# THE INFLUENCE OF PUBLIC SERVICE EXPENDITURES ON HOUSING VALUES AND RENTS: AN INTERURBAN APPROACH

by

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# ABSTRACT

Although a wealth of research within the field of urban and regional economics focuses on intraurban variation in housing prices and rents, comparatively less research has been done on their variation at the interurban level – especially with respect to public services. This research attempts to fill this gap in the literature through the investigation of four questions: Do public service expenditures help to explain interurban variation in housing prices and rents? What types of spending make the most difference? How does their effect on housing values compare to their effect on rents? And do these effects change through time? Using an econometric analysis of housing prices and rents in a national data set of metropolitan counties, this research provides substantial evidence linking public goods and services to the place-to-place variations in the cost of living – suggesting that public policy may be used to directly influence the relative attractiveness of regions.

# 1. INTRODUCTION

Over the past five years, the metropolitan areas that have experienced the most dramatic increase in housing costs have largely been located along the east and west coasts. For example, the median cost of housing has risen approximately 50 percent in parts of Florida, nearly 60 percent in New York City and its suburbs, and a staggering 123 percent in Orange County, California. In fact, only two cities on the interior – Phoenix and Las Vegas – are currently experiencing housing price growth rates comparable to those on the coasts (Razzi, 2003). What all of these places have in common is that they are each rich in cultural and/or natural amenities – factors that contribute substantially to an area's quality of life and, thus, induce people to bid up the price of housing where located. Yet, what role, if any, does the quality of public services play in these trends? Do differences in public service provision across metropolitan areas also lead to perceptible changes in residents' quality of life and, in turn, the cost of housing?

The purpose of this research is to further explore this hypothesis through an investigation of four interrelated questions: Do public service expenditures, as a proxy for service quality, help to explain interurban variation in housing prices and rents? What types of spending make the most difference? How does their effect on housing values compare to their effect on rents? And, finally, do these effects change through time? These research questions stem from a significant gap in the present state of knowledge about the influence public goods and services have on housing markets at an interurban

level. That is, previous research has focused a great deal on *intra*urban variation in housing prices and rents; mostly through hedonic price models, researchers have found that various structural characteristics, neighborhood attributes, as well as non-market goods such as natural amenities and public services have all been shown to significantly affect housing costs at this level. However, comparatively less research has been done on *inter*urban variation in housing prices and rents – especially with respect to public services. While there is extensive empirical evidence that natural amenities have a substantive influence on migration flows and that compensating differentials account for interurban housing price and wage differences, very little is known about the role of public services. This omission is of practical importance because, unlike a particular region's inherent endowment of natural amenities, public services can be directly influenced by public policy to enhance regional well-being.

This research investigates the four guiding questions through a review of relevant literature and an econometric analysis involving a national data set of metropolitan counties. First, the literature review explains the concept of capitalization, focusing on the role of public services, and reviews the previous research on migration, household welfare, and compensating differentials. Second, the methods employed to examine how different types of public services affect interurban variation in housing values and rents are addressed. Specifically, this entails the estimation of a system of simultaneous equations using three-stage least squares in order to account for endogeneity between the two dependent variables – median housing values and rents. This model, which contains an aggregate measure of public service spending, is then used to develop coefficients that

are restricted in subsequent models, so that alternative service expenditures and different time lags may be tested while holding all else constant. This research design enables precise observation of how thirteen individual public service expenditures – capital facilities, education, fire protection, housing and community development, libraries, natural resources, parks, police protection, roadways, other transportation, sewerage, trash collection, and welfare – affect housing values and rents and provides evidence of how their influence changes through time. Finally, the results of the empirical analysis will be presented and used to derive a set of public policy recommendations and directions for future research.

The improvement and sustainability of regional growth, quality of life, and economic vitality are all of primary concern to public leaders and policy makers across the country. It is hoped that by extending the discussion and, in turn, the pool of knowledge concerning interurban variation in the cost of housing to include public services, these public actors will not only have more concrete evidence on which to base future decisions, but also the ability to play a more involved role in shaping their community's well-being.

# 2. LITERATURE REVIEW

## *2.1 Public Goods*

Education, police and fire protection, city streets and highways, sewer systems, parks, and libraries are all examples of local public goods and services that governments may provide for their citizens. Local public goods are those goods that have unique characteristics that make them either inefficient or impractical for a private market to supply (Lee, 1981). These characteristics are threefold. First, a local public good is one that is nonrivalrous in consumption – meaning that one person's enjoyment of the good does not detract from anyone else's enjoyment of that good. For example, a parade can be viewed by many without any diminution of enjoyment caused by an additional viewer. This is referred to as a pure local public good. Some public goods can become congested, however, such as roads during rush-hour traffic. In this case, the benefit provided by the road decreases as more drivers enter onto it and is thus known as an impure or semirivalrous public good (O'Sullivan, 2003).

The second characteristic of a local public good is that it is nonexcludable. This means that it is either inefficient or impractical to prevent anyone who does not pay for the good from using it. For example, parks are a public good that many people have access to but do not necessarily pay for and although it is possible to charge entrance fees to parkgoers and install fences to exclude those who do not pay, the expense of doing so could be prohibitively costly. Fire protection, on the other hand, is an example of a local public good that would be relatively easy to exclude based on the ability to pay for

services rendered. However, such a system of user charges is typically not implemented because, given the potential for fires to have negative externalities on neighboring land, most jurisdictions find it more efficient to cover all residents (O'Sullivan, 2003).

Finally, the third characteristic of a local public good is that it benefits only a relatively small area. For example, some public goods such as national defense and television signals benefit the entire nation and therefore cannot be called "local" public goods. However, roadways and libraries can serve as examples of local public goods because they typically provide the majority of their benefits to local citizens that use them (O'Sullivan, 2003).

Given the characteristics that define public goods and services, government bodies can more efficiently and practically deliver public goods than private markets can for a number of reasons. First, because public goods are both politically and practically difficult to charge for, private companies would suffer from the fact that many consumers are able to take advantage of not having to pay for them. Second, the provision of many public goods and services is simply not profitable for private companies because of the large up-front costs associated with their establishment as well as the inability to charge consumers for the average cost of the good, as opposed to its marginal cost. Lastly, private companies cannot provide public goods as efficiently as governments can because the former are not able to internalize externalities, such as the enforcement of merit goods, while the latter are. A merit good, such as education, is a good that citizens – if left to their own devices – might not consume as much of as would be beneficial to the larger public and it is for this reason that public schools require their students to stay until

they become sixteen years old. Educated citizens, therefore, have positive externalities, yet these broader benefits would not be taken into consideration if the decision as to how much education to consume were simply based on private costs and benefits (Lee, 1981; O'Sullivan, 2003).

Local governments have a number of funding mechanisms at their disposal in order to pay for the provision of public goods and services. These include the use of intergovernmental grants, public/private ventures, debt financing, and pay-as-you-go financing. Pay-as-you-go financing includes the levying of taxes; the implementation of user charges, negotiated exactions and impact fees; the establishment of special districts or special assessment districts; and, most importantly, the use of property taxes – which represents one of the largest sources of revenue available to local governments (O'Sullivan, 2003). Because these funding mechanisms depend on the amount that local citizens wish to pay, it is they who ultimately determine both the quantity and quality of public goods and services that are provided. The result typically follows the median voter (or median-home-value voter) rule; that is, the expenditure chosen will be the one preferred by that household whose median housing value splits the remainder of home values in a community into two equal halves (Fischel, 2001). This occurs because preferences for any expenditure lower (higher) than the median voter's will be outnumbered by those with higher (lower) preferences.

In order to avoid having to pay for public goods and services at a rate higher or lower than preferred, households often sort themselves into relatively homogenous communities based on their demands for public goods (O'Sullivan, 2003). This idea was

first put forth by Charles Tiebout (1956) in a now-famous model of public choice, which equates people's locational decisions within large, politically fragmented metropolitan areas to a shopping trip, where they select among numerous jurisdictions offering different combinations of public services. In this way, people "vote with their feet" – maximizing their utility, subject to a budgetary constraint, by locating in communities offering the best combination of benefits for the lowest possible price. Here, the price involved is the cost of purchasing a home or paying rent and, particularly for homeowners, the ongoing cost of paying the property tax[1]. In equilibrium, the system will have sorted households into communities based on their virtually identical preferences for public goods and, thus, the decision made by the median voter will reflect the demands of all other voters. As such, the Tiebout model allows citizens to avoid the inefficiencies arising from governments catering to a constituency with diverse demands (O'Sullivan, 2003).

### *2.2 The Capitalization of Public Services*

One of the basic assumptions of Tiebout's model is that an optimum community size exists because public goods and services can become congested and, in turn, devalued. As such, jurisdictions below the optimal size will seek growth, while those at or above the optimal size will resist growth (Tiebout, 1956). This growth is controlled through zoning regulations and other land-use controls, which restrict the supply of

[1] Renters do not generally pay for property taxes because they are difficult for landlords to pass on; instead high property taxes work to reduce the supply of rental housing (Rothenberg et al., 1991; DiPasquale and Wheaton, 1996).

developable land within a community. Because of this inelasticity, the benefits provided by public goods and services are not freely accessible and the costs of providing them are not commonly felt. This generates what is known as capitalization: the process by which the fully discounted stream of future benefits and costs that are expected to accrue to a given property are reflected in its value (Fischel, 2001). For example, it is well known that, other things being equal, buyers and renters alike expect to pay a premium for housing located in high quality school districts. A casual reading of the real estate section of nearly any local newspaper bears this out, with owners commonly advertising such benefits as a partial justification for the asking sales price or rent. Thus, highly valued amenities or services are positively capitalized into housing. On the other hand, property taxes are negatively capitalized because they raise the cost of holding a house through time and, in doing so, lower the amount that people, including landlords, are willing to pay for it (Rothenberg et al., 1991).

Location is particularly important to the process of capitalization because of spatial variation in the availability of various amenities. In the case of natural features, such as views or microclimates, quality is affected by topography, the character of the surrounding built environment, and numerous other factors. Likewise, benefits related to public services vary across space, as exemplified by the Tiebout model. What emerges is an underlying price landscape that reflects how housing values and rents differ from place to place based on the level of utility (disutility) people receive from location-specific amenities (disamenities), some of which are controlled by local governments. In other words, within real estate markets there exists a residual relative price above and

beyond the value of property itself, a significant part of which is attributable to public service expenditures.

Wallace Oates' 1969 study was the first to provide substantive evidence that homebuyers are aware of fiscal and public service differences between communities and, thus, that capitalization indeed takes place (Fischel, 2001). This seminal paper was based on an empirical study of fifty-three residential communities in highly fragmented northern New Jersey. Oates found that property values had a significant and negative correlation with a community's property tax rate, but a significant and positive correlation with its educational expenditure per pupil – a measure of service levels. In addition, he concluded that if a public service is efficiently provided, its benefits would roughly offset the cost effects of the property tax via capitalization (Oates, 1969). To this day, Oates' findings remain one of the most powerful examples of the strength of the Tiebout Hypothesis (Fischel, 2001).

More recently, researchers have refined the theory of capitalization by examining the role it plays in local public finance and by developing further empirical evidence that it takes place. Specifically, capitalization has been shown to arise as a result of movers bidding up the price of housing with desirable attributes – including natural amenities and tax-service packages; in long-run equilibrium, movers prefer to leave these tax-service combinations exactly as they are (Yinger, 1982). At the same time, the median voter rule ensures that homeowners, who represent the most politically active block of residents (DiPasquale and Glaeser, 1999), exert tremendous political pressure on their local government leaders to act in ways that will be positively capitalized into their property

values as well as refrain from actions that will result in the lowering of their property values. Homeowners tend to be more vocal in community matters, as opposed to renters, because renters have no real investment in their housing, whereas a homeowner's property is typically the largest single asset that they will own and therefore one of the most important sources for future returns and/or borrowing available to them. Consequently, homeowners have a substantially greater interest in protecting their homes from risks that could decrease their attractiveness to potential future buyers (Fischel, 2001). Thus, by viewing these two processes together, it can be seen that capitalization provides homeowners with an incentive to vote for levels of public spending that not only reflects their own preferences, but also those of prospective buyers (Brueckner and Joo, 1991). By voting, people work to ensure that their communities provide public services in a way that maximizes both the use and exchange values of their homes.

Hedonic price models are by far the most common method of measuring the effects of capitalization on the exchange value of housing. A hedonic price model uses multiple regression analysis to estimate an equation that considers the market price for housing or rent to be a function of the levels of each observable characteristic of the house (DiPasquale and Wheaton, 1996). For example, using variations on this general framework, numerous recent studies illustrate that the quality of public school systems has a significant effect on residential property values.

One such study was conducted by Haurin and Brasington (1996), which examined influences on the price of housing within metropolitan statistical areas using 1991 housing transaction data for the six largest Ohio MSAs. The authors tested two variants

of the random coefficients model: the first regressed the natural log of housing transaction prices on a vector of structural and land characteristics and a variable controlling for possible interaction between lot size and community characteristics, while the second contained the same form as the first, yet with the variable for lot size extracted from the equation. The community variables tested include property tax rates, accessibility measures, and amenity attributes such as arts and recreation opportunities. However, the variable of interest was the pass rate of ninth grade proficiency exams – a measure of public school outputs. Estimating each equation with generalized least squares (GLS), Haurin and Brasington found that such measures of school quality were the most important cause of constant-quality house price variation within MSAs; with each one percent increase in the pass rate on exams, house prices increased by one-half percent. In addition, capitalization of school quality differences was found to occur independently of lot size, affecting all lots within a jurisdiction equally (Haurin and Brasington, 1996).

A pair of articles by Bogart and Cromwell (1997, 2000) looks at the effects of public school districts on housing values within several Cleveland MSA communities. The first of these examined data on houses that sold between 1976 and 1994 in three separate areas, where the school district boundaries did not coincide with municipal boundaries. The logic behind this approach is that, because public services are delivered by overlapping jurisdictions, the effects of the public schools could be isolated from those of other public services and thus any difference in selling price between houses within the same community must be attributed to the quality of the school districts. Separate

regressions were estimated for each area in which the difference in mean house value was decomposed into a portion due to differences in observable characteristics (such as physical attributes and neighborhood quality) and a portion due to differences in unobservable characteristics (public services). Differences in the value of school districts were considered under a variety of assumptions about the degree of tax and service capitalization. The findings show that, regardless of the assumptions, high-quality school districts provided greater benefits to homeowners than the costs of the higher taxes they required. Also, Bogart and Cromwell found significant variation in housing value across the three areas – ranging between $186 and $2,171 annually, depending on the quality of the school districts (1997).

The second article by Bogart and Cromwell (2000) examined the effect of a 1987 school redistricting on housing values within Shaker Heights, Ohio – a suburb of Cleveland. It was expected that redistricting would have a negative impact on housing values because of what was called the "neighborhood schools effect", which implies that school quality would be reduced as a result of parents being less able to become involved and students being less able to participate in after-school activities on account of the increased distance. In order to measure this, Bogart and Cromwell estimated a difference-in-difference hedonic price equation, using data from house sales in the community between 1983 and 1994. This equation included house prices as the dependent variable and school, neighborhood, and physical characteristics as the independent variables. In addition, a dummy variable was included to capture the "neighborhood schools effect", which controlled for the possible interaction between

redistricting and house sales after this event. The findings suggest that disruption as a result of redistricting, all else being equal, had the effect of reducing sales prices by nearly ten percent – or $5,738 on average (Bogart and Cromwell, 2000).

Downes and Zabel (2002) examined the impact of school characteristics on housing prices in Chicago between 1987 and 1991. Data were collected from the American Housing Survey, the 1980 and 1990 Decennial Censuses, and the Illinois School Report Cards to define house values and owner, structural, neighborhood, and school characteristics. Three separate models were estimated: the first, a standard log-linear model using house value as the dependent variable and the observed characteristics as the independent variables; the second, a first-difference model; and the third, a value-added model that includes test scores taken by the same cohort at different grade levels. Downes and Zabel's major finding was that homeowners were more concerned with schools' final outputs (i.e., test scores) than spending, an input. Specifically, they found that a one percent increase in mean standardized test scores led to a one percent increase in house values, on average (Downes and Zabel, 2002).

Furthermore, it has been found that, within regions, the capitalization of school quality is stronger in smaller communities. This theory was first proposed by Hoyt (1999), who showed that, because larger communities have a significant share of the total metropolitan area's population, a change in tax or service levels has a small impact on their housing prices. This is due to the fact that a portion of the costs or benefits can be "passed on" to other communities as residents relocate and increase housing prices there. Conversely, full capitalization occurs in smaller jurisdictions because changes in

population here have relatively little impact on the rest of the metropolitan area. As such, larger cities tend to have inefficiently high taxes and lower public service levels because the costs to residents in these cities are not fully felt, whereas smaller communities have greater incentive to avoid such inefficiencies (Hoyt, 1999).

Brasington (2001) provided the first study to test Hoyt's theory empirically. Brasington collected data based on 1991 housing sales in Ohio's six largest MSAs. He then employed a hedonic price model that regressed housing prices as a function of structural and neighborhood characteristics, as well as an interaction term composed of a variable measuring the community's share of total MSA population and various tax and public service level variables. This interaction variable was included to test Hoyt's theory and was estimated using both school districts and municipal borders as representative of a community's size. Ultimately, Brasington found that although there was no strong relationship between tax capitalization and the size of a community, school quality and other measures of public service levels were indeed capitalized more strongly in small communities – supporting Hoyt's model (Brasington, 2001).

Finally, Brasington (2002) also found that, within regions, the capitalization of school quality is stronger closer to the central business district than towards the edge of metropolitan areas. This is because housing supply is more inelastic towards the interior of metropolises, which means that competition will insure that any increase in the demand for housing there will be sharply capitalized into the price of housing. On the other hand, there is greater housing supply elasticity towards the edge of metropolises and therefore capitalization will be less because developers are better able to respond to

demand changes. Brasington tested this idea by, again, using 1991 housing sales data in Ohio MSAs that were split into "interior" and "edge" communities. Separate OLS and GLS regressions were ran for the "interior" and "edge" samples, which contained housing prices as the dependent variable and housing, community, and tax and service level characteristics as the independent variables. Both methods revealed that capitalization of public services indeed occurs throughout a metropolitan area, but that school quality is capitalized into housing prices near the CBD twice as strongly as it is capitalized into edge communities (Brasington, 2002).

These and other studies clearly illustrate that the capitalization of public services has a measurable effect on real estate markets at the intraurban scale, but the question remains: How do service expenditures affect *interurban* variation in housing prices and rents?

### *2.3 Household Welfare and Compensating Differentials*

Just as amenities are positively capitalized into property markets at the intraurban scale, they positively affect household welfare at the interurban scale. An observable outcome of this is that, other things being equal, people are willing to pay more for housing and accept lower wages to live in attractive places; conversely, people pay less for housing and demand higher wages in areas offering a comparatively lower quality of life (Mulligan et al., 2003). This behavior is owed to compensating differentials – factors that enhance the utility that people receive from living in a given area and, therefore, raise the level of costs they are willing to incur and/or wages they are willing to forgo to

stay there. Just like housing, places can be viewed as a package deal, comprised of different combinations of desirable and undesirable characteristics, all of which affect the cost of living in them (Rosen, 1979). In the same way that cities exhibit an underlying price landscape attributable to location-specific amenities, so too do wider geographical areas – all the way up to the national and even international levels.

Porell (1982) and Graves (1983) advanced early empirical evidence of this in analyses demonstrating that quality of life factors have a significant influence on interurban migration flows. For example, Porell's study examined migration flows between 25 metropolitan areas over the period 1965-1970 and found that quality of life measures were responsible for inducing over three times the amount of inmigration to San Diego than to Pittsburgh during that time (Porell, 1982). In addition, Graves used rents as a proxy for amenity levels in a regression measuring inmigration among 137 metropolitan areas between 1960-1970 and found that rents (or, amenities) are one of the dominant determinants of net migration flows (Graves, 1983). These and subsequent studies suggest that the effect of location-specific amenities is so strong that migration models specified without them may suffer from omitted variable bias (Knaap and Graves, 1989).

A vast body of research has added even more to our understanding of the influence amenities have on interregional migration. One such study, conducted by Kahn (2000), examined the impact that improvements in air quality have had on population growth in the Los Angeles suburbs. To test this, Kahn first regressed population growth from 1969 to 1980 and from 1980 to 1994 on the log of 1969 county population for each

of 58 California counties. This revealed that Riverside and San Bernadino counties – whose smog reduction under the Clean Air Act were among the highest – experienced significantly sharp population growth between 1980 and 1994 in comparison to both the Los Angeles region and the previous time period. Next, Kahn sought to explain this growth by regressing it on a vector of economic controls and a variable indicating the number of "high ozone days" in each county. The results showed that reduced ozone levels have a significantly positive effect on population growth; a decrease in "high ozone days" by ten caused a county's population to grow by 7.8 percent more than an unimproved county (Kahn, 2000).

Articles by Deller et al. (2001) and Colwell et al. (2002) reveal the effect that recreational opportunities have on people's locational choice. For example, Deller et al. posit that, as the United States becomes increasingly urbanized, features that are typically characteristic of rural areas – such as open space and natural amenities – become more valuable. To test this, partial adjustment models were estimated using data collected for 2,243 non-metropolitan counties between 1985 and 1995. The dependent variables were population, employment, and income growth rates, while the independent variables included market, labor, government, and amenity factors. The major finding of this study was that all five categories of amenity variables (consisting of climate, land, water, winter recreation, and developed recreational infrastructure) consistently had a strong, positive effect on rural population growth during this time, as well as on employment and income growth to a lesser degree (Deller et al., 2001). Similarly, Colwell et al. (2002) examined a competitive location equilibrium, where both employment and recreation are location-

specific and, thus, utility is maximized by trading-off between the two. As shown by Deller et al., this study also finds that recreational amenities are a strong population pull; when trips to a recreation site increase, the distance between the site and the workplace decrease, and as the costs of recreation increase, people will increasingly migrate to residences closer to the recreation location (Colwell et al., 2002).

Lastly, climate has also been shown to exhibit a strong impact on interregional migration flows. For example, Glaeser and Shapiro (2003) examined the population growth rates of a number of cities and MSAs in the 1980s and 1990s in order to determine whether the increased migration to large, dense cities in the 1990s was simply an anomaly or indicative of shifting trends. The trends that had characterized urban growth throughout the twentieth century were that people preferred locations with strong human capital, automobile dominated transportation systems, and warm and dry climates. Using measures of each of these trends, for density, and for other basic controls as independent variables and population growth as the dependent variable, regressions were estimated which revealed that migration trends in the 1990s reinforced previous trends more than they signified a drastic change. An important outcome of this is that desirable weather – especially July temperatures – continued to have an enormous impact on the movement of people in the 1990s; during this period, a ten degree increase in July temperature led to a 6.5 percent higher growth rate (Glaeser and Shapiro, 2003).

In addition to influencing where people choose to live, quality of life factors measurably affect wages and housing prices across cities. In a groundbreaking theoretical and empirical analysis, Roback (1982) found that preferences for amenities

are reflected in both wage and rent levels; disamenities, including crime, heat, snow, pollution, and poor weather, lead to higher wages and lower rents. However, the extent to which wages and rents are influenced depends not only on consumer demand, but also on the effect that the quality of life factors have on firms' production. That is, wages will be lowered and the change in rents will be uncertain when an amenity is unproductive because the firm will not value it as highly as its workers, while when an amenity is productive, rents will rise and the change in wages will be uncertain (Roback, 1982). Likewise, Henderson's (1982) examination of compensating variation in wages across cities revealed that amenities (disamenities) are negatively (positively) capitalized into wages – an effect that is robust across three alternative measures of the dependent variable and among different occupations. For example, it is shown that a one standard-deviation rise in the murder rate increases wages by 2.5 percent, whereas a similar increase in sunshine leads to a 2.9 percent decrease in wages (Henderson, 1982).

Further research has reinforced this theory that compensating differentials mediate the place-to-place cost of living. For example, Cragg and Kahn (1999) conducted a study in which four climatic variables were estimated as functions of earnings and rents in the lower 48 states for the years 1960, 1970, 1980 and 1990. The four variables representing climate included average February and July temperatures and the percentage of days with sunshine and humidity. The findings revealed that not only had the consumption of milder climate increased over the thirty-year period, but at the same time, the capitalization of climate into rents was rising while the capitalization of climate into wages was falling. For instance, an increase in February temperature by one

standard deviation in 1960 was shown to lower earnings by 3.1 percent and rents by 10 percent. However, the same increase in 1990 had the effect of raising rents by 7.3 percent, yet no longer had a significant influence on wages (Cragg and Kahn, 1999).

Also, a pair of articles by Hoehn et al. (1987) and Blomquist et al. (1988) illustrate that climatic as well as urban and environmental characteristics all affect wages and rents. The authors estimated a set of hedonic equations that regressed annual earnings and monthly housing costs in 1980 on a host of amenity and non-amenity control variables for over 200 urban areas. The amenity variables included six measures of climatic conditions; urban data on school quality, crime, and central city status; as well as environmental variables such as measures of air quality, water quality, and toxic substances. The results indicated that these amenities create significant differences in interregional housing prices and wages; for example, it was shown that households were willing to pay approximately 17 dollars in lost wages and increased rents for a ten percent decrease in toxic substances. Furthermore, constructing quality of life indexes from these amenity values revealed that the least desirable area is compensated at over 5,000 dollars more per year than the most desirable area (Hoehn et al., 1987; Blomquist et al., 1988). Together, these and other related studies demonstrate that, in addition to influencing where people choose to live, amenities act as compensating differentials by shaping the financial tradeoffs they face in their decision-making processes.

Finally, public services have also been demonstrated to act as compensating differentials. In a study by Gyourko and Tracy (1991), Roback's (1982) model was expanded to include local fiscal conditions in an estimation of wages and housing prices.

Specifically, local fiscal conditions included property tax rates as well as output measures of police, fire, health, and education services. These variables, along with controls on worker traits, structural traits, industry, and natural amenities, were estimated for a sample of 130 cities. The results showed that differences in the locally produced amenities indeed lowered wages and increased rents – with public safety and health services having the largest influences. In addition, the authors found that the cost of paying for these services (via taxes) had an offsetting effect by lowering people's willingness to pay for housing and causing them to demand higher earnings. Finally, it is also shown that fiscal conditions exhibit nearly as large an effect on quality of life as natural amenities do (Gyourko and Tracy, 1991).

Unfortunately, the role of public spending patterns as compensating differentials has not been directly addressed since Gyourko and Tracy first called attention to it over a decade ago. This omission is of significant importance, given the strength of public services' influence. For example, drawing on a national dataset of metropolitan counties (described in the following chapter), Figures 1a and 1b illustrate that per household total direct spending alone may account for as much as 13 percent of the interurban variation in both housing values and rents. This issue is also of practical importance because, whereas natural amenities are fixed for any given region, public services are directly influenced by public policy. Thus, government bodies can manipulate public services in order to have a direct influence on local and regional quality of life.

The evidence presented in this chapter indicates that public spending does indeed matter from an interurban perspective. However, it is still not clear which types of

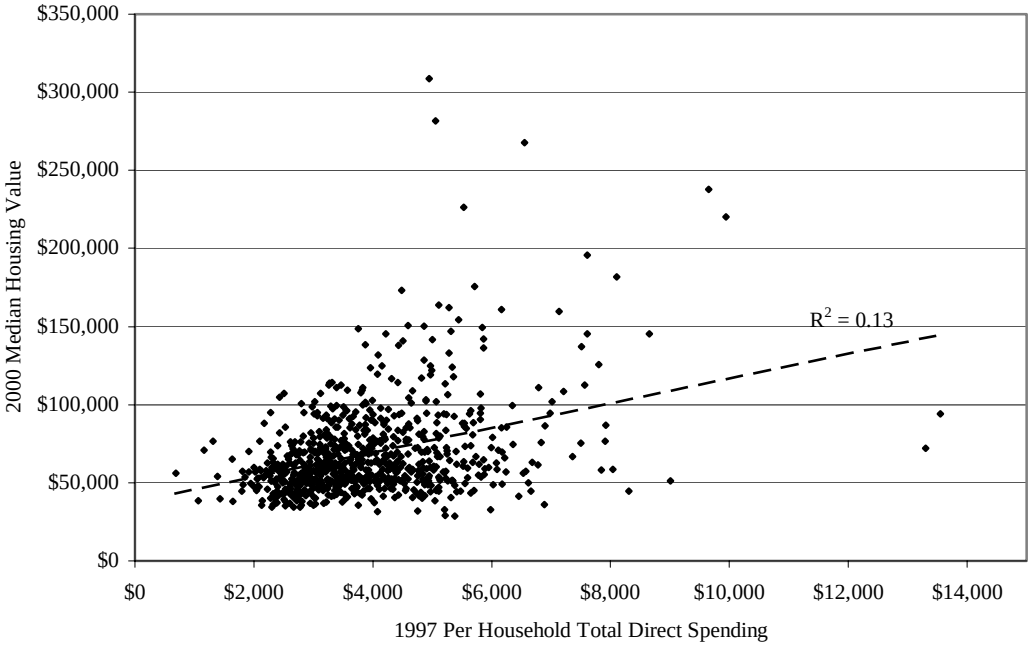


**Figure 1a.** Relationship Between Median Housing Value and Per Household Total Direct Spending

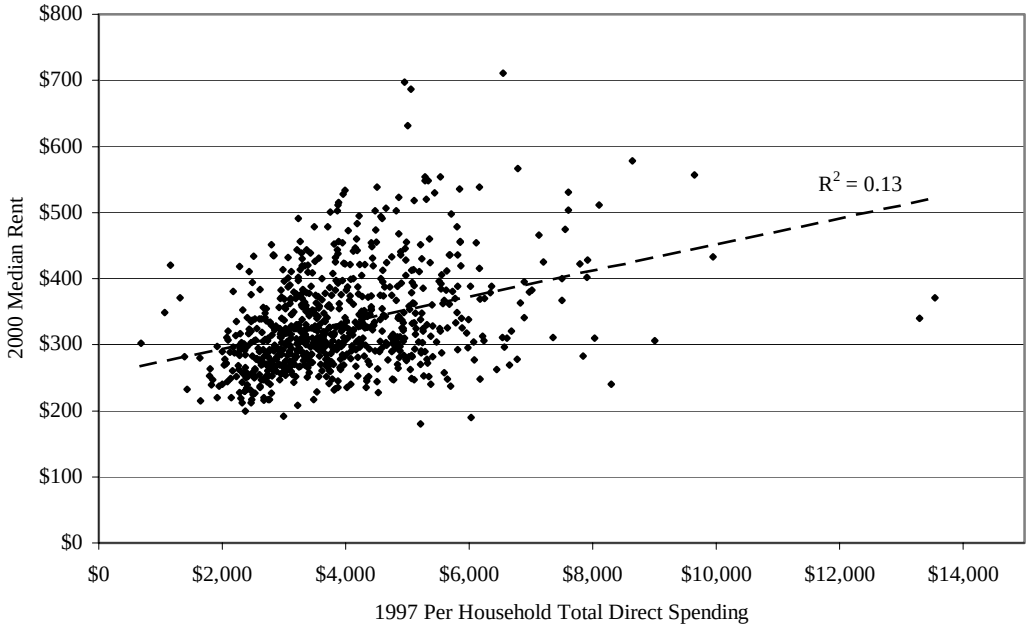


**Figure 1b.** Relationship Between Median Rent and Per Household Total Direct Spending

expenditures make the most difference, how their individual effects differ between ownership and rental markets, and whether or not their influence changes through time. Addressing this gap in the literature will be the focus of the remaining chapters.

# 3. METHODOLOGY

## *3.1 Simultaneous Equations*

To reiterate, the four primary questions my research seeks to answer are: Do public service expenditures help explain interurban variation in housing prices and rents? What types of spending make the most difference? How does their effect on housing values compare to their effect on rents? And, finally, do these effects change through time? In order to answer these questions, I will employ an econometric analysis that uses median housing value and median rent for the year 2000 as the dependent variables. Furthermore, my analysis will explicitly account for the linkages between the renter and homeowner subsectors of the housing market. These subsectors are related in two ways: first, the relative price of owning compared with renting affects how many households will choose to own versus rent and, second, both subsectors contribute to the demand for land in the urban land market which ultimately affects the price of urban land (Ozanne and Thibodeau, 1983).

A number of previous studies examining the sources of variation in metropolitan housing values and rents have applied similar econometric frameworks, but – with the notable exception of Potepan (1996) – none of them have explicitly linked the renter and homeowner subsectors of the housing market. For example, Ozanne and Thibodeau (1983) developed a model of the supply and demand relationships in a metropolitan housing market that is divided into renter and homeowner subsectors. On the demand side such factors as median income, nonhousing prices, population, property taxes and

maintenance costs were included, while construction costs and land prices were included on the supply side. The authors attempted to relate the two subsectors by positing that any change in the demand or supply of either market should affect both markets similarly because of the inelastic supply of land. However, the model does not specifically allow for a price interaction between the two subsectors and is thus estimated using the seemingly unrelated regression (SUR) method. Overall, Ozanne and Thibodeau's findings are mixed; the model was able to explain substantially more of the variation in the rental market than in the homeowner market.

Another study that has examined both the owner-occupied and rental subsectors of the housing market is by Izraeli (1987), who looked at the influence of environmental amenities and disamenities on both earnings and housing markets. Izraeli's housing market model was estimated using both median housing value and median rent as dependent variables, yet it too does not explicitly allow for interaction between the two. The model was estimated using the ordinary least squares (OLS) method and, again, was able to explain considerably more of the variation in the rental market than in the homeowner market.

Potepan (1996), on the other hand, conducted a study in which he explicitly linked the homeowner and renter subsectors of the housing market in order to explain their variation between metropolitan areas. Potepan accounted for these linkages by employing a system of simultaneous equations – where the endogenous variables were

median housing value and rent[2], and the exogenous variables included such factors as median income, population levels and growth, land use constraints, and amenities. The two-stage least squares (2SLS) method was used to estimate the system, which yielded estimates that were able to explain a relatively large proportion of the variation in both the homeowner and renter submarkets. Thus, allowing the models to more accurately reflect the underlying theory of how metropolitan housing markets are structured enhanced empirical findings.

My empirical framework follows the work of Potepan in that I will also use a system of simultaneous equations to explicitly account for the interaction between the owner-occupied and rental subsectors of the housing market. Specifically, a system of simultaneous equations allows an equation to be interrelated with other equations in a model by including endogenous variables as independent variables. For example, because housing values, **H**, and rents, **R**, have been determined to have an interdependent relationship, each would serve as functions of the other plus a host of exogenous explanatory variables, **X**, including public service expenditures, **P**:

$$\begin{aligned} \ln \mathbf{H} &= \alpha_0 + \alpha_1 \mathbf{R} + \alpha_2 \mathbf{P} + \mathbf{X}\alpha_3 + \varepsilon, \\ \ln \mathbf{R} &= \beta_0 + \beta_1 \mathbf{H} + \beta_2 \mathbf{P} + \mathbf{X}\beta_3 + \varepsilon. \end{aligned} \tag{1}$$

However, applying a standard OLS estimator to a system of simultaneous equations will yield biased and inconsistent results. This is because each endogenous variable is affected by any change in either of their disturbance terms, $\varepsilon$, since they are simultaneously determined. In effect, the covariance between the endogenous variables

[2] Potepan also includes an urban land submarket in his analysis, but this is not considered here due to data limitations.

used as regressors, **H** and **R,** and the disturbance term, ε, does not equal zero (nor does the covariance between the disturbance terms in each equation) and thus violates one of the basic assumptions of the classical linear regression model. Put in another way, biased and inconsistent estimates arise because OLS estimates are only intended to show causation in the direction of the independent to the dependent variable, yet endogeneity in the variables means that causation actually runs in both directions. Thus, OLS estimates cannot provide an accurate depiction of the influence each variable has on the dependent variables. Therefore, an alternative estimator is required to correct the problem of simultaneous-equation bias (Kelejian and Oates, 1981; Kennedy, 1998).

A number of different techniques have been developed to account for the problems created by simultaneous equations, yet perhaps the most popular technique is the two-stage least squares (2SLS) method. This technique is appealing because it is a relatively simple method to understand and it does not impose high computational demands on its users. Furthermore, 2SLS relies on instrumental variables as its primary component and thus will always produce consistent estimates of the parameters (Kelejian and Oates, 1981; Kennedy, 1998). As such, before we can begin to understand the 2SLS method, we must first have an understanding of what instrumental variables are.

Instrumental variables are essentially proxy variables that are used as a substitute for a regressor variable that is contemporaneously correlated (that is, has a nonzero covariance) with the disturbance term. In other words, instrumental variables are meant to extract from a system of simultaneous equations those variables that violate the basic assumptions of the classical linear regression model (Kelejian and Oates, 1981). As such,

each independent variable that is contemporaneously correlated with its error term must be assigned its own instrumental variable, which must fit two criteria. First, the variable must be contemporaneously uncorrelated (have a zero variance) with the disturbance term and, second, it must have a high correlation with the regressor for which it is acting as a proxy. The higher this correlation is between the instrumental variable and the regressor, the smaller will be the variance of the estimator (Kennedy, 1998).

The difficulty with using the instrumental variable technique is finding an appropriate instrumental variable for each regressor. However, some common approaches do exist. For example, instruments are often obtained by regressing each endogenous variable acting as a regressor in the equation being estimated on all of the exogenous variables in the system of simultaneous equations. The estimated values for the endogenous variables would then be used as instrumental variables. This approach is usually considered to be superior because the exogenous variables in the system of simultaneous equations have a higher correlation with the endogenous variables than any other combination of exogenous variables. Furthermore, because these variables are exogenous, they fit the criteria of being contemporaneously uncorrelated with the disturbance term (Kennedy, 1998).

Another common selection for an instrumental variable is simply to approximate for the endogenous variable acting as a regressor with its lagged value. For example, housing values, **H**, and rents, **R**, in (1) would be substituted with the instruments $\mathbf{H}_{-t}$ and $\mathbf{R}_{-t}$, respectively, which represent housing values and rents in a previous time period:

$$\mathbf{H} = \gamma_0 + \gamma_1 \mathbf{H}_{-t} + \gamma_2 \mathbf{P} + \mathbf{X}\gamma_3 + \varepsilon,$$
$$\mathbf{R} = \delta_0 + \delta_1 \mathbf{R}_{-t} + \delta_2 \mathbf{P} + \mathbf{X}\delta_3 + \varepsilon. \quad (2)$$

This is typically a suitable instrument because, in most cases, it is highly correlated with the independent variable for which it is acting as a proxy and it is not contemporaneously correlated with the error term since it is a lagged variable (Kennedy, 1998). The major advantage of using lagged values as instruments is its simplicity – both comprehensibly and computationally.

Once an instrumental variable is found and substituted for each exogenous variable acting as a regressor, the first stage of the 2SLS method is complete. Because the system of simultaneous equations is now free of the components that were contemporaneously correlated with the disturbance terms, it no longer violates the assumptions of the classical linear regression model. As such, the system can then be estimated equation by equation using a standard OLS method to arrive at estimates of the coefficients. This completes the 2SLS procedure (Kelejian and Oates, 1981; Kennedy, 1998).

Another technique that has been developed to account for the problems created by simultaneous equations is the three-stage least squares (3SLS) method, which is a counterpart to the 2SLS method. The fundamental difference between the two methods is that 2SLS is a “single equation” method, meaning that each equation in the system of simultaneous equations is estimated separately. Such methods are also referred to as “limited information” methods because – by estimating each equation separately – they only incorporate knowledge of the restrictions in the particular equation being estimated.

3SLS, on the other hand, is a "systems" or "full information" method, meaning that all of the equations in the system are estimated together as a set and, as such, all of the available information in the system is incorporated into the estimates. Because of this, the 3SLS method generally produces more efficient estimates (that is, a smaller variance) than the 2SLS method. However, the disadvantage of using a systems method is that if the system is misspecified, the fact that all equations are estimated simultaneously will mean that the estimates of *all* of the parameters will be biased. This and the method's high computational demands prevent 3SLS from being as popular a method as 2SLS (Kennedy, 1998).

Procedurally, 3SLS differs from 2SLS in the following respects. First, 2SLS estimates are derived for all of the equations in the system. Second, the 2SLS estimates of the equations' error terms are used to construct a contemporaneous variance-covariance matrix of the errors. This matrix is made up of the variance of each of the equations' disturbance terms along the diagonal and the covariance between sets of disturbance terms in the off-diagonal spaces. The construction of this matrix is necessary because it allows one to observe whether or not the disturbances in each equation are correlated with one another. If the matrix shows zeros in the off-diagonal (zero covariance), the equations' disturbance terms are uncorrelated and 3SLS becomes equivalent to 2SLS. If, however, the disturbance terms are found to be contemporaneously correlated (have a non-zero covariance) across equations, another basic assumption of the classical linear regression is violated. As such, the system must be estimated using an alternative estimator to OLS (Kennedy, 1998; Carruthers, 2002).

Therefore, in a final step, the entire system is estimated using the generalized least squares (GLS) method. This technique allows for the contemporaneous correlation across equations by making use of the variance-covariance matrix in its estimation. That is, instead of simply minimizing the sum of squared residuals as in OLS, GLS minimizes a sum of squared residuals that is weighted based on the information contained in the matrix. For example, observations that are expected to have large residuals because either their disturbances are shown to have large residuals or other residuals are large (due to correlation between the error terms) would be compensated by being given smaller weights. In effect, the estimates produced are more efficient than either OLS or, consequently, 2SLS (Kennedy, 1998).

To make these distinctions more clear, Table 1 provides an example of the different results that are obtained from using an OLS, 2SLS or 3SLS method to estimate a system of simultaneous equations. The table shows the effects of the two endogenous variables, median rent and median housing value, as well as the effects of a subset of exogenous variables on housing prices and rents. The most interesting aspect of these results is the large difference between the endogenous variables' t-statistics when employing OLS versus the two simultaneous equations techniques – ranging from 14.51 to approximately 10 for median rent and from 11.81 to approximately 3 for median housing value. It is also clear that although the 2SLS and 3SLS estimates overall all quite similar, the 3SLS estimator does indeed increase the significance level of the estimates.

In light of both the theoretical differences behind OLS, 2SLS and 3SLS and the

**Table 1.** Comparison of Estimators

| | 2000 Median Housing Value | | | | | |
|---|---|---|---|---|---|---|
| | OLS | | 2SLS | | 3SLS | |
| | coefficient | t-statistic | coefficient | t-statistic | coefficient | t-statistic |
| Median Rent | 0.001897 | 14.51 | 0.001607 | 9.89 | 0.00163 | 10.47 |
| Median Number of Rooms | 0.054445 | 2.65 | 0.06722 | 3.19 | 0.0663 | 3.29 |
| % Housing Built Before 1939 | -0.001209 | -1.66 | -0.001658 | -2.22 | -0.00163 | -2.28 |
| Population | 1.55E-08 | 1.94 | 1.58E-08 | 1.96 | 1.57E-08 | 2.04 |
| | 2000 Median Rent | | | | | |
| | OLS | | 2SLS | | 3SLS | |
| | coefficient | t-statistic | coefficient | t-statistic | coefficient | t-statistic |
| Median Housing Value | 2.77E-06 | 11.81 | 1.41E-06 | 3.27 | 1.44E-06 | 3.49 |
| Median Number of Rooms | 0.135441 | 9.31 | 0.140084 | 9.37 | 0.14 | 9.79 |
| % Housing Built Before 1939 | -0.004659 | -9.03 | -0.004741 | -8.98 | -0.00474 | -9.37 |
| Population | 4.06E-09 | 0.69 | 4.68E-09 | 0.77 | 4.66E-09 | 0.81 |
| *n* | 777 | | 777 | | 777 | |

disparate results they each produce, I will estimate the system of simultaneous equations in this research using the 3SLS method. Not only does it produce unbiased and consistent estimates, it also produces more efficient estimates than when using the 2SLS method. However, the most important benefit of using 3SLS for this research stems from its estimation of each equation in the system simultaneously, as opposed to separately like 2SLS. Because shocks to the system will affect both endogenous variables – that is, both housing markets – simultaneously, it acts as a more realistic model of the real world.

### *3.2 Econometric Design*

In total, my econometric analysis addresses the primary research questions through a series of four steps. In the first step, the linkages between the homeowner and renter subsectors of the housing market are accounted for by specifying a system of

simultaneous equations (as discussed in section 3.1), where the dependent values are median housing values and rents in the year 2000:

$$\begin{aligned} \ln \mathbf{H} &= \alpha_0 + \alpha_1 \mathbf{R} + \alpha_2 \mathbf{P} + \mathbf{X}\alpha_3 + \varepsilon, \\ \ln \mathbf{R} &= \beta_0 + \beta_1 \mathbf{H} + \beta_2 \mathbf{P} + \mathbf{X}\beta_3 + \varepsilon. \end{aligned} \tag{3}$$

In these equations, $\alpha_0$, $\alpha_1$, $\alpha_2$, $\beta_0$, $\beta_1$, and $\beta_2$ are parameters; $\alpha_3$ and $\beta_3$ are parameter vectors; **H** is a vector of median housing values; **R** is a vector of median rents; the vector **P** represents per household total direct spending in 1997; **X** is a matrix of exogenous variables; and $\varepsilon \sim N(0, \sigma^2)$ represents the stochastic error term. Using

$$\begin{aligned} \mathbf{H} &= \gamma_0 + \gamma_1 \mathbf{H}_{-t} + \gamma_2 \mathbf{P} + \mathbf{X}\gamma_3 + \varepsilon, \\ \mathbf{R} &= \delta_0 + \delta_1 \mathbf{R}_{-t} + \delta_2 \mathbf{P} + \mathbf{X}\delta_3 + \varepsilon \end{aligned} \tag{4}$$

as instruments, where $\mathbf{H}_{-t}$ and $\mathbf{R}_{-t}$ represent lagged median housing values and rents for 1990, respectively, the system is estimated via 3SLS.

From here, the econometric framework integrates the system of simultaneous equations with a disaggregation of total direct spending, **P**, into various public service expenditures. This is necessary in order to isolate and individually test the effects that different types of public expenditures have on housing values and rents. Therefore, the second step involves disaggregating total direct spending into K types of public expenditures via:

$$\mathbf{P} = \mathbf{P}_k + (\mathbf{P} - \mathbf{P}_k) \;\; \forall \, k = 1, \ldots, K \tag{5}$$

The identity divides per household total direct spending into per household public expenditures of type k, $\mathbf{P}_k$, and all other expenditures, $\mathbf{P} - \mathbf{P}_k$.

In the third step, the disaggregation of the public service expenditures as specified

in equation (5) is integrated with the estimated simultaneous equation model specified in equation (3). That is, by holding the coefficients derived in the first step constant, the effect of each public expenditure type k on median housing values and rents can be estimated individually, while controlling for multicollinearity between the various expenditure types. This is specified as:

$$\begin{aligned} \ln \mathbf{H} &= \hat{\alpha}_0 + \hat{\alpha}_1 \mathbf{R} + \lambda_k \mathbf{P}_k + \pi_k (\mathbf{P} - \mathbf{P}_k) + \mathbf{X}\hat{\alpha}_3 + \varepsilon, \ \forall\, k = 1, \ldots, K \\ \ln \mathbf{R} &= \hat{\beta}_0 + \hat{\beta}_1 \mathbf{H} + \omega_k \mathbf{P}_k + \psi_k (\mathbf{P} - \mathbf{P}_k) + \mathbf{X}\hat{\beta}_3 + \varepsilon, \ \forall\, k = 1, \ldots, K \end{aligned} \tag{6}$$

where $\hat{\alpha}$ and $\hat{\beta}$ denote the estimated parameters from equation (3) and $\lambda_k$ and $\omega_k$ represent the effects of public expenditure of type k on median housing values and rents, respectively[3]. The model is estimated via OLS and, because the models are estimated in semi-log form, elasticities are then calculated to enable easy comparison of the relative influence that each explanatory variable has on the dependent variables.

Finally, model (4) is re-estimated using per household public service expenditures from 1992, as opposed to 1997[4]. Comparing the effects of public expenditures in 1992 versus 1997 allows for observation of the changing effects (that is, short-term and longer-term capitalization) that various types of public expenditures have on the homeowner and renter submarkets through time.

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[3] Note that the estimation does not impose the restrictions $\lambda_k + \pi_k = \alpha_2$ and $\omega_k + \psi_k = \beta_2$. Instead, to check for consistency in the estimations, the sum of the elasticities for $\mathbf{P}_k$ and $(\mathbf{P} - \mathbf{P}_k)$ is compared to the elasticity of **P** derived from model (3).

[4] The time lags are dictated by data availability; the dependent variables come from the U.S. Census, which is collected every ten years, while the public expenditure variables come from the Census of Governments, which collected every five years (the second and seventh year of the decade).

*3.3 Data*

Whereas the majority of the research reviewed in Chapter 2 focuses on individuals or households, the present analysis is concerned with aggregate measures of housing prices. Thus, I use metropolitan counties as the unit of analysis. Relevant data were collected for all 777 metropolitan counties in the continental United States, as well as Washington D.C. (based on 1999 U.S. Census definitions). The only exception is Virginia, which was omitted from the analysis because its unique political structure, which includes numerous independent cities, makes consistent data collection impractical. The dependent variables, median housing values and rents, were collected for the year 2000 from the U.S. Census Bureau. Individual public service expenditures were collected for both 1992 and 1997 and data for a host of other explanatory variables were gathered. These explanatory variables were organized into five groups: *Housing Market Characteristics*, *Demographic Characteristics*, *Economic Characteristics*, *Political Structure and Fiscal Characteristics*, and *State-Based Fixed Effects*. For ease of exposition, Table 2 provides the definition and sources for all variables included in the analysis and Table 3 provides a description of the 13 different public expenditures examined, as defined by the Census of Government surveys used to collect the data. In addition, Table 4 is provided to show the expected relationships between the independent and dependent variables.

The first group of explanatory variables, *Housing Market Characteristics*, is used to control for the variations in housing size, quality and other characteristics between metropolitan areas that influence its price. Included in this category are median housing

**Table 2.** Variable Definitions and Sources

| | *Definition* | *Source* |
|---|---|---|
| *Housing Market Characteristics* | | |
| Median Rent | Median county rent. | United States Census, 2000 (1990 is used for instrumental variables). |
| Median Housing Value | Median county housing value. | United States Census, 2000 (1990 is used for instrumental variables). |
| Median Number of Rooms | Median number of rooms in houses. | United States Census, 2000. |
| % Housing Built Before 1939 | Proportion of housing that was built prior to 1939. | United States Census. 2000. |
| % Owner Occupied | Proportion of housing that is owner occupied. | United States Census, 2000. |
| % Single Family Housing | Proportion of single-family housing. | United States Census, 2000. |
| % Vacant | Proportion of unoccupied housing. | United States Census, 2000. |
| *Demographic Characteristics* | | |
| Population | County population. | United States Census, 2000. |
| Population Change | Population change, 1990 - 2000. | United States Census, 1990 and 2000. |
| Per Capita Income | Income divided by population. | Regional Economic Information System, 1997. |
| % Population >18 Years Old | Proportion of population that is younger than 18 years. | United States Census, 2000. |
| % Black | Proportion of population that is Black. | United States Census, 2000. |
| *Economic Characteristics* | | |
| Cost of Living Index | Relative cost of living. | *Places Rated Almanac*, 1997. |
| Construction Cost Index | Relative cost of construction. | *RS Means Building Construction Cost Data*: 58th Annual Edition, 2000. RS Means Company, Inc.: Kingston, MA. |
| Natural Amenity Index | Natural amenity score | Economic Research Service, 1993. |
| *Political Structure and Fiscal Characteristics* | | |
| Suburban Indicator | 1 if yes, 0 if no. | n/a |
| Per Capita Municipalities | Number of municipal governments divided by population (1000s). | United States Census, 1990 and 2000 and Census of Governments, 1992 and 1997. |
| Property Tax Burden | Per household property tax divided by median housing value. | United States Census, 1990 and 2000, Natural Resources Inventory, and Census of Governments, 1997. |
| Per Household Total Direct Expenditures* | Expenditure divided by estimated number of households. | United States Census, 1990 and 2000 and Census of Governments, 1992 and 1997. |

*Includes all thirteen other measures of public spending.

**Table 3.** Description of Public Expenditure Variables

| | *Variable Description* |
|---|---|
| Per Household Total Direct Expenditures | Sum of direct expenditures, including salaries and wages |
| Per Household Spending on Capital Facilities | Sum of capital outlays, including new construction, and the purchase of equipment, and land and existing structures. |
| Per Household Spending on Education | Expenditures on local schools. |
| Per Household Spending on Fire Protection | Expenditures incurred for fire fighting and fire prevention, including contributions to volunteer fire units. |
| Per Household Spending on Housing and Community Development | Expenditures on urban renewal, slum clearance, and housing projects. |
| Per Household Spending on Libraries | Expenditures on municipal and non-governmental libraries |
| Per Household Spending on Natural Resources | Flood control and soil and water conservation, drainage, irrigation, forestry and forest fire protection, agricultural fairs, and any other activities for the promotion of agriculture and conservation of natural resources. |
| Per Household Spending on Parks | Expenditures on parks and recreation, including playgrounds, golf courses, swimming pools, museums, marinas, community music, drama, celebrations, zoos, and other cultural activities. |
| Per Household Spending on Police Protection | Expenditures on municipal police agencies, including coroners, medical examiners, vehicular inspection activities, and traffic control and safety activities. |
| Per Household Spending on Roadways | Expenditures for construction and maintenance of municipal streets sidewalks, bridges and toll facilities, street lighting, snow removal, and highway engineering, control, and safety. |
| Per Household Spending on Other Transportation | Expenditures on municipal airports, parking facilities, sea and inland port facilities, and subsidies to private transit facilities. |
| Per Household Spending on Sewerage | Expenditures for construction, maintenance, and operation of sanitary and storm sewer systems and sewage disposal plants. |
| Per Household Spending on Trash Collection | Expenditures on street cleaning and the collection and disposal of garbage. |
| Per Household Spending on Welfare | Support and assistance to needy persons, including expenditure from state and federal grants. |

*Source: Census of Governments, form F-21 (2000) "2000 Annual Survey of Local Government Finances."*

value and rent – which, as described in sections 3.1 and 3.2, serve as both dependent variables and instrumental variables in the econometric analysis. These variables are defined as the median value of owner-occupied housing and the median monthly price of rental housing in the county, respectively. Also included are the median number of rooms in houses; the proportion of housing that was built before 1939; the proportion of housing that is owner-occupied; the proportion of housing that is single-

**Table 4**. Expected Effects of Independent Variables

| | 2000 Median Housing Value | 2000 Median Rent |
|---|---|---|
| *Housing Market Characteristics* | | |
| Median Rent | + | N/A |
| Median Housing Value | N/A | + |
| Median Number of Rooms | + | + |
| % Housing Built Before 1939 | -- | -- |
| % Owner Occupied | +/-- | +/-- |
| % Single Family Housing | +/-- | +/-- |
| % Vacant | -- | -- |
| *Demographic Characteristics* | | |
| Population | + | + |
| Population Change, 1990 – 2000 | + | + |
| Per Capita Income, 1997 | + | + |
| % Population >18 Years Old | -- | -- |
| % Black | -- | -- |
| *Economic Characteristics* | | |
| Cost of Living Index, 1997 | -- | -- |
| Construction Cost Index | + | + |
| Natural Amenity Index | + | + |
| *Political Structure and Fiscal Characteristics* | | |
| Suburb Indicator | + | + |
| Per Capita Municipalities, 1997 | +/-- | +/-- |
| Property Tax Burden, 1997 | -- | +/-- |
| Per Household Total Direct Expenditures, 1997 | + | +/-- |

[ϕ]All fixed effects have been suppressed in order to conserve space.

family; and the proportion of housing that is vacant. Each of these variables were collected from the U.S. Census Bureau for the year 2000 – except for the median housing value and rent variables acting as instruments, which were collected for 1990.

The second group of explanatory variables, *Demographic Characteristics*, is used to control for influences on the price of housing that are inherent to the population and, thus, external to the housing itself. This category includes the population level in 2000 and the change in population between 1990 and 2000 (gathered from the U.S. Census

Bureau); a measure of per capita income, collected for 1997 from the Regional Economic Information System; as well as the proportion of the population under 18 years of age and the proportion who were Black in 2000 – both collected from the U.S. Census.

The third category, *Economic Characteristics*, includes variables meant to capture the relative place-to-place cost of living. The first variable is the cost of living index, which was gathered from the *Places Rated Almanac* for 1997. This variable represents the relative cost of living in different metropolitan areas and is measured by comparing prices on such items as housing, utilities, taxes, food, health and transportation. The second variable, the construction cost index, is a price index for construction labor and materials in different cities across the country and was collected from the 2000 publication of *RS Means Building Construction Cost Data*. Because this data was divided by cities, I assigned to each county in my analysis the index for the reported city falling in that county or their average if there were more than one. Finally, the third variable in this category is the natural amenity index, which was gathered from the Economic Research Service for 1993. This variable represents the relative quality of the physical environment across counties and is constructed by combining measures on six attributes most people prefer. These attributes are warm winters, winters with a high number of sunlit days, temperate summers, low summer humidity, topographic variation, and a high number of water features.

The fourth category, *Political Structure and Fiscal Characteristics*, includes two types of variables. Those defined as *Political Structure* variables are intended to capture the effects of land use and legal restrictions imposed on land use by local governments.

The first of these variables, the suburban indicator, is included as a means to test for housing price differences between downtowns and suburban areas. This is simply a dummy variable that indicates whether the county being observed contains a central city (in which case it is assigned a value of 0) or otherwise (in which case it is assigned a value of 1). Another variable in this category is a measure of per capita municipalities, which utilizes population data collected from the U.S. Census Bureau and data on the number of municipal governments collected from the Census of Governments for 1992 and 1997. This variable is meant to reflect the degree of political fragmentation within counties, which is directly correlated with the number of growth control policies implemented (Carruthers, 2003).

The second type of variables included in the *Political Structure and Fiscal Characteristics* category are those variables intended to capture the effects that public spending has on housing prices. The first variable, property tax burden, is included in order to measure the capitalization of property taxes into housing values and rents. It is defined as per household property tax divided by median housing value and is constructed with data gathered from the U.S. Census, the Natural Resources Inventory, and the Census of Governments. The second variable, per household total direct expenditures, represents an aggregate of the thirteen types of public service expenditures that form the core of this analysis, divided by the number of households per county. As described in Table 3, these thirteen individual public spending measures include capital facilities, education, fire protection, housing and community development, libraries, natural resources, parks, police protection, roadways, other transportation, sewerage,

trash collection, and welfare. Data were collected for 1992 and 1997 using the Census of Governments and were combined with U.S. Census population data.

Lastly, the fifth group of explanatory variables in the analysis includes the *State-Based Fixed Effects*. The purpose of this category is to control for any unique, location-specific traits that may go unobserved in the analysis. This is accomplished by including each state represented in the analysis, as well as Washington D.C., as a dummy variable and assigning a value of 1 to every county located within a particular state or a value of 0 otherwise. In this analysis, Texas is the category omitted to avoid perfect multicollinearity with the overall constants.

As a final note, all dollar denominated variables included in the analysis were adjusted for inflation to 1982 dollars. This was accomplished by using the consumer price index (CPI), which is a measure of the average price change of a standard "basket" of goods and services over time and is provided by the Statistical Abstracts of the United States (U.S. Census Bureau). This "basket" of goods and services includes such items as food, clothing, shelter, transportation, medical visits and medicines, and other daily expenses. The CPI is used to adjust for inflation by dividing the CPI of the year costs are to be adjusted to by the CPI for the year the data is collected from. This ratio is then multiplied by the nominal cost of the good or service, which is then expressed in real terms and can be easily compared with other prices.

### *3.4 Descriptive Statistics*

Table 5 provides descriptive statistics for each variable – including the mean,

**Table 5.** Descriptive Statistics

| | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|
| *Housing Market Characteristics* | | | | |
| Median Rent, 2000 (1990) | $331.71 ($313) | $75.09 ($78) | $180.60 ($179) | $711.00 ($631) |
| Med. Housing Value, 2000 (90) | $68,527 ($59,493) | $29,935 ($32,644) | $28,620 ($24,742) | $308,760 ($271,317) |
| Median Number of Rooms | 5.53 | 0.44 | 3.80 | 7.30 |
| % Housing Built Before 1939 | 14.01% | 10.88% | 0.30% | 52.80% |
| % Owner Occupied | 65.35% | 8.53% | 23.91% | 84.52% |
| % Single Family Housing | 66.44% | 10.18% | 8.10% | 88.90% |
| % Vacant | 8.27% | 5.22% | 1.54% | 53.71% |
| *Demographic Characteristics* | | | | |
| Population | 279,817 | 595,893 | 5,623 | 9,519,338 |
| Population Change | 1.05 | 0.06 | 0.55 | 1.38 |
| *Economic Characteristics* | | | | |
| Per Capita Income | 16,084.44 | 3,624.86 | 8,543.20 | 30,998.86 |
| % Population >18 Years Old | 25.85% | 2.77% | 14.52% | 36.18% |
| % Black | 9.49% | 11.79% | 0.03% | 67.25% |
| Cost of Living Index | 50.36 | 27.43 | 1.09 | 99.30 |
| Construction Cost Index | 92.36 | 11.75 | 67.20 | 133.80 |
| Natural Amenity Index | 0.33 | 2.45 | -5.40 | 11.17 |
| *Political and Fiscal Characteristics* | | | | |
| Suburb Indicator | 0.48 | 0.50 | 0 | 1 |
| Per Capita Municipalities | 0.0921 | 0.0993 | 0 | 0.9634 |
| Property Tax Burden | 1.55% | 0.75% | 0.20% | 5.82% |
| Per Household Total Direct Expenditures, 1997 (92) | $3,930 ($3,709) | $1,378 ($1,454) | $689 ($106) | $13,545 ($16,350) |
| Per Household Spending on Capital Facilities, 1997 (92) | $455 ($459) | $238 ($508) | $43 ($12) | $1,759 ($5,237) |
| Per Household Spending on Education, 1997 (92) | $1,707 ($1,559) | $468 ($526) | $419 ($45) | $3,547 ($5,903) |
| Per Household Spending on Fire Protection, 1997 (92) | $84 ($78) | $55 ($52) | $0 ($0) | $662 ($593) |
| Per Household Spending Housing and Comm. Dev, 1997 (92) | $70 ($63) | $73 ($73) | $0 ($0) | $623 ($644) |
| Per Household Spending on Libraries, 1997 (92) | $27 ($24) | $23 ($22) | $0 ($0) | $175 ($191) |
| Per Household Spending on Natural Resources, 1997 (92) | $21 ($18) | $61 ($57) | $0 ($0) | $1,005 ($1,184) |
| Per Household Spending on Parks,1997 (92) | $67 ($62) | $60 ($58) | $0 ($0) | $423 ($519) |
| Per Household Spending on Police Protection, 1997 (92) | $172 ($157) | $86 ($85) | $5 ($4) | $749 ($803) |
| Per Household Spending on Roadways, 1997 (92) | $177 ($176) | $98 ($103) | $3 ($0) | $714 ($981) |
| Per Household Spending Other Transportation, 1997 (192) | $30 ($30) | $76 ($74) | $0 ($0) | $1,000 ($1,396) |
| Per Household Spending on Sewerage, 1997 (92) | $111 ($107) | $80 ($89) | $0 ($0) | $806 ($755) |
| Per Household Spending on Trash Collection, 1997 (92) | $63 ($59) | $51 ($51) | $0 ($0) | $410 ($434) |
| Per Household Spending on Welfare, 1997 (92) | $111 ($118) | $189 ($197) | $0 ($0) | $2,679 ($2,239) |

[a]All dollars adjusted to 1982 constant dollars; [b]All expenditure values in $1,000s.

standard deviation, minimum, and maximum of the values in the dataset. One of the most interesting aspects of these statistics is that although median rent increased nationally by only 0.6 percent per year between 1990 and 2000, the average annual increase in median housing value was more than twice as high, amounting to 1.3 percent per year. Also of interest is that total direct expenditures rose by 1.2 percent per year between 1992 and 1997. However, as highlighted in Figure 2, this increase was not equally shared across all types of public spending. For example, spending on natural resources and libraries experienced substantial annual average growth rates of approximately 3.5 percent and three percent, respectively, while spending on welfare actually declined by about one percent per year. As for the overall importance of each type of public expenditure, Figure 2 shows that education is by far the most important – accounting for more than 40 percent of total expenditures in 1997. In addition, capital

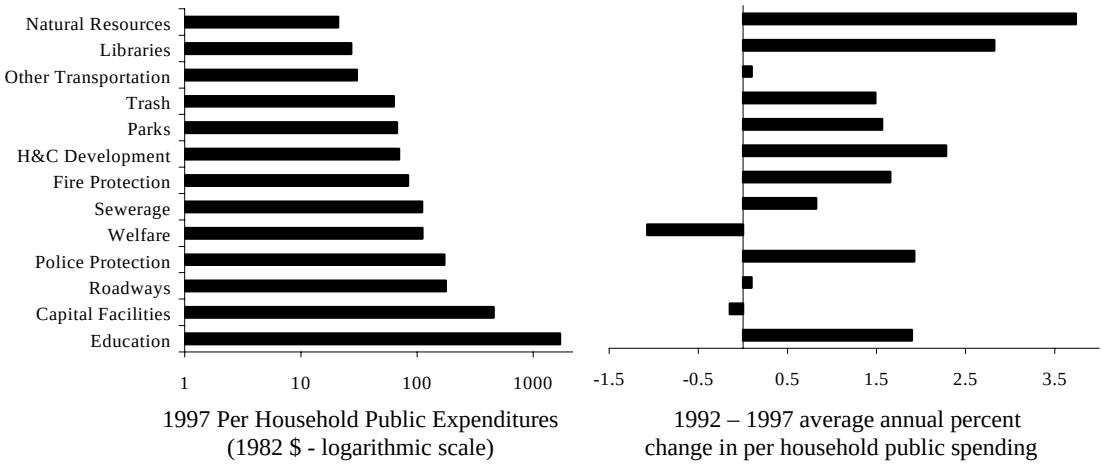


**Figure 2.** 1997 Per Household Public Service Expenditure and Annual Percent Change in Individual Expenditures, 1992 – 1997

facilities, roadways, and police protection are highly important public expenditures, while natural resources and libraries – though making the greatest gains – appear to be the least important.

Figures 3a, 3b, and 3c enhance these descriptive statistics by showing the spatial distribution of median housing values, median rent, and per household total direct expenditures, respectively, by metropolitan county. These figures are meant to give a sense of how these three variables are spatially related to one another. In addition, they are also intended to highlight any spatial autocorrelation among the counties, although accounting for this is beyond the scope of this research. Upon examination of these figures, it is apparent that median housing values and median rent in the country are each at their highest along the west coast (especially in the San Francisco Bay area) and in the northeastern United States, whereas the lowest values are found in the midwest and southern U.S. It is also clear that – except for a large outlier in Benton County, Washington – total direct expenditures also generally follow a similar pattern. Thus, housing values, rents, and (to a lesser degree) expenditures appear to be positively spatially autocorrelated in this dataset and – at least visually – lend considerable support to the hypothesis that housing values and rents are indeed correlated with public service expenditures.

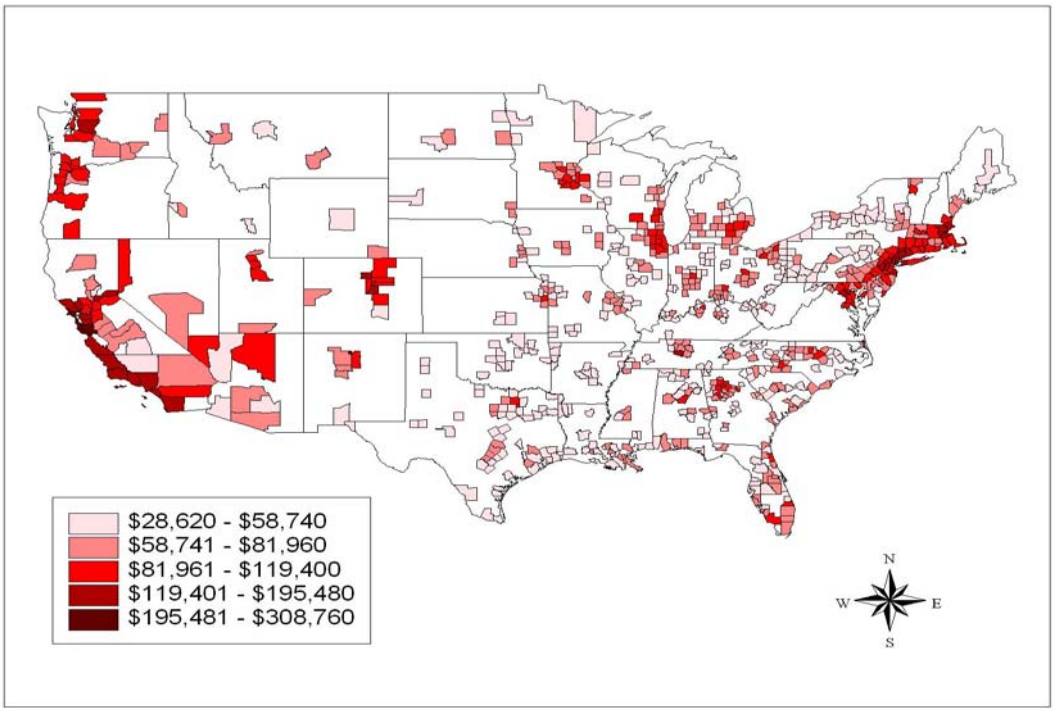


**Figure 3a.** Spatial Distribution of Median Housing Values, 2000, by County

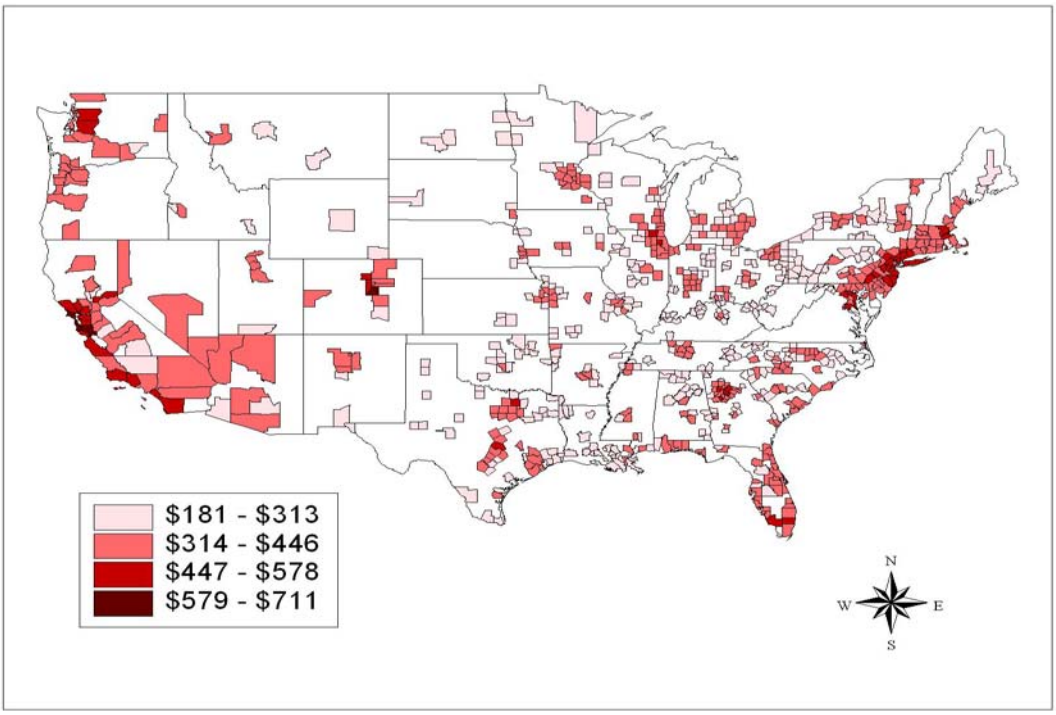


**Figure 3b.** Spatial Distribution of Median Rents, 2000, by County

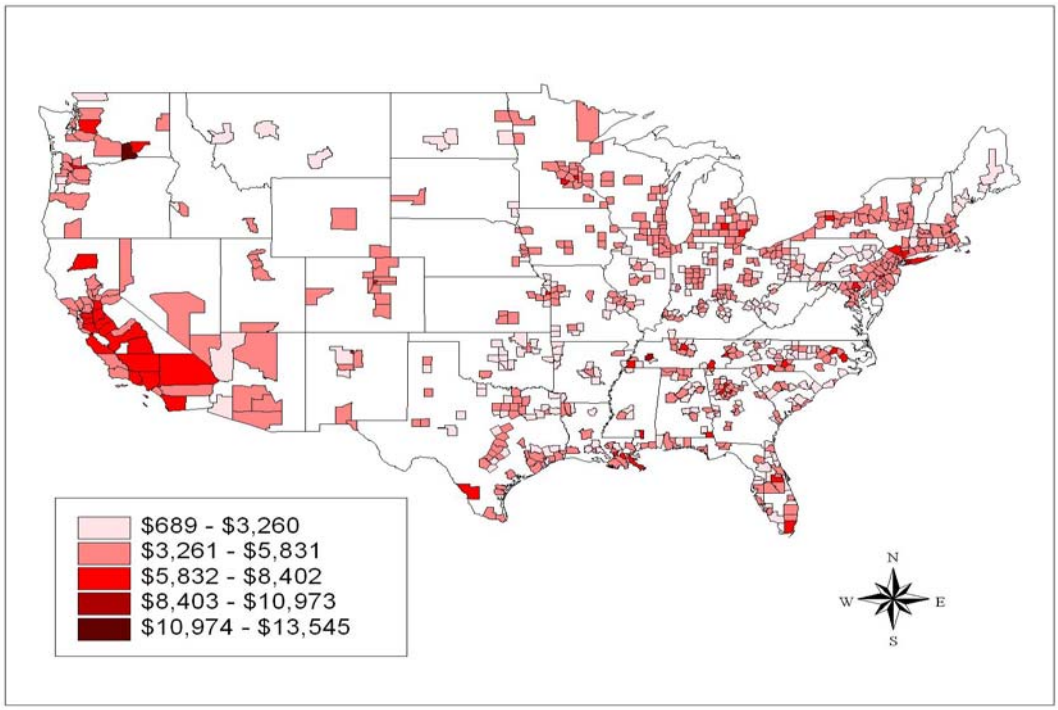


**Figure 3c.** Spatial Distribution of Per Household Total Direct Expenditures, 1997, by County

# 4. ESTIMATION RESULTS

The results of the first step of the empirical analysis are presented in Table 6. Nearly all of the estimates are found to be statistically significant and, where the direction of influence could be anticipated in advance (denoted by the one-tailed hypothesis tests), each coefficient carries its expected sign. Moreover, the adjusted $R^2$ values show that the model represents the two dependent variables very well – explaining 86 percent of the variation in median rents and 91 percent of the variation in median housing values. The results of each of the five groups of explanatory variables are examined below.

In the first group of variables – *Housing Market Characteristics* – all but one estimate are statistically significant and carry their expected signs where previously anticipated. The first two variables – median rent and median housing value – are both positive, revealing that a strong feedback indeed exists between the two submarkets. It is shown that a one percent increase in median rent led to a 0.54 percent increase in 2000 median housing value, while a one percent increase in median housing value led to a 0.403 percent increase in 2000 median rent. These findings are consistent with expectations: high rents raise values due to the opportunity cost associated with occupying housing, while high values raise rents because of the rates landlords must charge in order to make the venture worthwhile.

In addition, the estimates for *Housing Market Characteristics* show that a greater number of rooms is associated with both higher values and rents – adding approximately 0.4 percent to the median value of housing and approximately 0.8 percent to the median

**Table 6.** 3SLS Estimates of Median Housing Value and Rent[ϕ]

| | 2000 Median Housing Value | | | 2000 Median Rent | | |
|---|---|---|---|---|---|---|
| | *coefficient:* | *elasticity:* | *t–statistic:* | *coefficient:* | *elasticity:* | *t–statistic:* |
| *Intercept* | 9.51E+00[†††] | n/a | 65.38 | 4.73E+00[†††] | n/a | 42.00 |
| *Housing Market Characteristics* | | | | | | |
| Median Rent | 1.63E-03[***] | 0.540 | 10.47 | – | – | – |
| Median Housing Value | – | – | – | 1.44E-06[***] | 0.403 | 3.49 |
| Median Number of Rooms | 6.63E-02[***] | 0.367 | 3.29 | 1.40E-01[***] | 0.774 | 9.79 |
| % Housing Built Before 1939 | –1.63E-04[***] | –0.002 | –2.28 | –4.74E-04[***] | –0.007 | –9.37 |
| % Owner Occupied | 7.93E-02[n/s] | 0.052 | 0.76 | –7.16E-01[†††] | –0.468 | –9.68 |
| % Single Family Housing | –1.88E-04[†††] | –0.125 | –2.74 | 1.20E-04[†††] | 0.079 | 2.32 |
| % Vacant | –1.73E-01[*] | –0.014 | –1.59 | –4.13E-01[***] | –0.03 | –5.13 |
| *Demographic Characteristics* | | | | | | |
| Population | 1.57E-08[***] | 0.004 | 2.04 | 4.66E-09[n/s] | 0.001 | 0.81 |
| Population Change, 1990 – 2000 | 2.77E-01[***] | 0.291 | 3.32 | 2.84E-01[***] | 0.299 | 4.61 |
| Per Capita Income, 1997 | 2.89E-05[***] | 0.429 | 12.55 | 1.38E-05[***] | 0.205 | 5.75 |
| % Population >18 Years Old | –4.42E-01[***] | –0.114 | –2.11 | 1.39E-01[n/s] | 0.036 | 0.88 |
| % Black | –2.64E-01[***] | –0.025 | –5.15 | –9.69E-02[***] | –0.009 | –2.51 |
| *Economic Characteristics* | | | | | | |
| Cost of Living Index, 1997 | –2.7E-03[***] | –0.104 | –7.60 | –1.97E-03[***] | –0.099 | –9.90 |
| Construction Cost Index | 3.36E-03[***] | 0.310 | 3.52 | 3.45E-03[***] | 0.319 | 4.56 |
| Natural Amenity Index | 1.20E-02[***] | 0.004 | 3.19 | 8.97E-03[***] | 0.003 | 3.02 |
| *Political Structure and Fiscal Characteristics* | | | | | | |
| Suburb Indicator | 7.00E-04[n/s] | n/a | 0.06 | –1.92E-03[n/s] | n/a | –0.23 |
| Per Capita Municipalities, 1997 | 1.39E-01[†††] | 0.013 | 2.56 | –1.88E-01[†††] | –0.017 | –4.63 |
| Property Tax Burden, 1997 | –9.62+00[***] | –0.150 | –10.77 | –7.92E-03[n/s] | –0.000 | –0.01 |
| Per Household Total Direct Expenditures, 1997 | 7.82E-06[**] | 0.031 | 1.84 | –5.02E-07[n/s] | –0.002 | –0.16 |
| Adjusted $R^2$ | | | 0.91 | | | 0.86 |
| *n* | | | 777 | | | 777 |

[ϕ]All fixed effects have been suppressed in order to conserve space.

[***]One-tailed test, significant at $p < .01$; [**]one-tailed test, significant at $p < .05$; [*]one-tailed test, significant at $p < .10$.

[†††]Two-tailed test, significant at $p < .01$; [††]two-tailed test, significant at $p < .05$; [†]two-tailed test, significant at $p < .10$.

[n/s]Denotes not significant.

rent. On the other hand, older housing stock – represented by the percentage of housing built before 1939 – is shown to lead to decreases in both median housing value and median rent. Table 6 also indicates that the percentage of owner occupied housing in a county does not affect housing values but negatively affects rents – decreasing median rents by nearly 0.5 percent per one percent increase; the percentage of single family

housing in a county negatively affects median housing value, but positively affects median rent; and higher vacancy rates lead to reduced prices in both submarkets.

The most interesting results here – apart from the connection between the two submarkets that forms the core of the modeling framework – stem from the two two-tailed hypothesis tests. The first showed that the percentage of owner occupied housing is insignificant with respect to the ownership market, but negative and strongly significant with respect to the rental market. The latter result may be attributable to the kind of land use regulations that often accompany high rates of home ownership: communities with large proportions of owner-occupied units commonly implement single-use zoning to limit other forms of development as a means of protecting local property values. Renters, in turn, pay less because of the reduced availability of public transportation, convenient shopping, and other services typically found in areas with a more diverse mix of land uses. The second test, however, showed an alternating sign pattern on the percentage of single family housing, suggesting that it captures a density effect in the housing market but, at the same time, picks up a premium in the rental market. This is a plausible explanation, given that low densities result from low land values and that there are fewer opportunities for renters to find housing in such areas, leading to higher prices via competition over scarce units.

The results for the second group of variables – *Demographic Characteristics* – are all statistically significant in the ownership market and mostly significant in the rental market. The findings for the first variable, population, show that more populous areas have higher housing values, whereas rents are unaffected by population size. However, it

is also shown that both the ownership and rental markets are positively and significantly influenced by population growth. That is, a one percent increase in growth between 1990 and 2000 led to an approximately 0.3 percent increase in both 2000 median housing value and median rent. Similarly, per capita income is also found to have a positive and significant effect on both submarkets – increasing median housing value by about 0.4 percent and median rent by about 0.2 percent. In addition, Table 6 reveals that areas with large proportions of families with children, measured as the percentage of people under 18 years of age, have more affordable owner-occupied housing, while rents go unaffected. Finally, it is also found that areas with high proportions of Black residents have reduced housing values (by nearly 0.03 percent) and rents (by nearly 0.01 percent).

Each of the findings in this category is consistent with expectations, except for the two insignificant coefficients found in the rental market. The first of these showed that population size is insignificant with respect to rents, which may be the case because larger places have greater amounts of rental housing and, thus, reduced competition. Secondly, it was also shown that the percentage of people under 18 years of age is insignificant with respect to rents. This finding may be due to the fact that renters generally have fewer options than homeowners and, as such, the market is insensitive to family structure. However, it may also be that the results are simply spurious.

The results for the third group of variables – *Economic Characteristics* – are all highly significant in the two submarkets. The first variable examined is the cost of living index, which revealed that the cost of living negatively influences both housing values and rents. That is, a one percent increase in an area's living costs in 1997 led to an

approximately 0.1 percent decrease in 2000 median housing value and median rent. This outcome is as expected because housing – whether owner-occupied or rented – is a normal good and therefore competes for consumption with other goods. This finding is also consistent with the positive coefficients in both submarkets on per capita income, which allows for greater consumption of normal goods. The second variable in this category, the construction cost index, also performs as anticipated: higher construction costs are associated with both higher housing values and rents. Finally, the natural amenity index variable shows that it also has a positive influence on both submarkets – reinforcing our knowledge that this factor plays an important role in contributing to the place-to-place variation in the cost of housing.

Finally, the results for the *Political Structure and Fiscal Characteristics* group are only statistically significant in half of the cases. For example, the coefficients on the suburban county indicator show that this variable is insignificant in both the ownership and rental markets. However, municipal fragmentation, measured as the per capita number of municipalities, is shown to have a positive and significant effect on housing values and a negative and significant effect on rents. For the most part, these findings make sense: although housing in suburban locations is no more expensive that central city locations in and of itself, the effect of exclusivity is captured by the positive effect of municipal fragmentation in the housing value equation. This is consistent with the idea that more fragmented and, thus, smaller governments have a greater ability to restrict growth at the insistence of homeowners seeking to protect their property values. However, it is a bit puzzling that the coefficient is negative in the rent equation, but it

may be that fragmentation offers renters more choice, even as it works to make homeownership more difficult to obtain.

Furthermore, the estimates for *Political Structure and Fiscal Characteristics* reveal that property tax burden lowers housing values, whereas rents are unaffected because landlords cannot easily pass on such taxes. Table 6 shows that a one percent increase in property tax burden in 1997 led to a 0.15 percent decrease in 2000 median housing value. In addition, it is shown that public spending, measured as per household total direct expenditures, positively affects the ownership market, yet has no significant effect on rents. That is, a one percent increase in 1997 spending led to a 0.03 percent increase in 2000 median housing value. The finding that both property taxes and public expenditures (on the whole) are capitalized into the ownership market but not the rental market is consistent with expectations: homeowners bear the costs and enjoy the financial benefits of service provision while renters do not.

### *4.1 The Influence of Individual Public Service Expenditures*

As an overarching finding, the positive effect of total direct expenditures in the homeownership market lends good support to the hypothesis that public services account for a significant proportion of interurban variation in housing prices. However, there has been no evidence so far that the same is true for rents. Even so, certain types of spending are viewed as more beneficial than others, causing their influence to vary by type through the two markets and necessitating the need to isolate their individual effects. This is achieved via the three remaining steps of the modeling framework, the results of which

are summarized in Table 7, and shown graphically in Figures 4a, 4b, 5a, and 5b. Specifically, the table shows elasticities calculated from OLS estimates of the parameters $\lambda_k$ and $\omega_k$ in (6) and their associated *t*-statistics, and the figures map out the statistically significant elasticities for easy visual comparison.[5] Together, the table and figures respond directly to the three remaining research questions: Which types of expenditures make the most difference? How does their effect on housing values compare to their effect on rents? And, do these effects change through time?

First, it is shown that the expenditures that make a difference in the ownership market – that is, those that are statistically significant – are capital facilities, education, housing and community development, other transportation, police protection, roadways, and trash collection. Each of these positively contributes to an area's median housing value. The magnitudes of their individual effects are presented in Figure 4a. This figure reveals that, as measured by the elasticities, expenditures on police protection and education make by far the most difference in the ownership market – increasing median housing value by 0.024 percent and 0.022 percent, respectively, per one percent increase in spending. In addition to police protection and education, it is shown that capital facilities and roadways also contribute significantly to housing value; that is, for every one percent increase in spending on capital facilities, median housing value increases by 0.016 percent, while the same increase on roadway spending increases housing value by 0.009 percent. Lastly, Figure 4a shows that spending on trash collection, housing and

[5] The sum of elasticities shown in the gray lines of Table 7 represent *a posteriori* tests of the restriction that the sum of each individual expenditure is equal to $\beta_1$ and $\alpha_1$ from the first step of the modeling framework, as specified in equation (6). In all cases, the numbers sum to essentially the same numbers shown in Table 6; where they do not, they only deviate by one-hundredth of a point.

**Table 7a.** Elasticities for Individual Public Service Expenditures[3]

| | 2000 Median Housing Value | | | | 2000 Median Rent | | | |
|---|---|---|---|---|---|---|---|---|
| | 1997 Spending | | 1992 Spending | | 1997 Spending | | 1992 Spending | |
| | *elasticity:* | *t–stat:* | *elasticity:* | *t–stat:* | *elasticity:* | *t–stat:* | *elasticity:* | *t–stat:* |
| *Capital Facilities* | | | | | | | | |
| Per Household Expenditure | 0.016*** | 2.181 | 0.006** | 1.850 | 0.013*** | 2.352 | 0.001n/s | 0.474 |
| Per Household Expenditure on Other Services | 0.016*** | 1.989 | 0.026*** | 6.431 | –0.015*** | –2.616 | –0.004* | –1.366 |
| Sum of Elasticities | 0.032 | n/a | 0.032 | n/a | –0.002 | n/a | –0.003 | n/a |
| *Education* | | | | | | | | |
| Per Household Expenditure | 0.022*** | 3.092 | 0.025*** | 3.900 | –0.001n/s | –0.149 | –0.003n/s | –0.600 |
| Per Household Expenditure on Other Services | 0.010* | 1.570 | 0.008n/s | 1.360 | –0.002n/s | –0.357 | 0.000n/s | –0.103 |
| Sum of Elasticities | 0.032 | n/a | 0.033 | n/a | –0.003 | n/a | –0.003 | n/a |
| *Fire Protection* | | | | | | | | |
| Per Household Expenditure | 0.001n/s | 0.102 | –0.005n/s | –0.849 | 0.009*** | 1.819 | 0.008** | 1.628 |
| Per Household Expenditure on Other Services | 0.031*** | 4.301 | 0.037*** | 5.279 | –0.011*** | –2.094 | –0.011*** | –2.044 |
| Sum of Elasticities | 0.031 | n/a | 0.032 | n/a | –0.003 | n/a | –0.003 | n/a |
| *Housing and Community Development* | | | | | | | | |
| Per Household Expenditure | 0.006** | 1.614 | 0.002n/s | 0.666 | 0.001n/s | 0.378 | 0.000n/s | 0.117 |
| Per Household Expenditure on Other Services | 0.025*** | 4.881 | 0.029*** | 6.029 | –0.004n/s | –0.957 | –0.003n/s | –0.957 |
| Sum of Elasticities | 0.031 | n/a | 0.032 | n/a | –0.003 | n/a | –0.003 | n/a |
| *Libraries* | | | | | | | | |
| Per Household Expenditure | 0.003n/s | 0.560 | 0.007*** | 1.800 | 0.004n/s | 1.185 | 0.003n/s | 1.047 |
| Per Household Expenditure on Other Services | 0.029*** | 5.140 | 0.024*** | 4.662 | –0.007* | –1.561 | –0.006** | –1.618 |
| Sum of Elasticities | 0.031 | n/a | 0.032 | n/a | –0.003 | n/a | –0.003 | n/a |
| *Natural Resources* | | | | | | | | |
| Per Household Expenditure | 0.001n/s | 0.613 | 0.001n/s | 0.508 | –0.001* | –1.357 | 0.000n/s | –0.070 |
| Per Household Expenditure on Other Services | 0.031*** | 8.496 | 0.031*** | 8.850 | –0.001n/s | –0.474 | –0.003n/s | –1.181 |
| Sum of Elasticities | 0.031 | n/a | 0.032 | n/a | –0.003 | n/a | –0.003 | n/a |
| *Other Transportation* | | | | | | | | |
| Per Household Expenditure | 0.002* | 1.481 | 0.000n/s | 0.023 | 0.002*** | 1.816 | 0.001n/s | 1.024 |
| Per Household Expenditure on Other Services | 0.029*** | 7.700 | 0.032*** | 8.587 | –0.005** | –1.732 | –0.004** | –1.596 |
| Sum of Elasticities | 0.031 | n/a | 0.032 | n/a | –0.003 | n/a | –0.003 | n/a |

[3]Derived from 3SLS parameter estimates

[e]Note that the sum of elasticities represents an *a posteriori* test of the restriction that the sum of each individual expenditure are equal to $\beta_1$ and $\alpha_1$ from the first step of the modeling framework, as specified in equation (6).

***One-tailed test, significant at $p < .01$; **one-tailed test, significant at $p < .05$; *one-tailed test, significant at $p < .10$.

n/sDenotes not significant.

**Table 7b.** Elasticities for Individual Public Service Expenditures (continued…)[3]

| | 2000 Median Housing Value | | | | 2000 Median Rent | | | |
|---|---|---|---|---|---|---|---|---|
| | 1997 Spending | | 1992 Spending | | 1997 Spending | | 1992 Spending | |
| | *elasticity:* | *t–stat:* | *elasticity:* | *t–stat:* | *elasticity:* | *t–stat:* | *elasticity:* | *t–stat:* |
| *Parks* | | | | | | | | |
| Per Household Expenditure | $0.005^{n/s}$ | 1.078 | $0.001^{n/s}$ | 0.139 | $0.004^{*}$ | 1.297 | $0.005^{**}$ | 1.539 |
| Per Household Expenditure on Other Services | $0.026^{***}$ | 4.672 | $0.031^{***}$ | 5.621 | $-0.007^{**}$ | –1.657 | $-0.008^{***}$ | –2.004 |
| Sum of Elasticities | 0.031 | n/a | 0.032 | n/a | –0.003 | n/a | –0.003 | n/a |
| *Police Protection* | | | | | | | | |
| Per Household Expenditure | $0.024^{***}$ | 2.635 | $0.015^{**}$ | 1.769 | $0.015^{***}$ | 2.216 | $0.017^{***}$ | 2.659 |
| Per Household Expenditure on Other Services | $0.008^{n/s}$ | 0.833 | $0.017^{**}$ | 1.887 | $-0.017^{***}$ | –2.446 | $-0.020^{***}$ | –2.958 |
| Sum of Elasticities | 0.032 | n/a | 0.032 | n/a | –0.002 | n/a | –0.003 | n/a |
| *Roadways* | | | | | | | | |
| Per Household Expenditure | $0.009^{*}$ | 1.368 | $0.007^{n/s}$ | 1.204 | $0.004^{n/s}$ | 0.735 | $0.003^{n/s}$ | 0.661 |
| Per Household Expenditure on Other Services | $0.023^{***}$ | 3.315 | $0.025^{***}$ | 3.903 | $-0.006^{n/s}$ | –1.145 | $-0.006^{n/s}$ | –1.233 |
| Sum of Elasticities | 0.032 | n/a | 0.032 | n/a | –0.002 | n/a | –0.003 | n/a |
| *Sewerage* | | | | | | | | |
| Per Household Expenditure | $0.003^{n/s}$ | 0.643 | $0.009^{***}$ | 1.875 | $0.009^{***}$ | 2.358 | $0.003^{n/s}$ | 0.899 |
| Per Household Expenditure on Other Services | $0.028^{***}$ | 4.462 | $0.023^{***}$ | 4.138 | $-0.012^{***}$ | –2.558 | $-0.006^{*}$ | –1.488 |
| Sum of Elasticities | 0.031 | n/a | 0.032 | n/a | –0.002 | n/a | –0.003 | n/a |
| *Trash Collection* | | | | | | | | |
| Per Household Expenditure | $0.007^{**}$ | 1.565 | $0.004^{n/s}$ | 0.824 | $-0.004^{n/s}$ | –1.198 | $0.000^{n/s}$ | 0.095 |
| Per Household Expenditure on Other Services | $0.024^{***}$ | 4.233 | $0.028^{***}$ | 5.137 | $0.002^{n/s}$ | 0.370 | $-0.003^{n/s}$ | –0.850 |
| Sum of Elasticities | 0.032 | n/a | 0.032 | n/a | –0.003 | n/a | –0.003 | n/a |
| *Welfare* | | | | | | | | |
| Per Household Expenditure | $0.001^{n/s}$ | 0.480 | $0.000^{n/s}$ | 0.057 | $-0.001^{n/s}$ | –0.741 | $-0.002^{*}$ | –1.405 |
| Per Household Expenditure on Other Services | $0.030^{***}$ | 7.095 | $0.032^{***}$ | 7.462 | $-0.001^{n/s}$ | –0.339 | $0.000^{n/s}$ | –0.092 |
| Sum of Elasticities | 0.031 | n/a | 0.032 | n/a | –0.002 | n/a | –0.003 | n/a |

[3]Derived from 3SLS parameter estimates

[e]Note that the sum of elasticities represents an *a posteriori* test of the restriction that the sum of each individual expenditure are equal to $\beta_1$ and $\alpha_1$ from the first step of the modeling framework, as specified in equation (6).

$^{***}$One-tailed test, significant at $p < .01$; $^{**}$one-tailed test, significant at $p < .05$; $^{*}$one-tailed test, significant at $p < .10$.

$^{n/s}$Denotes not significant.

community development, and other transportation plays an important, yet smaller role in influencing the ownership market.

The expenditures that are shown to make the most difference in the rental

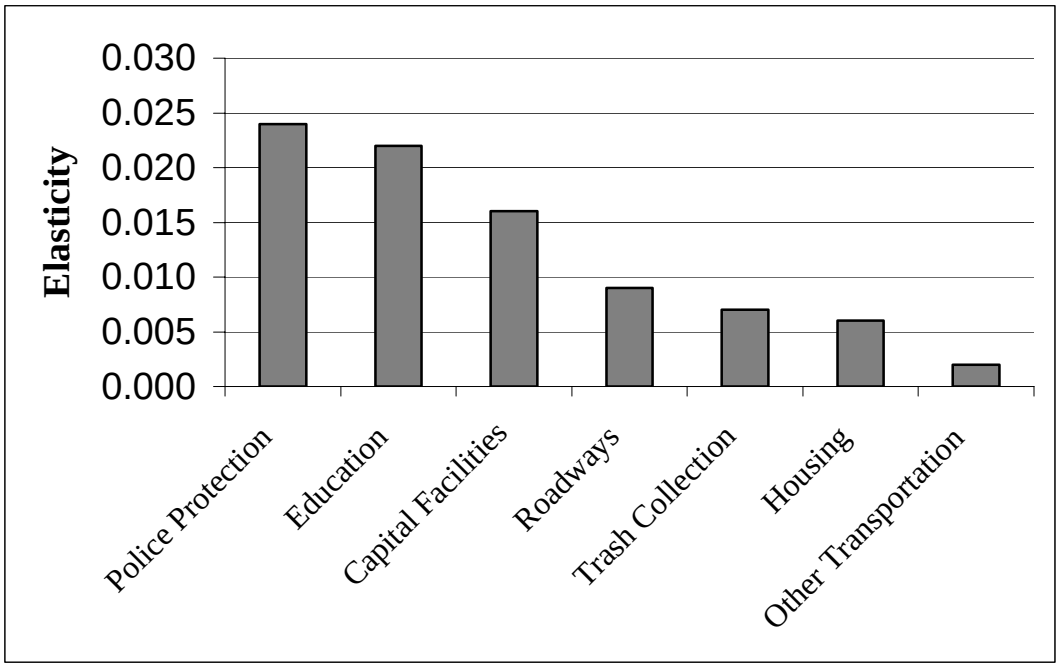


**Figure 4a.** Influence of 1997 Expenditures on 2000 Median Housing Value

market are capital facilities, fire protection, other transportation, parks, police protection, and sewerage – which all make positive contributions. In addition, natural resources are found to make a significant, yet negative, contribution to rents. In terms of magnitudes, which are presented in Figure 4b, it is shown that expenditures on police protection and capital facilities are what make the greatest difference in the rental market – increasing median rent by 0.015 percent and 0.013 percent, respectively, per one percent increase in spending. Figure 4b also shows that fire protection and sewerage expenditures also have a large effect on rents; that is, median rent increases by 0.009 percent for every one percent increase on fire or sewerage spending. Lastly, the results for the rental market reveal that smaller effects are made by expenditures on parks, other transportation, and natural resources.

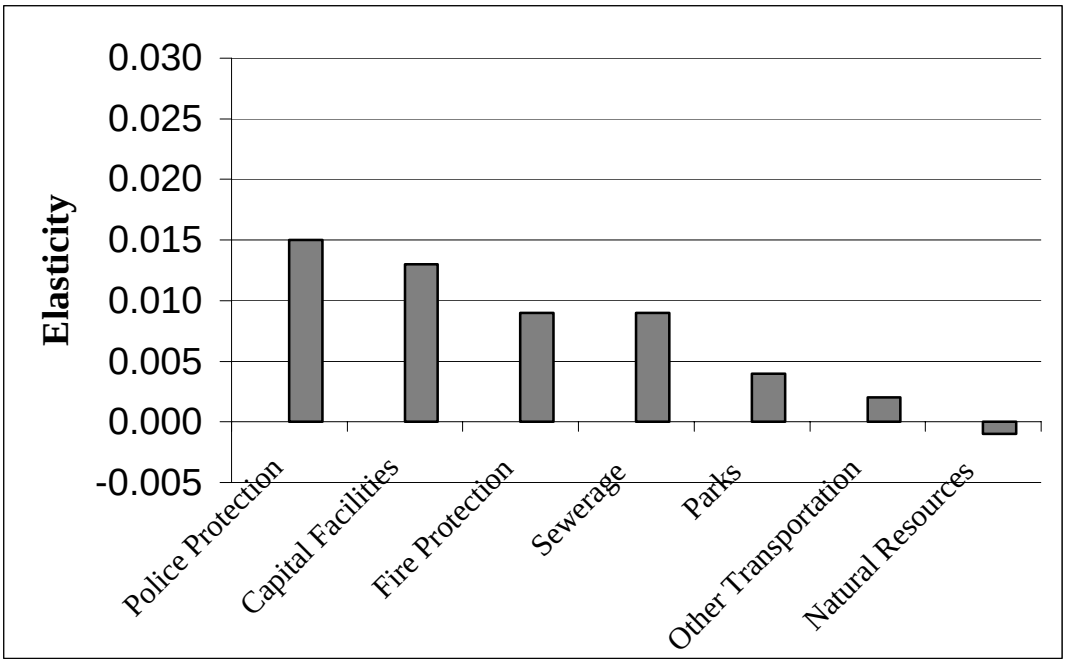


**Figure 4b.** Influence of 1997 Expenditures on Median Rent

It is clear that several important differences emerge between the ownership and rental markets. Although spending on police protection and capital facilities make large contributions to both housing values and rents, the effect of spending deviates from there. In particular, the evidence suggests that the ownership market responds to factors affecting home values directly (such as education and roadways) and indirectly via neighborhood quality (such as housing and community development and trash collection), while the rental market responds to factors necessary for living in dense urban environments (such as fire protection and parks). These differences are interesting because they speak to what residents gain from the different kinds of service provision. While renters clearly benefit from the factors that affect the ownership market, they do not pay a premium for doing so because they are not invested. For example, homeowners

benefit from quality schools, whether they have children attending them or not, because future buyers will pay more for their housing if they choose to sell. However, renters gain nothing, unless family members make use of public education. Meanwhile, it is possible that homeowner's insurance insulates people from concern over fire protection and, if they also own yards, the perceived benefit of parks may be too small. A final important difference is the negative effect that spending on natural resources has in the rental market, but this may just be a spurious correlation.

Finally, to illustrate how the effect of spending changes through time, Figures 5a and 5b show elasticities derived by estimating equation (6) with public service expenditures lagged by eight years, instead of three. Figure 5a shows that the effect of the 1992 expenditures on median housing value is that housing and community development, other transportation, roadways, and trash collection drop out of significance, while sewerage and libraries come into significance. That is, a one percent increase in spending on sewerage in 1992 led to a 0.009 percent increase in 2000 median housing values, while the same increase in spending on libraries in 1992 led to a 0.007 percent increase in 2000 median housing values. In addition, this figure reveals that spending on police protection and capital facilities in 1992 maintains a strong, though smaller, influence on the ownership market, whereas education expenditures appear to increase their effect on housing values over time.

The effect of 1992 expenditures on median rent is shown in Figure 5b. Here, we see that the effects of natural resources, other transportation, and sewerage become insignificant. However, spending on welfare gains significance, though with a small

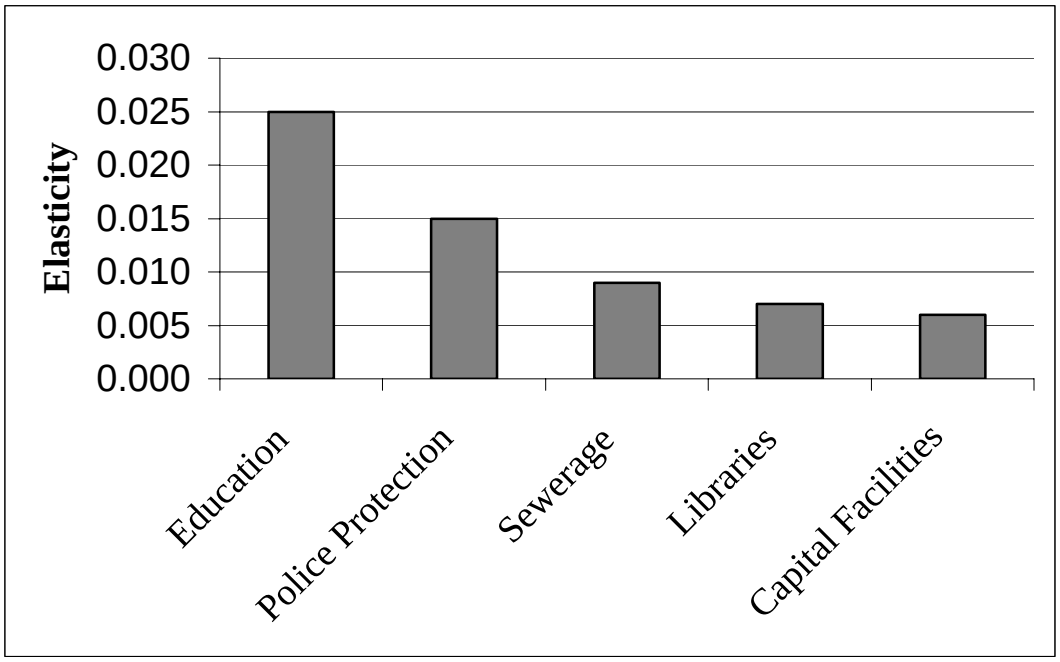


**Figure 5a.** Influence of 1992 Expenditures on 2000 Median Housing Value

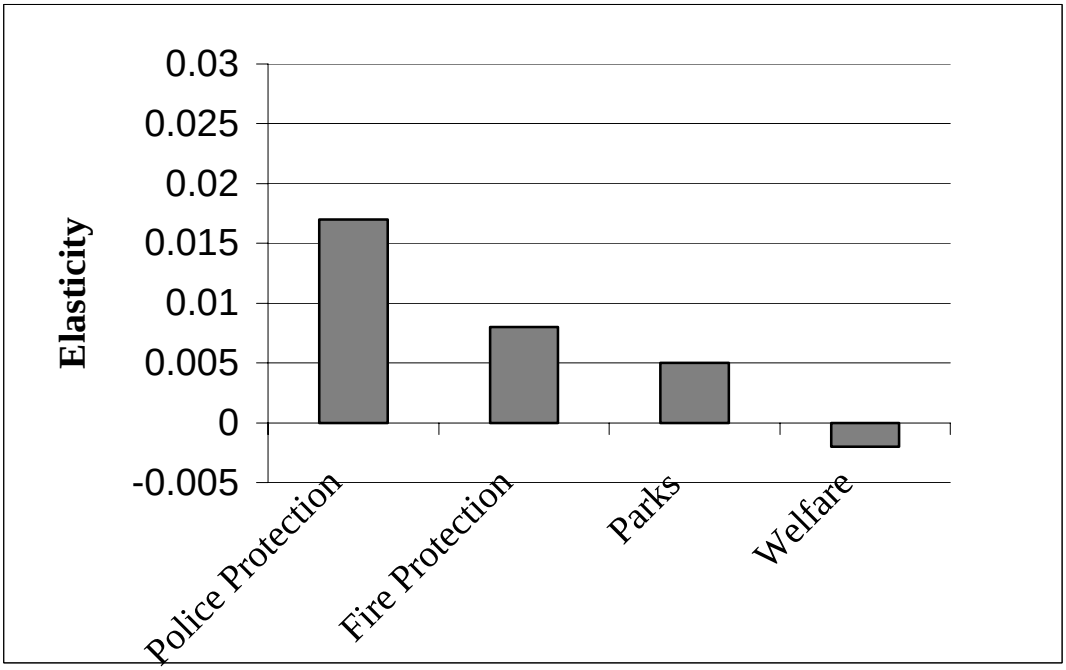


**Figure 5b.** Influence of 1992 Expenditures on 2000 Median Rent

negative effect; that is, a one percent increase in spending on welfare in 1992 decreased 2000 median rent by 0.002 percent. In addition, it is shown that spending on fire protection in 1992 maintains a strong, though smaller, influence on the rental market, whereas spending on both police protection and parks appear to increase their effect on rents over time.

The key finding from these results is that the benefits of certain public expenditures take longer or shorter amounts of time to take hold on the two submarkets. For example, the finding that spending eight years past on sewerage and libraries raises values in the ownership market indicates that the services are valued, but not for their immediate benefits. This pattern may be due to the fact that such services characteristically generate low levels of annual spending and it is their cumulative effects that make the greatest difference. On the other hand, certain expenditures do have an influence over the short-term only. In the ownership market, the services that drop out of significance in the long-term are, generally speaking, associated with routine neighborhood maintenance, suggesting that people expect to pay as they go, instead of investing a long way out. In the rental market, capital-intensive expenditures – on other transportation, sewerage, and capital facilities – drop out of significance, suggesting that landlords are able to pass along costs and benefits in the short run, but not the long run.

# 5. DISCUSSION

From these estimation results emerge clear answers to the four primary questions motivating this research: Do public service expenditures help explain interurban variation in housing prices and rents? What types of spending make the most difference? How does their effect on housing values compare to their effect on rents? And, finally, do these effects change through time? First, the results show that public service expenditures, in the aggregate, indeed play an important part in explaining interurban variation in housing prices, yet have little influence on rents; this finding is consistent with expectations because, unlike homeowners, renters are not invested and thus feel substantially less of the pain and gain of service provision. Second, when disaggregated, it is found that spending on police protection makes the most difference for owners and renters alike; spending on education and capital facilities are close behind in the ownership market; and spending on capital facilities and fire protection are close behind in the rental market. Third, the differences between the two submarkets suggest that homeowners place greater weight on expenditures that affect exchange value, while renters place greater weight on factors influencing use value. Each of these findings is consistent with the theory of compensating differentials, which predicts that people will incur greater costs to live in areas that offer perceived benefits. Finally, the results show that, in both markets, certain services (such as police protection) have constant or even increasing effects through time, while others take less (such as capital facilities) or more (such as libraries, in the ownership market) time to materialize. Several policy

recommendations and directions for future research follow from these findings.

### *5.1 Policy Recommendations*

Although much research has focused on the effect of environmental features on migration flows, property values, and wages, the present analysis reveals that – contrary to popular opinion – the elasticities of most public service expenditures by far outweigh those of the natural amenity index in both the ownership and rental markets. Given that public service expenditures, unlike natural amenities, are malleable, it is recommended that policy-makers use this evidence to directly influence the relative attractiveness of regions through improved service provision. An example of where this tactic – whether followed consciously or not – has proven successful is in the older cities of the Northeast and Midwest, where the economy has rebounded from decline in recent times; despite having cold winter climates and comparatively fewer natural amenities, these places have captured significant proportions of the information economy due to its well-educated employees' penchant for high-quality public schools, low crime rates, good transportation, and efficient public services (Drennan, 2002). Moreover, fiscal planning should not become a public policy tool used by low-amenity areas alone; high-amenity areas currently attracting large numbers of people and firms should also be conscious of fiscal factors because deteriorating public services as a result of poor growth management may eventually overwhelm their ability to remain competitive in the national economy (Munnell, 1992).

It should also be reiterated that, of all expenditures, those related to public safety

(police and fire protection) and human capital (education) emerged as the most important overall. But inequities in the quality of these services in particular are on the rise in metropolitan areas nationwide, creating in many cases an intractable cycle of socioeconomic decline, as the poor become increasingly cut off from benefits enjoyed by the public at large. For example, the fact that educational spending is inadequate in many areas of the country means that subsequent job skills in these communities are meager at best – preventing access to meaningful employment. Consequently, such areas often spiral into a concentration of poverty, where an "underclass" plagued by crime, drug abuse, unemployment, out of wedlock births, welfare reliance, and high teenage dropout rates typically develops (Wilson, 1987). If regions become winners or losers based on their relative desirability as places to live – as this and much previous research suggests – their ability to avoid such social polarization will depend on the maintenance of as high a level of public safety and human capital as possible. This task should also be at the forefront of forward-looking urban policy.

Finally, it must be mentioned that although the capitalization of public services into housing prices and rents can be a positive thing when it makes people take an interest in the quality of their schools (in the ownership market) and other municipal goods, it has arguably negative consequences when the fear of land-use changes that would appear to pose a fiscal drain to a community, such as low-income housing developments, leads to segregative land-use patterns. Therefore, a third policy recommendation – which was first put forth by Marcus and Taussig (1970) and later reintroduced by Fischel (2001) – is to establish some form of home-value insurance that would alleviate the risk aversion

associated with such land-use changes. The insurance would require that an insurer, such as a public or private developer, compensate a property owner looking to sell if, at that time, his or her property value did not rise to the amount that it would have had the "risky" project not taken place (Fischel, 2001). Chicago serves as an example of where such a program has been successfully implemented, though risk aversion to racial change in neighborhoods has been the primary motivation in their case. Although carrying out such a process would have its difficulties (for example, in drawing linear causation between a project and the capitalization), it appears that home-value insurance could be quite effective in reducing "not in my backyard" sentiments among homeowners – the most influential members of most communities.

### *5.2 Directions for Future Research*

Although this research has made a positive contribution by deepening the pool of empirical evidence linking public services to regional well-being, additional research is needed to justify just how public services may be leveraged. The first step relates to the estimation results presented here: although property tax burden and total direct spending are both found to be significant in the median housing value equation, as shown in Table 6, the elasticities suggest that costs (-0.15) are felt at a rate five times as high as benefits (0.03). If services were fully capitalized, the two would offset one another, so this discrepancy indicates either that they are being inefficiently provided – or that owners *perceive* a substantially higher share of the costs than the benefits of public spending. Such misperceptions could stem from a number of factors. For example, a service may

be negatively capitalized via its contribution to the property tax burden, but not positively capitalized if people take it for granted and/or don't want it in the first place. On the other hand, it may be that the costs of a service are more readily felt when its benefits take a longer time to materialize than others – as this research found to be characteristic of several service types; in this case, the discrepancy would likely only occur in the short run. Future research should look more deeply into this conclusion and its causes because perceived benefits dictate taxpayers' willingness to pay for services and, in turn, the flow of revenues that local governments have to work with.

In addition, future research should examine the connections between inputs (measured by spending) and final outputs (measured by quality) of public services from an interurban perspective. This research has employed expenditures as a proxy for service quality due to data availability and, although this measure appears to have performed consistently with expectations, an exploration of the differential effects outputs may produce must be performed as well. This is because there is a large debate within the literature as to which type of variable most accurately predicts the amount of benefits or disbenefits households will receive from them. For example, in the case of school quality, a number of authors argue that expenditure per pupil is an adequate measure of school quality because what matters is the *perceived* benefits different schools offer; these perceptions – which are usually formulated by such things as student-to-teacher ratios and better facilities – are all closely related to expenditures (Oates, 1969). In fact, Lankford and Wyckoff (1992) and Downes (1993) both found that the majority of those choosing to attend private schools base their decisions more strongly on input

levels and racial/ethnic compositions than on outputs, such as test scores. However, it has also been argued that no credible evidence exists that relates variation to school quality to variation in spending. Moreover, many believe that, since school-report cards are a relatively recent phenomenon, factors on which perceptions of quality are based were previously limited to inputs and therefore incorrect (Downes and Zabel, 2002).

Finally, future research should also account for spatial dependency – especially in the dependent variables – as was exhibited in this research in Figures 3a, 3b, and 3c and described in Chapter Three. Although the presence of spatial autocorrelation in a dataset does not substantially affect the parameters of one's model, controlling for autocorrelation is nonetheless an important exercise because it implies a misspecified model. Thus, any estimates produced that are ignorant of spatial dependency in the variables will be biased and inconsistent.

# 6. SUMMARY AND CONCLUSION

This research has demonstrated the important part that public service expenditures play in explaining interurban variation in housing prices and rents through an exploration of whether or not public spending matters at the interurban level, which types of expenditures make the most difference, how their individual effects differ between ownership and rental markets, and whether or not their influence changes through time. As discussed in the literature review, an exploration into these questions was necessitated by a significant gap in the urban and regional economics literature in terms of comprehensive knowledge about the influence public goods and services have on housing markets at an interurban level. That is, previous research has focused a great deal on *intra*urban variation in housing prices and rents; mostly through hedonic price models, researchers have found that various structural characteristics, neighborhood attributes, as well as non-market goods such as natural amenities and public services have all been shown to significantly affect housing costs at this level. However, comparatively less research has been done on *inter*urban variation in housing prices and rents – especially with respect to public services. While there is extensive empirical evidence that natural amenities have a substantive influence on migration flows and that compensating differentials account for interurban housing price and wage differences, very little is known about the role of public services. It was argued that this omission is of practical importance because, unlike a particular region's inherent endowment of natural amenities, public services can be directly influenced by public policy to enhance regional

well-being.

In order to answer the four core questions guiding this research, median housing values and rents in a national data set of metropolitan counties were then analyzed through a system of simultaneous equations and estimated using a three-stage least squares approach. As discussed in the methodology chapter, this framework was necessary in order to account for the linkages between the homeowner and renter subsectors of the housing market, as well as to allow shocks to the system to affect both markets simultaneously – a more realistic model of the real world. In this model, the dependent variables, housing values and rents, were estimated as a function of per household total direct spending, as well as five categories of control variables: *Housing Market Characteristics*, *Demographic Characteristics*, *Economic Characteristics*, *Political Structure and Fiscal Characteristics*, and *State-Based Fixed Effects*. The coefficients produced from this model were then restricted in subsequent models, so that alternative service expenditures and different time lags could be tested while holding all else constant. This research design enabled precise observation of how thirteen individual measures of public service expenditures – capital facilities, education, fire protection, housing and community development, libraries, natural resources, parks, police protection, roadways, other transportation, sewerage, trash collection, and welfare – affect housing values and rents and provided evidence of how their influence changes through time.

The findings revealed that public service expenditures indeed make a significant contribution to the interurban variation in housing prices, yet have little influence on

interurban variation in rents. This finding is as anticipated because homeowners bear the costs and enjoy the financial benefits of service provision while renters do not. However, when disaggregated to show the importance of various expenditures by type, it was found that spending on police protection makes the most difference for both owners and renters alike; spending on education and capital facilities are close behind in the ownership market; and spending on capital facilities and fire protection are close behind in the rental market. These differences suggest that homeowners place greater weight on expenditures that affect exchange value, while renters place greater weight on factors influencing use value. This finding is also as anticipated because, in line with the theory of compensating differentials, people will incur greater costs to live in areas that offer perceived benefits. Finally, the results showed that the time it takes for certain services to exhibit a measurable effect on housing prices and rents varies considerably – with some services exhibiting constant or increasing effects through time, while others take more or less time to materialize.

Although additional research is necessary to expand even further our knowledge of public services and just how they may be leveraged, the findings presented here highlight the importance of public service expenditures to the well-being of contemporary urban areas. In an era where compensating differentials have such a large impact on the outcome of regional development, fiscal planning should be viewed as fundamental to the growth process. Unfortunately, however, it is all too commonly overlooked. As a result, policy makers have little to go on in their fiscal planning processes and even less to act upon when calling on the public to make financial

sacrifices for the good of the whole. It is hoped that by making public services the center of attention in this and future research, policy makers will have a greater foundation on which to apply public service provision towards the improvement of our cities' quality of life and economic vitality.

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