUCCO	820.18	326.34	2.513	0.0120	1101.38	325.67	3.382	0.0007
FIREPL	4406.77	223.78	19.692	0.0000	4584.42	222.84	20.573	0.0000
GARGAREA	17.44	0.83	20.846	0.0000	17.97	0.84	21.361	0.0000
GTDETACH	-2704.40	345.37	-7.830	0.0000	-2496.13	346.52	-7.203	0.0000
GTATTACH	4002.06	593.65	6.741	0.0000	4397.40	596.16	7.376	0.0000
HOMESTD	2111.70	483.54	4.367	0.0000	2322.61	488.11	4.758	0.0000
HTNOTFA	-2435.15	380.54	-6.399	0.0000	-2045.81	381.48	-5.363	0.0000
LIVAREA	43.33	0.46	93.337	0.0000	43.85	0.46	94.238	0.0000
LIVRMS	-2331.61	155.55	-14.989	0.0000	-2221.84	156.42	-14.204	0.0000
LOCCORN	-796.67	343.49	-2.319	0.0204	-737.21	344.79	-2.138	0.0325
LOTAREA	0.07	0.00	16.982	0.0000	0.08	0.00	18.575	0.0000
OSPAREA	6.65	1.78	3.721	0.0002	7.73	1.78	4.339	0.0000
POOLAREA	14.81	1.60	9.208	0.0000	15.31	1.62	9.436	0.0000
PTNOT1FM	-25239.39	493.58	-51.135	0.0000	-24877.23	487.72	-51.007	0.0000

Most of the structural coefficients are significant, of the expected sign and of reasonable magnitude. One result which may be confusing at first glance is that both number of bedrooms and living rooms are significantly negative. This is because after controlling for square feet of living space, more rooms in a house imply smaller rooms, thereby decreasing the value of the house.

THE LOCATIONAL VARIABLES

Table 4.3 presents results for the locational variables in the same format as table 4.2. Some of these results deserve brief elaboration. Percent black (PBLACK) was negatively significant in all regressions, ranging in effect from -$128 to -$44, indicating that neighborhoods with higher proportions of blacks to whites tend to have slightly lower property values. The literature on race and property values (e.g., Bailey 1966; Laurenti 1960; Nourse 1963) has generally come to similar conclusions as did the studies on subsidized housing and property values reviewed in chapter two: inconclusive results, but no apparently clear negative effect. The results given here, while statistically significant and negative, are of small magnitude, and therefore do not contradict this general consensus. As can be seen from table 3.1, Ramsey County has a very small minority population (although it is growing). However, this population tends to be very highly concentrated in a few census tracts near downtown St. Paul. Therefore, it is difficult to draw firm conclusions about the effects of race on property values in the study area.

Three other locational variables deserve mention. Travel time to work (TTWORK), which is intended as an indicator of economic accessibility, shows no clear pattern of significance or magnitude across the regressions. This may be because the study area is heavily developed and economic accessibility does not necessarily decline as one moves farther from the central business district. The river dummy (RIVER), which indicates whether houses are situated on the Mississippi river or not, is highly significant and of quite large magnitude. This is the case because only a handful houses are situated on the Mississippi, and they are very expensive.

An anomalous result is the signs of the school district dummies (SDNEWBR to SDWBLAKE). The base case dummy, included in the intercept term, is the St. Paul school district. On the surface, the pattern of coefficients indicate that the St. Paul school system is more highly valued than any of the others, while the White Bear Lake school district has the worst effect on property values. It may be that an omitted variable highly coincident with the geographic pattern of school districts, such as tax districts, is being captured in the regressions. It is an interesting question which merits attention in future research.

THE SUBSIDIZED HOUSING VARIABLES

Tables 4.4 through 4.8 present results for the subsidized housing variables of interest for each model and each radius. It is important to identify the pattern of effects across the radii, as well as the individual effects within each radius. There are a number of conclusions to be drawn from these tables.

TABLE 4.3

MINIMUM AND MAXIMUM COEFFICIENTS FOR LOCATIONAL VARIABLES FROM ALL REGRESSIONS

n=26503	MINIMUM				MAXIMUM			
	BETA	SE	T	SIG	BETA	SE	T	SIG
LAKE	43022.15	927.72	46.374	0.0000	43736.67	932.92	46.881	0.0000
MEDFAMIN	0.58	0.05	10.847	0.0000	0.74	0.05	14.211	0.0000
MRENT	-40.19	2.82	-14.235	0.0000	-28.73	2.69	-10.660	0.0000
PBELOWPO	62.38	54.10	1.153	0.2489	210.36	54.22	3.880	0.0001
PBLACK	-128.09	24.14	-5.305	0.0000	-44.40	22.24	-1.996	0.0459
PCOLGRAD	409.36	56.33	7.267	0.0000	586.60	53.99	10.864	0.0000
PHSGRAD	-479.67	31.15	-15.396	0.0000	-339.71	32.31	-10.513	0.0000
POVER65	-10.01	36.40	-0.275	0.7832	70.29	37.38	1.880	0.0601
POWNOCC	84.40	22.11	3.817	0.0001	125.55	21.05	5.962	0.0000
PSPAN	-306.55	56.60	-5.416	0.0000	-111.89	54.34	-2.059	0.0395
PSPFFAM	-102.82	46.34	-2.218	0.0265	12.69	45.07	0.282	0.7782
PUNDER21	-224.96	37.49	-5.999	0.0000	-90.37	37.77	-2.392	0.0167
PWHITE	-16.09	13.67	-1.178	0.2390	10.81	13.73	0.787	0.4311
RIVER	55283.96	3786.40	14.601	0.0000	58509.99	3795.80	15.414	0.0000
SDMAPLEW	-1551.02	597.20	-2.597	0.0094	2047.58	693.84	2.951	0.0032
SDNEWBR	-5152.97	1889.99	-2.726	0.0064	771.02	1800.77	0.428	0.6685
SDROSEV	-4284.41	527.26	-8.126	0.0000	-548.10	752.92	-0.728	0.4666
SDSHOREV	-2630.93	724.92	-3.629	0.0003	984.39	615.05	1.601	0.1095
SDWBLAKE	-6422.74	710.51	-9.040	0.0000	-2556.73	865.60	-2.954	0.0031
TOPHILLY	334.78	418.97	0.799	0.4243	643.09	421.64	1.525	0.1272
TTWORK	-93.30	76.27	-1.223	0.2212	66.03	75.83	0.871	0.3839
ZONMF	-120.03	348.08	-0.345	0.7302	543.96	339.57	1.602	0.1092

TABLE 4.4

REGRESSION RESULTS FOR VARIABLES OF INTEREST FOR THE 300 FOOT RADIUS
(SQUARED TERMS ARE BELOW FIRST ORDER TERMS)

		BETA	SE	T	SIG
Model 1	NLOCS	1491.69	8958.71	0.167	0.8678
		-1932.98	7539.56	-0.256	0.7977
	MAINDIS	-1.55E+05	3.09E+05	-0.502	0.6158
		2.03E+06	3.28E+06	0.620	0.5352
Model 2	NSUNITS	-12.08	43.48	-0.278	0.7812
		0.12	0.16	0.751	0.4528
	MAINDIS	-2.28E+05	2.72E+05	-0.838	0.4022
		2.61E+06	2.93E+06	0.892	0.3723
Model 3	MAINDIS	-2.10E+05	2.99E+05	-0.703	0.4818
		2.37E+06	3.19E+06	0.743	0.4575
	SUBDIS	-1.24E+07	4.86E+07	-0.211	0.8328
		5.02E+09	2.64E+10	0.190	0.8491
	SDSUBDIS				
	UNITVAL	5.51E+07	2.64E+08	0.202	0.8403
		-1.86E+12	4.34E+12	-0.428	0.6687
	ELDERLY	-7.75	87.63	-0.088	0.9295
		0.11	0.41	0.275	0.7837
	FAMILY	-28.74	84.30	-0.341	0.7332
		0.61	0.21	0.778	0.4364
	HANDICAPPED	1184.45	1001.68	1.182	0.2370
		-12.05	10.02	-1.203	0.2291
Model 4	MAINDIS	-2.27E+05	3.19E+05	-0.712	0.4760
		2.91E+06	3.40E+06	0.854	0.3930
	SUBDIS	-1.03E+07	5.99E+07	-0.172	0.8634
		4.27E+08	2.70E+10	0.159	0.8740
	SDSUBDIS				
	UNITVAL	-1.06E+08	2.36E+08	-0.448	0.6541
		1.12E+12	3.70E+12	0.302	0.7640
	S8NCR	30.37	161.50	0.188	0.8508
		-0.33	1.37	-0.241	0.8098
	S8EV	0.05	107.20	0.000	0.9996
		-0.33	1.37	-0.241	0.8098
	S202	-2.55	375.83	-0.007	0.9946
		-0.62	3.49	-0.176	0.8600
	S236	-81.81	184.86	-0.443	0.6576
		1.47	1.61	0.913	0.3612
	S221D				
		25.66	24.39	1.052	0.2928
	BMIR				
		12.22	59.31	0.206	0.8368
	PUBH	124.53	128.90	0.966	0.3340
		-0.61	0.73	-0.841	0.4003

Some terms are expressed in scientific notation to conserve space, i.e., -1.06E+08 means -1.06×10^8.

TABLE 4.5
REGRESSION RESULTS FOR VARIABLES OF INTEREST FOR THE QUARTER MILE RADIUS (SQUARED TERMS ARE BELOW FIRST ORDER TERMS)

		BETA	SE	T	SIG
Model 1	NLOCS	-1585.25	565.74	-2.802	0.0051
		-243.99	189.18	-1.290	0.1972
	MAINDIS	1.00E+05	5.90E+04	1.700	0.0887
		-2.53E+05	4.05E+05	-0.624	0.5327
Model 2	NSUNITS	-20.91	5.48	-3.815	0.0001
		0.03	0.02	1.973	0.0485
	MAINDIS	1.47E+05	6.13E+04	2.406	0.0162
		-4.67E+05	4.12E+05	-1.132	0.2575
Model 3	MAINDIS	1.08E+05	6.34E+04	1.706	0.0880
		-2.95E+05	4.18E+05	-0.706	0.4800
	SUBDIS	1.09E+06	1.23E+06	0.880	0.3746
		-3.53E+08	2.72E+08	-1.297	0.1947
	SDSUBDIS	-2.46E+06	1.02E+06	-2.400	0.0161
		2.24E+08	1.70E+08	1.319	0.1873
	UNITVAL	-7.60E+07	5.77E+07	-1.318	0.1874
		3.51E+11	1.05E+12	0.336	0.7370
	ELDERLY	6.11	10.92	0.559	0.5759
		-0.04	0.04	-1.038	0.2994
	FAMILY	-13.96	9.01	-1.550	0.1220
		0.03	0.02	1.505	0.1323
	HANDICAPPED	110.98	96.37	1.152	0.2495
		-0.96	0.95	-1.017	0.3093
Model 4	MAINDIS	4.14E+04	6.39E+04	0.648	0.5168
		-9.03E+03	4.20E+05	-0.022	0.9828
	SUBDIS	4.12E+05	1.23E+06	0.334	0.7382
		-7.09E+07	2.76E+08	-0.257	0.7969
	SDSUBDIS	-1.30E+06	1.07E+06	-1.209	0.2286
		2.31E+08	1.78E+08	1.294	0.1955
	UNITVAL	-7.02E+07	6.21E+07	-1.131	0.2582
		1.30E+11	1.10E+12	0.118	0.9062
	S8NCR	-49.97	20.65	-2.420	0.0155
		0.33	0.12	2.802	0.0051
	S8EV	-11.23	11.13	-1.009	0.3128
		0.03	0.03	0.969	0.3324
	S202	-199.65	81.24	-2.457	0.0140
		1.53	0.74	2.061	0.0393
	S236	19.35	13.44	1.440	0.1490
		-0.10	0.05	-2.250	0.0260
	S221D	906.26	228.69	3.960	0.0010
		-25.35	6.04	-4.198	0.0000
	BMIR	78.71	88.43	0.890	0.3735
		-1.33	0.98	-1.364	0.1724
	PUBH	19.76	12.21	1.619	0.1055
		-0.06	0.05	-1.189	0.2344

Some terms are expressed in scientific notation to conserve space, i.e., -1.06E+08 means -1.06 x 10^8.

TABLE 4.6

REGRESSION RESULTS FOR VARIABLES OF INTEREST FOR THE HALF MILE RADIUS (SQUARED TERMS ARE BELOW FIRST ORDER TERMS)

		BETA	SE	T	SIG
Model 1	NLOCS	-1398.36	195.17	-7.165	0.0000
		12.90	26.10	0.494	0.6212
	MAINDIS	-9.90E+04	4.76E+04	-2.077	0.0378
		7.35E+05	3.69E+05	1.991	0.0465
Model 2	NSUNITS	-17.41	2.04	-8.533	0.0000
		0.02	0.00	4.925	0.0000
	MAINDIS	4.18E+04	5.00E+04	0.835	0.4038
		5.58E+04	3.77E+05	0.148	0.8823
Model 3	MAINDIS	8.29E+04	5.18E+04	1.598	0.1100
		-1.96E+05	3.82E+05	-0.514	0.6070
	SUBDIS	3.50E+06	8.37E+05	4.181	0.0000
		-7.64E+08	2.68E+08	-2.855	0.0043
	SDSUBDIS	2.10E+05	5.40E+05	0.388	0.6977
		-1.13E+08	8.21E+07	-1.375	0.1691
	UNITVAL	-2.65E+08	3.33E+07	-7.945	0.0000
		4.51E+12	5.86E+11	7.690	0.0000
	ELDERLY	10.85	4.85	2.236	0.0254
		-0.03	0.02	-2.001	0.0454
	FAMILY	-24.81	4.13	-6.007	0.0000
		0.05	0.01	5.909	0.0000
	HANDICAPPED	-186.78	64.27	-2.906	0.0037
		1.97	0.63	3.098	0.0020
Model 4	MAINDIS	6.58E+04	5.23E+04	1.258	0.2083
		-1.05E+05	3.83E+05	-0.275	0.7834
	SUBDIS	3.18E+06	8.54E+05	3.724	0.0002
		-7.48E+08	2.71E+08	-2.765	0.0057
	SDSUBDIS	-5.62E+05	5.70E+05	-0.986	0.3241
		-2.17E+07	8.54E+06	-0.254	0.7994
	UNITVAL	-3.32E+08	3.48E+07	-9.540	0.0000
		5.34E+12	6.10E+11	8.769	0.0000
	S8NCR	-10.24	10.33	-0.991	0.3216
		0.03	0.06	0.534	0.5932
	S8EV	-4.94	6.40	-0.771	0.4406
		0.02	0.02	1.202	0.2295
	S202	-63.33	31.22	-2.028	0.0425
		0.31	0.27	1.145	0.2522
	S236	4.05	5.40	0.751	0.4528
		-0.02	0.01	-1.621	0.1050
	S221D	602.79	135.41	4.452	0.0000
		-15.77	3.46	-4.555	0.0000
	BMIR	-48.45	32.11	-1.509	0.1313
		-0.06	0.23	-0.261	0.7943
	PUBH	19.46	4.64	4.190	0.0000
		-0.03	0.01	-1.878	0.0604

Some terms are expressed in scientific notation to conserve space, i.e., -1.06E+08 means -1.06×10^8.

TABLE 4.7

REGRESSION RESULTS FOR VARIABLES OF INTEREST FOR THE ONE MILE RADIUS (SQUARED TERMS ARE BELOW FIRST ORDER TERMS)

		BETA	SE	T	SIG
Model 1	NLOCS	-938.23	91.76	-10.225	0.0000
		16.82	4.70	3.576	0.0030
	MAINDIS	-3.29E+05	1.42E+05	-2.323	0.0202
		9.44E+06	6.53E+06	1.444	0.1487
Model 2	NSUNITS	-10.06	0.92	-10.901	0.0000
		0.00	64540.00	4.334	0.0000
	MAINDIS	1.91E+05	1.46E+05	1.311	0.1899
		-4.05E+06	6.61E+06	-0.612	0.5403
Model 3	MAINDIS	1.96E+05	1.50E+05	1.306	0.1915
		-5.04E+06	6.65E+06	-0.758	0.4482
	SUBDIS	8.07E+05	8.86E+05	0.910	0.3628
		-2.30E+08	3.06E+08	-0.754	0.4511
	SDSUBDIS	6.15E+05	6.08E+05	1.012	0.3114
		-3.73E+08	1.04E+08	-3.586	0.0003
	UNITVAL	-1.85E+08	2.70E+07	-6.872	0.0000
		2.72E+12	4.77E+11	5.699	0.0000
	ELDERLY	-5.34	2.02	-2.648	0.0081
		0.00	0.00	-1.425	0.1543
	FAMILY	-15.05	1.94	-7.767	0.0000
		0.02	0.00	6.840	0.0000
	HANDICAPPED	-74.33	29.32	-2.535	0.0112
		0.58	0.27	2.164	0.0304
Model 4	MAINDIS	1.92E+04	1.53E+05	0.125	0.9004
		-3.04E+05	6.69E+06	-0.045	0.9637
	SUBDIS	-1.79E+05	9.11E+05	-0.197	0.8441
		5.88E+07	3.10E+08	0.190	0.8495
	SDSUBDIS	-5.85E+05	6.35E+05	0.921	0.3571
		-2.00E+08	1.07E+08	-1.862	0.0626
	UNITVAL	-1.83E+08	2.75E+07	-6.671	0.0000
		2.65E+12	4.84E+11	5.475	0.0000
	S8NCR	-31.37	6.09	-5.153	0.0000
		0.11	0.03	3.906	0.0001
	S8EV	-2.92	3.93	-0.743	0.4577
		0.00	0.01	-0.158	0.8744
	S202	-37.45	10.96	-3.417	0.0006
		0.20	0.09	2.314	0.0207
	S236	-5.30	2.44	-2.170	0.0300
		0.00	0.00	1.313	0.1893
	S221D	518.38	88.27	5.873	0.0000
		-14.46	2.21	-6.543	0.0000
	BMIR	10.39	19.83	0.524	0.6003
		-0.29	0.12	-2.335	0.0195
	PUBH	2.32	1.96	1.185	0.2361
		-0.01	0.00	-2.192	0.0284

Some terms are expressed in scientific notation to conserve space, i.e., -1.06E+08 means -1.06×10^8.

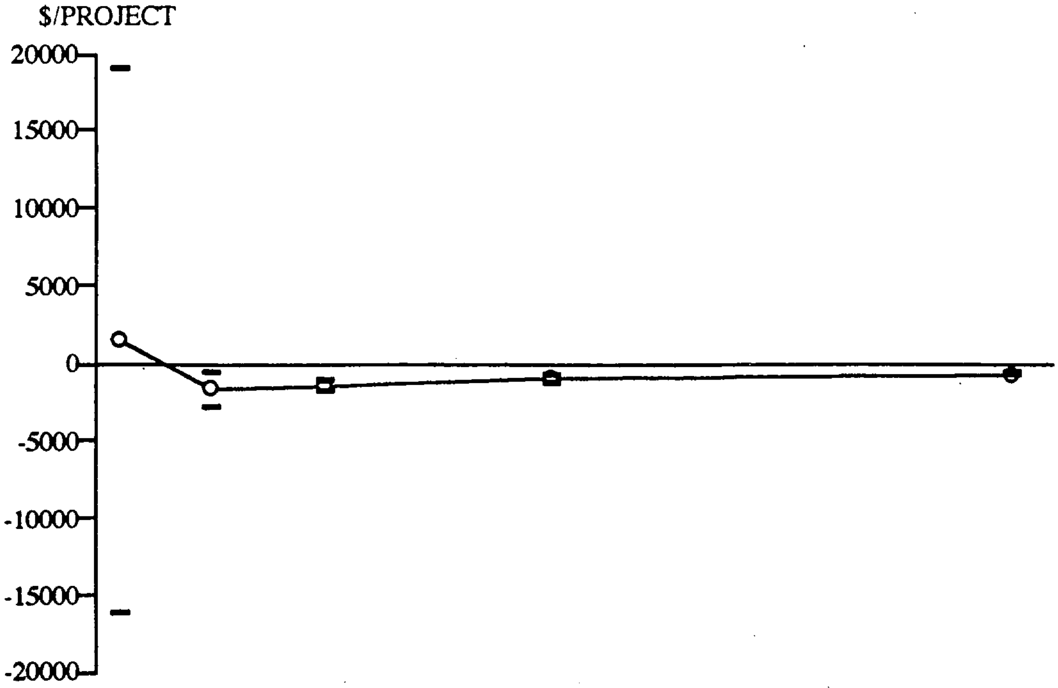
TABLE 4.8
REGRESSION RESULTS FOR VARIABLES OF INTEREST FOR THE TWO MILE RADIUS (SQUARED TERMS ARE BELOW FIRST ORDER TERMS)

		BETA	SE	T	SIG
Model 1	NLOCS	-608.75	53.97	-11.280	0.0000
		8.69	1.17	7.440	0.0000
	MAINDIS	-1.20E+07	1.29E+06	-9.242	0.0000
		3.48E+09	6.38E+08	5.449	0.0000
Model 2	NSUNITS	-4.56	0.57	-7.949	0.0000
		0.00	0.00	4.989	0.0000
	MAINDIS	-8.13E+06	1.29E+06	-6.290	0.0000
		2.47E+09	6.39E+08	3.867	0.0001
Model 3	MAINDIS	-4.17E+06	1.44E+06	-2.890	0.0039
		7.44E+08	6.62E+08	1.125	0.2605
	SUBDIS	-7.86E+06	4.25E+06	-1.849	0.0645
		2.16E+09	5.55E+09	0.390	0.6965
	SDSUBDIS	-8.70E+06	2.17E+06	-3.999	0.0001
		5.19E+09	1.14E+09	4.534	0.0000
	UNITVAL	-5.46E+08	5.23E+07	-10.445	0.0000
		8.72E+12	9.94E+11	8.772	0.0000
	ELDERLY	4.28	1.35	3.180	0.0015
		0.00	0.00	-6.002	0.0000
	FAMILY	-11.61	0.99	-11.782	0.0000
		0.00	0.00	9.509	0.0000
	HANDICAPPED	19.62	17.07	1.149	0.2504
		-0.09	0.12	-0.763	0.4452
Model 4	MAINDIS	-6.07E+06	1.48E+06	-4.117	0.0000
		1.33E+09	6.65E+08	1.990	0.0457
	SUBDIS	-1.13E+07	4.39E+08	-2.573	0.0101
		7.35E+08	5.60E+09	1.312	0.1894
	SDSUBDIS	-7.09E+06	2.21E+06	-3.217	0.0013
		4.14E+09	1.18E+09	3.519	0.0040
	UNITVAL	-5.22E+08	5.68E+07	-9.200	0.0000
		7.87E+12	1.08E+12	7.252	0.0000
	S8NCR	-24.09	2.53	-9.520	0.0000
		0.03	0.00	7.193	0.0000
	S8EV	-1.96	2.19	-0.894	0.3711
		0.00	0.00	0.337	0.7360
	S202	-4.34	4.63	-0.936	0.3493
		-0.03	0.01	-2.496	0.0126
	S236	4.43	1.83	2.415	0.0157
		-0.01	0.00	-3.572	0.0004
	S221D	-18.30	23.58	-0.776	0.4376
		0.54	0.41	1.326	0.1848
	BMIR	-47.61	15.03	-3.167	0.0015
		0.37	0.09	4.158	0.0000
	PUBH	5.47	1.35	4.043	0.0001
		0.00	0.00	-4.818	0.0000

Some terms are expressed in scientific notation to conserve space, i.e., -1.06E+08 means -1.06×10^8.

FIGURE 4.1

FIRST ORDER EFFECT OF AN ADDITIONAL SUBSIDIZED HOUSING PROJECT WITHIN EACH RADIUS

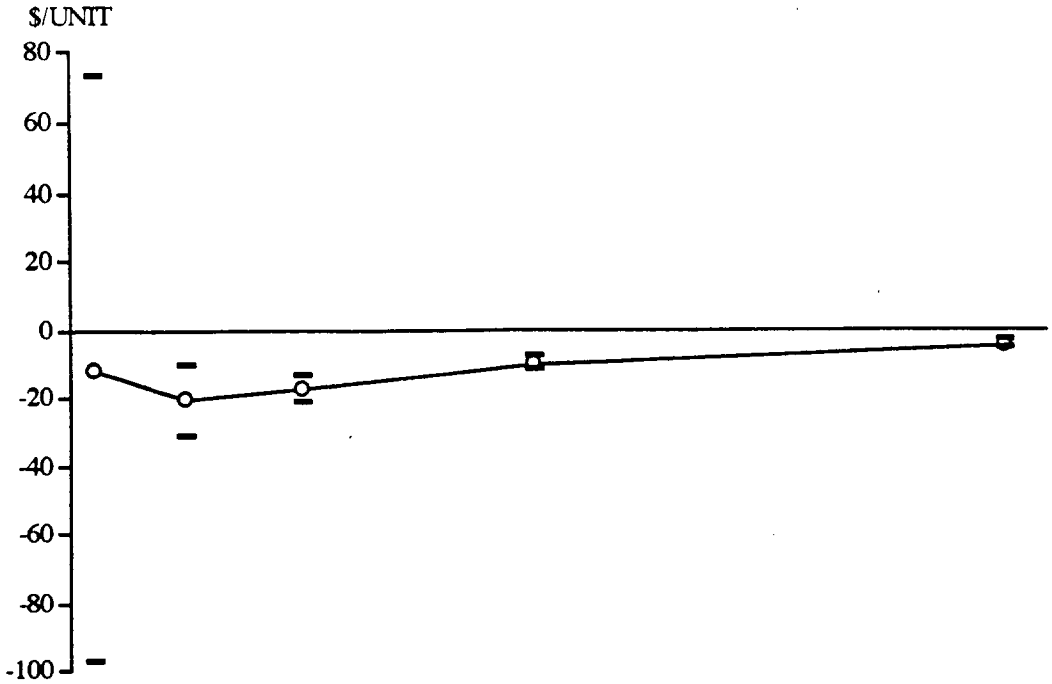


(A)	300 ft	1/4 mi	1/2 mi	1 mi	2 mi
(B)	1492	-1585	-1398	-938	-609
(C)	8959	566	195	92	54
(D)	0.5%	13%	40%	79%	97%
(E)	1.02	1.32	1.89	4.02	12.56

Heavy bars indicate 95% confidence interval around each estimate. The five lines at bottom of graph indicate: (A) the radius around each house; (B) the first order coefficient on NLOCS ; (C) the standard error of the coefficient; (D) the percentage of the total sample of 26,503 housing units which has subsidized projects within each radius; and (E) the average number of subsidized projects which fall within each radius.

FIGURE 4.2

FIRST ORDER EFFECT OF ADDING ANOTHER SUBSIDIZED UNIT WITHIN EACH RADIUS



(A)	300 ft	1/4 mi	1/2 mi	1 mi	2 mi
(B)	-12.08	-20.91	-17.41	-10.06	-4.56
(C)	43.48	5.48	2.04	0.92	0.57
(D)	0.5%	13%	40%	79%	97%
(E)	94	175	233	433	1242

Heavy bars indicate 95% confidence interval around each estimate. The five lines at bottom of graph indicate: (A) the radius around each house; (B) the first order coefficient on NSUNITS; (C) the standard error of the coefficient; (D) the percentage of the total sample of 26,503 housing units which has subsidized units within each radius; and (E) the average number of subsidized units which fall within each radius.

Nothing is very significant at the 300 foot radius. Even those variables most highly significant at the other radii (the presence variables NLOCS and NSUNITS) are insignificant at 300 feet. One explanation for this result is the comparatively small number of houses which have subsidized housing within 300 feet: only 123 out of 25,603 houses in the total sample. The quarter mile radius contains 3,437 affected houses; the half mile has 10,483; the one mile has 20,955; and the two mile has 25,557. The variance in the independent variables may be insufficient at the 300 foot radius to find any interesting results. Future research may want to broaden this small radius, however, no such test was done in this research.

The presence variables for models one and two are significant, negative and follow the expected pattern from a quarter to two miles. These two models provide a clearer pattern of effects than in the more complex models. Figures 6.1 and 6.2 plot the first order effect of adding another subsidized housing project and another subsidized unit, respectively, to a neighborhood. It is interesting that the second order effects on NLOCS do not become particularly statistically significant until beyond the half mile radius, and then are positive and diminishing. Within half a mile, the first order effects capture most of the variation in prices due to the presence of subsidized housing projects. After a half mile, the second order effects, while getting smaller, become increasingly significant predictors of housing value. The pattern of second order effects on NSUNITS is similar, but is statistically significant at the $p=.05$ level starting from a quarter mile. These results lend support to the diminishing marginal disutility postulate discussed in chapter three.

The coefficients on NSUNITS range from about -$21 per unit at a quarter mile to -$5 per unit at two miles. Using the quarter mile estimate, this is roughly equivalent in value to about half a square foot of living space (according to Table 4.2). The NLOCS coefficients range from -$1585 at a quarter mile to -$609 at two miles. Using the quarter mile estimate again, this is comparable to about 37 square feet of living space or a third of a fireplace. From the standpoint of hedonic theory, the second model, using number of subsidized units (NSUNITS), is preferable over the first model, which uses number of subsidized projects (NLOCS). Unit changes are more easily described as "marginal" than changes in the number of housing projects. However, from a policy outlook, NLOCS is a more interesting variable, since the NIMBY phenomenon arises most frequently when new projects are planned for neighborhoods, not simply when the size of existing projects change.

The spatial variables, MAINDIS, SUBDIS, and SDSUBDIS, while statistically significant in many cases from a quarter mile to two miles, are too small in magnitude to reveal any discernible pattern. Since the values reported in tables 4.4 through 4.8 are coefficients on the inverted variables, these estimates must be inverted and then adjusted according to equation 3.6. As discussed in chapter 3, the resulting estimates are only numerically significant at 10 or more decimal places. In dollar terms these effects are minuscule.

Two inferences can be made with regard to these variables, then. That MAINDIS has no real effect implies that variation due to distance is already controlled for by the definition of appropriate radii. Distance to subsidized housing is important, as is shown by the diminishing pattern on the presence variables. However, the particular design of these regression models, where each regression implicitly controls for distance by its reference to a particular radius, apparently makes the direct inclusion of distance measures redundant.

A major concern for communities deciding how to locate subsidized housing is the spacing of that housing within the neighborhood. SUBDIS and SDSUBDIS, which describe how subsidized units are arrayed within each radius, have no appreciable dollar effect on property values.

UNITVAL, which is intended to measure quality of subsidized housing, is also negligible in all cases. Again, the coefficients presented in tables 4.4 through 4.8 are for the inverted values. Reinverting them according to equation 3.6, however, makes them very small quantities. This indicates either that quality differentials are not important determinants of any effects which subsidized housing has on nearby properties or that per unit value is a poor indicator of housing quality. Unfortunately, the extensive list of structural variables available for residential housing units used in this research was not also available for the subsidized housing. Future research could use principal components analysis to generate a "quality" factor score for this set of variables using such data if it becomes available.

The tenant type variables from model three do not paint a particularly clear picture, either. Some pattern seems to exist for the number of family and handicapped unit variables FAMILY and SPECIAL. This effect is negative and declining from a half mile to two miles for family units and from a half mile to one mile for handicapped units. The size of the FAMILY coefficients are comparable to those on NSUNITS. However, the handicapped coefficients are quite a bit larger at a half mile and one mile. This may be an artifact of the small number of handicapped projects included in the sample (only 5).

The elderly units variable, ELDERLY, is statistically significant from a half mile to two miles, but fluctuates in sign and is rather small in any event, ranging from -$5 to $10. Therefore, these results provide very weak support to the hypothesis that people prefer elderly to family subsidized housing. This inference is conditional because the patterns for these two variables are not well defined across the quarter mile to two mile radii as for NSUNITS and NLOCS.

The subsidy type variables reveal a number of patterns. First, neither Section 8 Existing/Voucher, Section 236, nor BMIR, appear to have any significant pattern at any radius. Public housing shows positive significant first order effects at a quarter mile and half mile of close to $20. However, this pattern breaks down beyond a half mile.

Section 202 units show a significant, negative and diminishing effect from -\$199 at a quarter mile to -\$37 at one mile, however, again the pattern breaks down at two miles. Given that 202 units are all for elderly people, these results conflict somewhat with the non-pattern shown in the ELDERLY variable from model three.

An interesting pattern is that of the coefficients on the Section 221(d)(3) variable, S221D, which are of quite large magnitude (from about \$900 at a quarter mile to \$520 at one mile), significantly positive and diminishing from a quarter to one mile. Section 221(d) is not actually a subsidized program, but offers mortgage insurance and risk allowances to investors to build multifamily projects. It often has been used as the financing vehicle for Section 8 New Construction and Rehabilitation projects. There are only a handful of such projects in the county, and therefore this pattern may be affected by other factors coincident with these locations.

The pattern on the Section 8 New Construction and Rehabilitation variable, S8NCR, is unclear. With the exception of the half mile radius, S8NCR exhibits a significant, negative and diminishing pattern from -\$50 at a quarter mile to -\$24 at two miles. Neither the magnitude nor significance at a half mile (-\$10, sig=0.32) is consistent with this larger pattern. The Section 8 Existing/Voucher variable (S8EV) shows no particular pattern over the five radii nor are any of the estimates statistically significant at a level less than p=0.31.

AN IMPORTANT CAVEAT

Caution should be exercised in interpreting these results. Even assuming that all of the conditions that underlie the hedonic model are met, these functions are only accurate for *very small changes* in the amount of subsidized housing. For this reason, model two is preferable to the others, since NSUNITS is of an appropriate scale to measure "marginal" changes. Even with this model, however, care should be exercised in making statements concerning the welfare implications of subsidized housing policy changes. For instance, the following conclusion *is* reasonable: from a welfare standpoint, adding a *few* subsidized units into a neighborhood will require compensation of about \$20 for each property owner who falls within a quarter mile of the new units. This result comes from taking the partial derivative of the hedonic with respect to NSUNITS:

$$\frac{\partial P_{1/4mile}}{\partial NSUNITS} = -20.91 + 0.06 NSUNITS \tag{4.1}$$

However, it is inappropriate to argue that if 1000 units are added, property owners should *pay* close to \$40 (-20.91 + 0.06 x 1000) for the privilege.

This logic is readily apparent when comparing the estimates for NSUNITS and NLOCS. The coefficient on NLOCS is *not* simply the average number of units per project times the coefficient on NSUNITS. At a quarter mile, for instance, the average number of subsidized units surrounding a property is 175 and the average number of housing projects is 1.32. Thus the average size of a housing project in the quarter mile radius is about 133 units. Yet, 133 units per project times -$20.91 per unit is equal to -$2781, which is almost twice the actual estimated coefficient on NLOCS at a quarter mile, -$1585. This is the primary disadvantage of hedonic models. Extrapolation of the results for marginal changes in variables to a scale most policy considers can lead to quite large errors in welfare measurements.

These hedonic results do indicate, however, the importance of scale in making policy decisions on subsidized housing. Since an additional unit lowers property values by only $21, while the addition of a whole project has a negative effect close to $1600, housing policies which promote choice in location for subsidized renters, such as the Section 8 Existing/Voucher program, may be more acceptable to property owners. As discussed in chapter three, these programs are at least somewhat more successful in dispersing subsidized housing throughout an area than programs which tie subsidies to particular projects. The lack of any discernible negative effect on the Section 8 Existing/Voucher variable shown in Tables 4.4 through 4.8 supports this conclusion.

SINGLE MULTI-FAMILY AND URBAN-SUBURBAN EFFECTS

An interesting question involves how these results might vary if subsamples from the large set of 26,503 houses were drawn. For instance, it might be interesting to know if urban and suburban houses are affected differently by nearby subsidized units. A second interesting question is whether single family and multifamily dwellings are differentially affected. While recomputing all twenty regressions for each such subsample would add unnecessary complexity to the current research, four further regressions were done with model two at the quarter mile radius for urban, suburban, single family and multifamily subsamples. The results for the number of subsidized units variable, NSUNITS, are given in table 4.9.

TABLE 4.9

FIRST AND SECOND ORDER COEFFICIENTS ON NSUNITS
AT QUARTER MILE RADIUS FOR FOUR SUBSAMPLES

Subsample	R^2	N	BETA	SE	T	SIG
Urban	.827	14450	-8.32	5.57	-1.493	0.1355
			-0.003	0.017	-0.165	0.8688
Suburban	.741	12053	-28.28	10.98	-2.576	0.0100
			0.05	0.03	1.513	0.1302
Single Family	.801	23491	-21.62	6.20	-3.487	0.0005
			0.03	0.02	1.568	0.1170
Multi-family	.770	3012	-16.31	8.59	-1.900	0.0576
			0.04	0.02	1.762	0.0781

These results indicate that single family dwellings are slightly more affected than multifamily houses by subsidized units within a quarter mile. However, this difference is quite small. There does appear to be a significant difference between the effects on suburban and urban homes. The first order effect for suburban homes is 35 percent larger in the negative direction than for all houses in the pooled sample. The first order effect of adding subsidized units within a quarter mile radius of urban houses is less than a third of the pooled effect, and is significant only at the $p=.14$ level, compared to $p=.0001$ level for the pooled sample.

These results indicate that suburban homes are probably more adversely affected by new subsidized housing units than urban houses. This result may derive from the difference in the value of homes in the city and in the suburbs. The mean housing value in the urban subsample was only $71,693, compared to $102,115 for the suburbs. One reasonable inference from these statistics is that the greater the relative difference in value between subsidized units and non-subsidized units the greater the negative effect of the presence of subsidized units.

Chapter 5: Conclusions

WHAT DOES IT ALL MEAN?

Given the sea of results presented in the last chapter, what useful conclusions can be drawn concerning the effect of subsidized housing on neighboring property values? There is a small, statistically significant negative effect associated with the presence of subsidized housing units in a neighborhood, which follows the expected diminishing pattern with larger radii. It is important to stress, however, what "small" means. At the radius where the effect is most pronounced (a quarter mile) people value marginal reductions in the number of subsidized housing units around them at about half of what they value marginal increases in finished living square footage in their houses. In rough terms, adding one subsidized unit within a quarter mile radius of a house has the same dollar impact on that house's value as removing half a square foot of its living space. This small effect may be more pronounced in the suburbs, where the average value of residential properties is higher. Further, adding an entire project within a quarter mile radius of a house has an effect equivalent to removing roughly 37 square feet of living space from the house — a much less negligible figure for many homeowners.[14] From these results, one could conclude that policies which promote dispersal of subsidized renters are less likely to inflame community fears than those which tie subsidies to particular locations.

How confident can we be in these findings? The method used in this research ameliorates some of the limitations of previous work on this topic, namely small sample size and unclear theoretical basis, which should increase confidence in these results. This study develops a firm theoretical foundation upon which to build hypotheses concerning the relationship between subsidized housing and property values. From the standpoint of Lancastrian utility theory, if subsidized housing affects property values, this should be reflected, indirectly, by the behavior of economic agents in the housing market. This indirect effect can be measured by using an hedonic technique. An hedonic price function reveals how housing values vary with a set of housing attributes, some of which are measures of the relationship between a house and nearby subsidized units. In this study, sixteen such attributes were developed describing the presence and quality as well as the spatial, tenant and subsidy type distributions of subsidized housing in relation to *each* residential property in the sample. On this theoretical basis, regression techniques were used to test the hypothesis that these variables have no significant effect on property values.

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[14]The average number of square feet of living space for houses with subsidized projects within a quarter mile is 1402 (see Table A.4). Thus this effect is roughly equivalent to losing 2.6 percent of living space.

Regression analysis was used not only to estimate the parameters of the hedonic price function, but also to control for a number of important determinants of housing value in order to effectively isolate the effect of subsidized housing. Most studies done previously on this topic have compared price trends in neighborhoods *with* subsidized housing and similar neighborhoods *without* such housing. These studies all suffer from the inherent difficulty of finding comparable test and control areas. The regression models used for this research include close to 50 variables which help to control for structural and locational differences between residential properties. Most importantly, the regressions include a variety of important neighborhood level socioeconomic variables, such as educational level, median family income, racial distribution, and percent of single parent female headed households. An important concern early in this paper was how to overcome the causality dilemma: does subsidized housing lower neighboring property values or is it simply historically located in poor neighborhoods? By including appropriate socioeconomic measures, regression analysis can (at least, partially) remove variation in housing values due to poor neighborhood conditions. These measures do not account for all such variation. Future research could develop better measures, especially by developing more geographically specific neighborhood variables. However, the combination of a firm basis in utility theory, a well established statistical method, a large number of significant structural and locational variables, a large sample size, a reasonable set of hypotheses concerning the relationship between subsidized housing and property values, and the fact that neither the estimates for the presence variables nor the upper bounds of the confidence intervals around them reach above zero (except at the 300 foot radius) lends credence to the conclusions drawn above.

What the hedonic method has not been able to fully reveal is *why* subsidized housing has this negative effect. It does not appear to be strongly related to the spatial, tenant or subsidy type distributions of subsidized housing within a neighborhood. Nor is the quality (as measured by per unit value) of the subsidized housing particularly correlated with nearby property values. While the differential between the effect of marginal changes in units and marginal changes in projects suggest that housing policies should focus on options which improve choice and thus increase the dispersal of subsidized renters throughout a community, such a conclusion is hardly shocking. The fact that only the presence of subsidized housing is statistically significant begs the question already asked in chapter one: what is it about subsidized housing that causes people to fear for their property values?

DIRECTIONS FOR FUTURE RESEARCH

A number of variables have been left out of this analysis that may be important determinants of property value (such as neighborhood crime rates, employment measures, a variety of environmental amenities and disamenities). To answer the why question, however, the most useful place to start is to investigate the significance of race and class differences between subsidized renters and property owners. As in most previous studies, this research measured such distinctions with only the bluntest of instruments — census tract level variables. Much more detailed measures of race and class differentials may begin to uncover why this small negative effect exists.

In addition, no information regarding *when* a housing project entered a neighborhood was included in this analysis. Because this study only considered subsidized housing already in place, no distinction could be made between housing values in neighborhoods slated for new projects and those with long established subsidized units. Since neighborhood concern with subsidized housing is usually expressed *prior* to its construction, a methodology more sensitive to timing would provide an interesting comparison to the present study.

APPENDIX

DESCRIPTIVE STATISTICS ON VARIABLES USED IN THE REGRESSIONS

The following tables provide descriptive statistics on the variables entered into the regression equations. Tables A.1 and A.2 list statistics for the entire sample of 26,503 housing units. Tables A.3 to A.8 give similar statistics for each subsample of affected houses within each radius. An "affected" house is one which has subsidized housing within a given radius, from 300 feet to two miles, as described in chapter five.

TABLE A.1
DESCRIPTIVE STATISTICS ON THE DEPENDENT VARIABLE AND THE CONTINUOUS STRUCTURAL AND LOCATIONAL ATTRIBUTES

VARIABLE	MEAN	SD	MIN	MAX
VALUE	85528.25	44125.06	4700	1914400
LOTAREA	11755.02	28078.20	600	3022110
LIVRMS	7.63	2.17	0	39
BEDRMS	3.05	0.99	0	25
BATHRMS	1.43	0.59	0	13.25
LIVAREA	1438.69	611.28	0	13629
FIREPL	0.49	0.70	0	9
GARGAREA	370.48	216.99	0	1792
POOLAREA	9.62	77.60	0	1326
DECKAREA	35.28	96.47	0	1584
AGE	47.21	28.73	1	141
OSPAREA	31.75	75.16	0	1200
EPAREA	44.09	81.76	0	1095
MEDFAMIN	23368.10	7072.14	0	53979
PHSGRAD	30.71	8.90	0	44
PCOLGRAD	8.35	5.09	0	23
PWHITE	93.66	14.86	0	100
PBLACK	2.22	8.84	0	82
PSPAN	1.67	3.34	0	44
PUNDER21	33.81	8.45	0	49
POVER65	11.08	6.53	0	37
PSPFFAM	7.71	5.77	0	51
POWNOCC	74.94	16.95	0	100
MRENT	242.73	74.80	0	407
TTWORK	17.65	3.75	0	24
PBELOWPO	6.46	5.54	0	46

Number of Observations: 26,503.

TABLE A.2

FREQUENCIES FOR DUMMY STRUCTURAL AND LOCATIONAL ATTRIBUTES

VARIABLE	D=1	PERCENT	LABEL
GTATTACH	2143	8.1%	Garage in basement or attached
GTDETACH	14165	53.4%	Garage detached
CENTAIR	7443	28.1%	Has central air
HOMESTD	24326	91.8%	Homesteaded (not rented)
EWBRSTON	800	3.0%	Exterior wall is brick or stone
EWMETAL	5090	19.2%	Exterior wall is metal
EWSTUCCO	6872	25.9%	Exterior wall is stucco
EWOTHRNW	2251	8.5%	Exterior wall is other not wood
HTNOTFA	3916	14.8%	Located on corner
LOCCORN	4041	15.2%	Heating system not forced air
PTNOT1FM	3012	11.4%	Not single family dwelling
SDNEWBR	145	0.5%	New Brighton school district
SDSHOREV	4257	16.1%	Shoreview school district
SDMAPLEW	2137	8.1%	Maplewood school district
SDROSEV	2841	10.7%	Roseville school district
SDWBLAKE	2723	10.3%	White Bear Lake school district
TOPHILLY	2874	10.8%	Hilly topography
RIVER	29	0.1%	On Mississippi River
LAKE	532	2.0%	Has access/view of lake
ZONMF	6937	26.2%	Area zoned for multifamily dwellings

Number of observations: 26,503. Frequencies in column 2 indicate the number of cases where the associated dummy variable takes on the value 1.

TABLE A.3
DESCRIPTIVE STATISTICS FOR DEPENDENT VARIABLE,
CONTINUOUS STRUCTURAL AND LOCATIONAL ATTRIBUTES, AND SUBSIDIZED HOUSING
VARIABLES FOR AFFECTED HOUSES WITHIN 300 FOOT RADIUS (N=123)

VARIABLE	MEAN	SD	MIN	MAX
VALUE	64626.02	18758.77	7400.00	125700.00
LOTAREA	7150.72	5066.03	1260.00	36656.00
LIVRMS	7.93	2.66	5.00	19.00
BEDRMS	3.18	1.24	1.00	7.00
BATHRMS	1.42	0.54	0.50	3.50
LIVAREA	1421.48	603.69	660.00	3653.00
FIREPL	0.24	0.50	0.00	2.00
GARGAREA	301.64	220.88	0.00	832.00
POOLAREA	5.41	60.05	0.00	666.00
DECKAREA	22.91	61.84	0.00	360.00
AGE	62.15	34.71	5.00	121.00
OSPAREA	56.94	103.60	0.00	448.00
EPAREA	54.11	91.36	0.00	416.00
MEDFAMIN	18719.42	5318.59	8398.00	33634.00
PHSGRAD	30.93	8.21	15.00	43.00
PCOLGRAD	6.56	4.29	1.00	23.00
PWHITE	78.79	28.92	11.00	99.00
PBLACK	15.11	26.04	0.00	82.00
PSPAN	2.11	1.55	0.00	8.00
PUNDER21	35.01	8.25	19.00	49.00
POVER65	14.17	8.56	2.00	37.00
PSPFFAM	15.96	9.83	1.00	51.00
POWNOCC	68.37	9.52	52.00	95.00
MRENT	213.83	42.05	96.00	407.00
TTWORK	17.88	2.20	14.00	21.00
PBELOWPO	14.24	9.16	1.00	46.00
NLOCS	1.02	0.13	1.00	2.00
NSUNITS	93.91	76.30	11.00	459.00
UNITVAL	37453.00	15240.00	11013.00	74227.00
MAINDIS	173.00	85.87	9.00	300.00
SUBDIS	8.00	60.63	0.00	531.00
SDSUBDIS	0.00	0.00	0.00	0.00
ELDERLY	55.28	78.65	0.00	249.00
FAMILY	37.22	52.90	0.00	459.00
SPECIAL	1.41	9.58	0.00	103.00
S8NCR	18.93	32.84	0.00	172.00
S8EV	16.49	47.98	0.00	459.00
S202	3.82	16.28	0.00	124.00
S236	13.35	32.71	0.00	168.00
S221D	0.24	2.61	0.00	29.00
BMIR	0.89	3.02	0.00	11.00
PUBH	40.20	71.39	0.00	219.00

Statistics for UNITVAL, MAINDIS, SUBDIS, and SDSUBDIS are based on original, uninverted values.

TABLE A.4
DESCRIPTIVE STATISTICS FOR DEPENDENT VARIABLE,
CONTINUOUS STRUCTURAL AND LOCATIONAL ATTRIBUTES, AND SUBSIDIZED HOUSING
VARIABLES FOR AFFECTED HOUSES WITHIN QUARTER MILE RADIUS (N=3,437)

VARIABLE	MEAN	SD	MIN	MAX
VALUE	68536.08	33376.98	6500.00	617600.00
LOTAREA	8483.95	14775.94	784.00	675000.00
LIVRMS	7.81	2.66	3.00	32.00
BEDRMS	3.07	1.16	1.00	12.00
BATHRMS	1.41	0.65	0.00	13.25
LIVAREA	1401.85	661.30	384.00	9458.00
FIREPL	0.29	0.66	0.00	9.00
GARGAREA	326.40	218.08	0.00	1721.00
POOLAREA	4.22	49.76	0.00	840.00
DECKAREA	19.50	69.71	0.00	1207.00
AGE	59.28	31.69	1.00	131.00
OSPAREA	35.87	83.96	0.00	800.00
EPAREA	54.75	88.36	0.00	936.00
MEDFAMIN	20669.11	5393.46	0.00	33788.00
PHSGRAD	33.19	7.24	0.00	43.00
PCOLGRAD	6.43	4.84	0.00	23.00
PWHITE	88.69	19.76	0.00	100.00
PBLACK	6.38	17.30	0.00	82.00
PSPAN	3.25	6.44	0.00	44.00
PUNDER21	34.62	6.99	0.00	49.00
POVER65	13.46	6.52	0.00	37.00
PSPFFAM	11.96	8.10	0.00	51.00
POWNOCC	71.94	11.01	0.00	95.00
MRENT	223.58	50.03	0.00	407.00
TTWORK	18.34	2.57	0.00	24.00
PBELOWPO	10.68	7.68	0.00	46.00
NLOCS	1.32	0.70	1.00	6.00
NSUNITS	175.25	100.70	10.00	573.00
UNITVAL	45606.00	22516.86	11457.00	131503.00
MAINDIS	604.00	373.29	4.00	1320.00
SUBDIS	237.00	501.07	0.00	2171.00
SDSUBDIS	29.00	121.66	0.00	1373.00
ELDERLY	82.08	98.03	0.00	371.00
FAMILY	87.23	97.71	0.00	554.00
SPECIAL	5.94	21.85	0.00	103.00
S8NCR	33.95	54.80	0.00	238.00
S8EV	41.96	76.45	0.00	554.00
S202	11.96	32.64	0.00	124.00
S236	27.18	67.20	0.00	433.00
S221D	2.41	8.93	0.00	44.00
BMIR	2.05	11.36	0.00	165.00
PUBH	55.75	88.70	0.00	430.00

Statistics for UNITVAL, MAINDIS, SUBDIS, and SDSUBDIS are based on original, uninverted values.

TABLE A.5
DESCRIPTIVE STATISTICS FOR DEPENDENT VARIABLE,
CONTINUOUS STRUCTURAL AND LOCATIONAL ATTRIBUTES, AND SUBSIDIZED HOUSING
VARIABLES FOR AFFECTED HOUSES WITHIN HALF MILE RADIUS (N=10,483)

VARIABLE	MEAN	SD	MIN	MAX
VALUE	72540.44	31840.95	4700.00	617600.00
LOTAREA	8954.74	12108.31	660.00	675000.00
LIVRMS	7.64	2.32	0.00	32.00
BEDRMS	3.04	1.04	0.00	12.00
BATHRMS	1.38	0.57	0.00	13.25
LIVAREA	1379.99	583.89	384.00	9458.00
FIREPL	0.36	0.65	0.00	9.00
GARGAREA	341.10	210.91	0.00	1792.00
POOLAREA	5.53	58.38	0.00	1134.00
DECKAREA	21.05	70.65	0.00	1207.00
AGE	55.88	29.48	1.00	141.00
OSPAREA	33.58	79.08	0.00	936.00
EPAREA	52.95	87.17	0.00	1095.00
MEDFAMIN	21743.43	5847.35	0.00	33788.00
PHSGRAD	32.64	7.83	0.00	43.00
PCOLGRAD	7.09	5.02	0.00	23.00
PWHITE	91.48	16.43	0.00	100.00
PBLACK	4.35	13.57	0.00	82.00
PSPAN	2.46	4.53	0.00	44.00
PUNDER21	33.92	7.37	0.00	49.00
POVER65	12.86	6.31	0.00	37.00
PSPFFAM	9.85	7.19	0.00	51.00
POWNOCC	73.46	13.21	0.00	95.00
MRENT	231.29	53.95	0.00	407.00
TTWORK	18.11	3.04	0.00	24.00
PBELOWPO	8.73	6.94	0.00	46.00
NLOCS	1.89	1.56	1.00	15.00
NSUNITS	232.65	156.42	7.00	1225.00
UNITVAL	41356.00	20857.47	11013.00	229790.00
MAINDIS	1336.00	728.66	4.00	2640.00
SUBDIS	851.00	1180.16	0.00	4990.00
SDSUBDIS	211.00	469.18	0.00	2730.00
ELDERLY	90.64	98.26	0.00	616.00
FAMILY	137.59	148.31	0.00	816.00
SPECIAL	4.43	19.05	0.00	103.00
S8NCR	36.44	58.30	0.00	252.00
S8EV	50.40	79.65	0.00	554.00
S202	11.64	32.49	0.00	160.00
S236	55.40	121.78	0.00	774.00
S221D	3.06	10.17	0.00	44.00
BMIR	3.86	17.91	0.00	165.00
PUBH	71.86	103.98	0.00	622.00

Statistics for UNITVAL, MAINDIS, SUBDIS, and SDSUBDIS are based on original, uninverted values.

TABLE A.6
DESCRIPTIVE STATISTICS FOR DEPENDENT VARIABLE,
CONTINUOUS STRUCTURAL AND LOCATIONAL ATTRIBUTES, AND SUBSIDIZED HOUSING
VARIABLES FOR AFFECTED HOUSES WITHIN ONE MILE RADIUS (N=20,955)

VARIABLE	MEAN	SD	MIN	MAX
VALUE	79522.34	35839.81	4700.00	848500.00
LOTAREA	10124.81	26262.02	660.00	3022110.00
LIVRMS	7.61	2.19	0.00	39.00
BEDRMS	3.05	1.01	0.00	25.00
BATHRMS	1.39	0.56	0.00	13.25
LIVAREA	1403.04	581.76	0.00	12456.00
FIREPL	0.44	0.68	0.00	9.00
GARGAREA	357.18	208.75	0.00	1792.00
POOLAREA	7.77	68.49	0.00	1134.00
DECKAREA	27.03	84.39	0.00	1584.00
AGE	51.60	28.32	1.00	141.00
OSPAREA	31.82	75.59	0.00	1200.00
EPAREA	48.65	84.17	0.00	1095.00
MEDFAMIN	22573.63	6407.28	0.00	53979.00
PHSGRAD	31.19	8.75	0.00	44.00
PCOLGRAD	8.04	5.21	0.00	23.00
PWHITE	93.60	14.04	0.00	100.00
PBLACK	2.66	9.87	0.00	82.00
PSPAN	1.91	3.69	0.00	44.00
PUNDER21	33.43	8.43	0.00	49.00
POVER65	12.00	6.49	0.00	37.00
PSPFFAM	8.22	6.24	0.00	51.00
POWNOCC	73.40	16.05	0.00	100.00
MRENT	235.38	61.80	0.00	407.00
TTWORK	17.59	3.71	0.00	24.00
PBELOWPO	7.18	5.93	0.00	46.00
NLOCS	4.02	4.05	1.00	27.00
NSUNITS	432.94	348.86	7.00	2592.00
UNITVAL	39344.00	26243.02	11013.00	414186.00
MAINDIS	3017.00	1252.29	19.00	5279.00
SUBDIS	2802.00	2289.17	0.00	10266.00
SDSUBDIS	1126.00	1163.72	0.00	5123.00
ELDERLY	153.03	182.84	0.00	1315.00
FAMILY	273.08	240.06	0.00	1241.00
SPECIAL	6.83	23.11	0.00	139.00
S8NCR	60.74	75.88	0.00	466.00
S8EV	92.12	117.23	0.00	595.00
S202	23.08	46.51	0.00	253.00
S236	106.22	192.46	0.00	937.00
S221D	4.46	11.99	0.00	80.00
BMIR	9.00	31.28	0.00	176.00
PUBH	137.31	180.75	0.00	1438.00

Statistics for UNITVAL, MAINDIS, SUBDIS, and SDSUBDIS are based on original, uninverted values.

TABLE A.7
DESCRIPTIVE STATISTICS FOR DEPENDENT VARIABLE,
CONTINUOUS STRUCTURAL AND LOCATIONAL ATTRIBUTES, AND SUBSIDIZED HOUSING
VARIABLES FOR AFFECTED HOUSES WITHIN TWO MILE RADIUS (N=25,577)

VARIABLE	MEAN	SD	MIN	MAX
VALUE	83532.38	41377.77	4700.00	1914400.00
LOTAREA	11180.69	26890.01	600.00	3022110.00
LIVRMS	7.61	2.17	0.00	39.00
BEDRMS	3.05	0.99	0.00	25.00
BATHRMS	1.42	0.58	0.00	13.25
LIVAREA	1423.48	596.89	0.00	13629.00
FIREPL	0.47	0.70	0.00	9.00
GARGAREA	366.79	214.10	0.00	1792.00
POOLAREA	9.15	75.19	0.00	1326.00
DECKAREA	33.16	92.98	0.00	1584.00
AGE	48.34	28.40	1.00	141.00
OSPAREA	31.34	74.76	0.00	1200.00
EPAREA	44.82	82.07	0.00	1095.00
MEDFAMIN	23147.06	6604.62	0.00	53979.00
PHSGRAD	30.96	8.72	0.00	44.00
PCOLGRAD	8.30	5.08	0.00	23.00
PWHITE	93.83	14.15	0.00	100.00
PBLACK	2.29	8.98	0.00	82.00
PSPAN	1.72	3.38	0.00	44.00
PUNDER21	33.75	8.30	0.00	49.00
POVER65	11.35	6.47	0.00	37.00
PSPFFAM	7.83	5.81	0.00	51.00
POWNOCC	74.52	16.19	0.00	100.00
MRENT	241.07	67.72	0.00	407.00
TTWORK	17.64	3.64	0.00	24.00
PBELOWPO	6.62	5.57	0.00	46.00
NLOCS	12.56	11.12	1.00	50.00
NSUNITS	1242.47	1005.79	29.00	4874.00
UNITVAL	33855.00	25698.74	19557.00	250473.00
MAINDIS	6281.00	1944.93	183.00	10531.00
SUBDIS	7481.00	3054.83	0.00	20222.00
SDSUBDIS	3718.00	1807.04	0.00	9542.00
ELDERLY	467.01	510.02	0.00	2265.00
FAMILY	753.83	518.09	0.00	2798.00
SPECIAL	21.63	43.84	0.00	161.00
S8NCR	171.57	166.48	0.00	890.00
S8EV	251.33	214.29	0.00	1322.00
S202	74.45	99.89	0.00	555.00
S236	270.61	335.62	0.00	1567.00
S221D	11.86	19.28	0.00	101.00
BMIR	29.66	56.53	0.00	210.00
PUBH	433.00	528.82	0.00	2212.00

Statistics for UNITVAL, MAINDIS, SUBDIS, and SDSUBDIS are based on original, uninverted values.

TABLE A.8
FREQUENCIES FOR STRUCTURAL AND LOCATIONAL DUMMIES FOR AFFECTED HOUSES AT EACH RADIUS

	300 ft		1/4 mile		1/2 mile		1 mile		2 miles	
	(n=123)		(n=3437)		(n=10483)		(n=20955)		(n=25577)	
Variable	D=1	%	D=1	%	D=1	%	D=1	%	D=1	%
GTATTACH	5	4.1%	164	4.8%	584	5.6%	1446	6.9%	2001	7.8%
GTDETACH	70	56.9%	2099	61.1%	6338	60.5%	12285	58.6%	14057	55.0%
CENTAIR	23	18.7%	657	19.1%	2264	21.6%	5195	24.8%	6912	27.0%
HOMESTD	98	79.7%	2956	86.0%	9269	88.4%	19035	90.8%	23429	91.6%
EWBRSTON	2	1.6%	116	3.4%	365	3.5%	708	3.4%	787	3.1%
EWMETAL	19	15.4%	704	20.5%	2235	21.3%	4168	19.9%	4967	19.4%
EWSTUCCO	36	29.3%	859	25.0%	2794	26.7%	5790	27.6%	6801	26.6%
EWOTHRNW	16	13.0%	522	15.2%	1277	12.2%	2042	9.7%	2245	8.8%
HTNOTFA	27	22.0%	683	19.9%	1906	18.2%	3426	16.3%	3870	15.1%
LOCCORN	17	13.8%	525	15.3%	1615	15.4%	3243	15.5%	3903	15.3%
PTNOT1FM	35	28.5%	655	19.1%	1489	14.2%	2445	11.7%	2873	11.2%
SDNEWBR	0	0.0%	0	0.0%	0	0.0%	51	0.2%	145	0.6%
SDSHOREV	3	2.4%	138	4.0%	672	6.4%	2012	9.6%	3494	13.7%
SDMAPLEW	10	8.1%	293	8.5%	859	8.2%	1839	8.8%	2110	8.2%
SDROSEV	5	4.1%	189	5.5%	1017	9.7%	2259	10.8%	2830	11.1%
SDWBLAKE	4	3.3%	234	6.8%	783	7.5%	1817	8.7%	2648	10.4%
TOPHILLY	10	8.1%	268	7.8%	817	7.8%	1928	9.2%	2646	10.3%
RIVER	0	0.0%	0	0.0%	0	0.0%	16	0.1%	24	0.1%
LAKE	1	0.8%	7	0.2%	59	0.6%	255	1.2%	477	1.9%
ZONMF	73	59.3%	1473	42.9%	3493	33.3%	5685	27.1%	6536	25.6%

The second row of the table indicates in parenthesis the number of cases out of the total sample (26,503) which have subsidized housing within the associated radius. 'D=1' columns contain the frequencies of cases where the associated dummy variable takes on the value of 1.

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