The Effect of an Urban Growth Boundary on Property Prices; The Case Of Virginia Beach, Virginia

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THE EFFECT OF AN URBAN GROWTH BOUNDARY ON PROPERTY PRICES; THE CASE OF VIRGINIA BEACH, VIRGINIA

by

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Abstract

This thesis was originated by the debate over the effect of urban growth boundary on the value of vacant land. The case of Virginia Beach was studied. In 1979 a green line policy was enacted in this city. This study was dedicated to assess the effect of this policy on the value of the vacant land. A hedonic price model was used to isolate the importance of various characteristics of land in price determination and a simulation equation model was performed to obtain the total change in land value after the green line policy was introduced.

Acknowledgement

I would like to express my gratitude for the assistance of the member of my graduate committee. Special thanks are given to Dr. Paul Driscoll for serving as program chairman, without his guidance this thesis wouldn't be possible, to Dr. Leonard Shabman for his help in offering academic background, and to Dr. Daniel B. Taylor for his help throughout my graduate study.

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Chapter 1: The problem

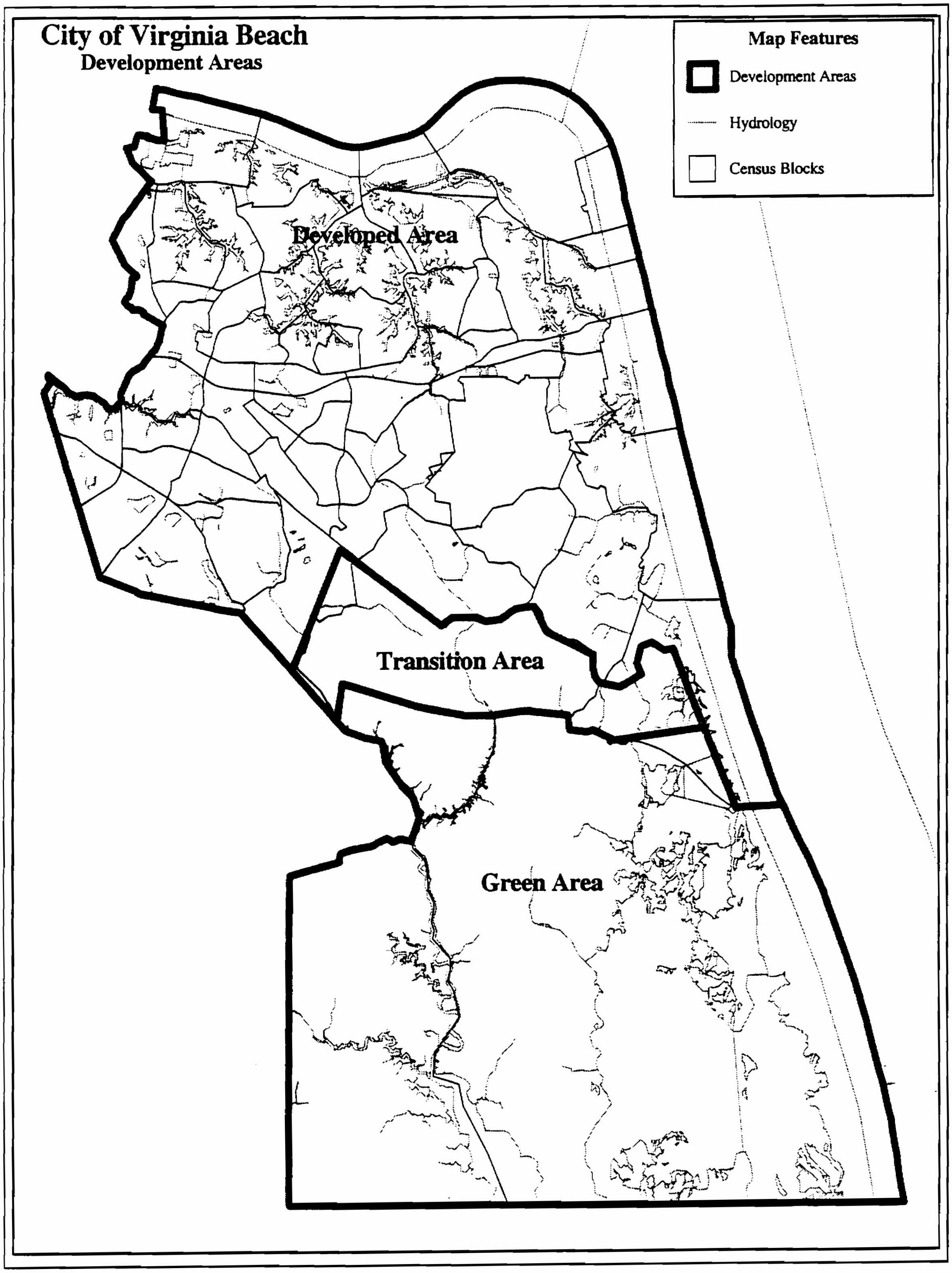
1.1 Introduction

In recent years there has been increased concern expressed by private landowners that environmental restrictions on land use diminish their property values. In the past year a bill was passed by the House of Representatives that awards compensation to landowners whose property has been devalued by over 20% from a pre-regulation condition. Opponents of this legislation argued that, in many cases, public actions create values as much as they destroy values. For example, they argued that public infrastructure investment near property raises its market value, yet there is no recapture of that value from the benefiting landowner.

Among the most controversial kinds of land use control are regulations that redirect development in cities from one area to another. Such zoning of large areas is implemented by state and local governments. The most significant example of this approach is the Oregon urban growth boundary program. In that state each locality is expected to define an area where development will be concentrated and then take actions to assure that development does not spill beyond those boundaries. This growth boundary program has been the subject of much study, but few areas have copied the Oregon approach, in part because of the opposition of landowners whose property falls outside the growth boundary.

One area where such a boundary has been applied in Virginia is within the City of Virginia Beach. Following a rapid increase in development in the city in the 1960s and 1970s, the city council authorized the imposition of what came to be known as the "green line". This area (see map 1.1) divided the city into two sections and directed most post-1979 growth to the north of the line. Below the line the city refused to provide roads, water and other infrastructure and vigorously maintained the agricultural and low density zoning of the agricultural area.

Now, after almost 15 years of experience, the green line's effect on land prices in the city can be assessed. This assessment is especially timely due to current controversy over regulation of land use and lack of information on how regulation might have both positive and negative effects on land prices in an area. A determination of how a policy such as the green line affects property prices will be especially important in providing information on the debate over the effects of land use regulation on property owners.


City of Virginia Beach
Development Areas
Map Features
Development Areas
Hydrology
Census Blocks
Developed Area
Transition Area
Green Area

1.2 Framework for the Issue

Land as bought and sold in the land market, is spatially limited and is heterogenous with respect to its characteristics. The market value of land is a function of three components: productive, consumptive, and speculative. The productive component, based on the expectations theory of asset pricing , reflects the present value of the expected returns to land. The consumptive component reflects the utility of owning land because of its intrinsic value. The speculative component reflects the expectation that external forces, for example residential growth, will result in an upward trend in land values in the future. Xu et. al. (1993) summarizes the three, noting that " it is generally accepted that expected net return (monetary and psychic) to land is the driving force behind land values".

The impact of land use restrictions on the expectations that establish land value has been discussed in the literature. Grieson and White (1981) modeled a positive effect on property values from a restriction limiting the amount of land in a particular use. In their work, they classified all land as belongings to one of two categories: land with an allowable use and land facing the restriction on that use. Such restrictions raise the price of land with the allowed use (because supply of it is limited) and lower the price of land without the allowed use. Norris (1995) employ Grieson and White's supply and demand framework to conceptually analyze the effects of regulations that cover only some land parcels in a region. They conclude that regulation puts negative pressure on land prices for properties that face regulations, but puts positive pressure on land values for the properties that are not regulated. This is because the regulations dampen the demand for regulated land (because regulation lowers expected returns, ex. reduce the speculative component of value). Because the supply of land is fixed, the demand for unregulated parcels then rises, putting upward pressure on the unregulated land prices.

Two points can be derived from this conceptual framework. First, in the aggregate, environmental regulations have an ambiguous effect on land values: they enhance values of non-regulated land while lowering values on regulated land, but the relative effects are not known because of external influences on the demand for a land parcel. Second, there are many types of public policies that might work to increase the demand for certain land parcels and will increase prices: the selective provision of public services such as extension of sewer lines, roads, to particular areas and not in others increase development pressure in some areas while having less effect in others.

Knowing the exact effect in a given area requires empirical measurement. A common procedure for measuring the effects of regulation effects on land prices is a hedonic price approach. This approach isolates the importance of specific attributes of land parcels in determining the parcel's market value and includes among those attributes a measure of the land use regulation. Hedonic models have been used to predict the importance of different factors such as soil type, distance to a road, access to public services on land prices. Empirical work on the effects of regulations has been limited. However, most of the studies considered only the negative effects of regulation of land use on specific parcels and have not considered the area-wide effects.

1.3 Objectives

1. To determine the effects of the green line urban growth boundary on property prices in Virginia Beach, Virginia.

2. To estimate the effects of the green line on the total value of currently vacant land in Virginia Beach, Virginia.

1.4 Procedure

A hedonic price equation approach was used to isolate the effects of different characteristics of vacant land, including the location in relation to the green line urban growth boundary on market sales prices. The hedonic approach was applied to land that was still vacant in 1994. The analysis of vacant land simplifies the analysis by avoiding the need to consider and control for the effects of housing and commercial development on land prices.

Data on sales of these still vacant parcels from 1959 to 1994 were available from computerized records in the Virginia Beach assessor's office. The record included the date of the most recent sale, the sale price and characteristics of the parcel. These parcels were also described by a spatial identification number. That number was used in conjunction with other data in a Geographic Information System (GIS) to define critical location factors that would be determinants of land price: location in the city, location in relation to urban development pressure and location to the green line.

The rest of this thesis is organized as follows. Chapter 2 provides the theoretical aspects of the hedonic model. Chapter 3 explores the econometric issues associated with hedonic estimation. Chapter 4 describes the variables and data used for regression. Chapter 5 gives the results and analysis from regression. Chapter 6 reviews the conclusion reached.

Chapter 2: Theory of Land Price Determination

2.1 Land Valuation Theories

The simple theory of land price determination is that the market price of land is the present value of net monetary inflow (economic rents) which the land is expected to yield over time. So the value of land is contingent on the discount rate and the length of time. Mathematically this relationship is given as:

$$V=\sum_{i=1}^{n}\frac{a_i}{(1+R)^i}$$

where: a_i is the expected economic return in the ith year, R is the discount rate used, and n is the number of years.

However some researchers suggest that this simple theoretical framework must be expanded to recognize the fact that the actual market value of land depends on a number of factors other than the discounted present value of a future income stream. A land parcel's attributes such as the number of acres, location in the city, the number of properties available on the market, and the government policies are typical examples. The motivations and expectations of prospective buyers and sellers also, to some extent, influence the value of land [Moore]. These motivations or expectations are determined to a great extent by the market participants [Dunford, Marti, and Mittelhammer]. Both buyers and sellers have subjective or speculative components, in their determination of the land reservation or bid price. Therefore, the present value of land changes as the buyer's or seller's expectations change.

Although land is a commodity that responds to various market forces, it differs in several ways from other economic goods. The total quantity of land in a region is fixed, though transitory with respect to uses. Although land exists nationwide, the markets for land are often very localized with only a relatively small percentage of land changing hands each year. Buyers and sellers, therefore, do not have perfect knowledge of the market conditions [Moore and Myers].

These arguments have encouraged researchers to consider the significance of major attributes of land in determining the sales prices of land [Zeimerand White; Pope and Gorden; Miranowski and Hammers; Reynolds; Moore and Myers]. They argue that for a more accurate modeling of the land valuation, such major attributes must be considered. This analytic approach is best represented by the hedonic pricing framework. Hedonic price analysis is based on the hypothesis that the qualities of nonhomogeneous goods are valued as a function of their utility-bearing attributes or characteristics [Griliches].

2.2 Introduction to Hedonic Price Model

Definition of the Hedonic Price Function

Goods such as automobiles or properties that are differentiated with respect to their characteristics are called composite goods. The characteristics of a composite good are not priced separately but, taken together, determine the price of the composite good [e.g., Court(1939), etc.; also see Berndt (1991, chapter 4)]. For example, an automobile is a typical composite good that has a variety of characteristics such as horse power, gas mileage, front-rear seating space, luggage capacity, length, air conditioner etc. Every automobile's value is essentially determined by its particular set of characteristics and the price differences among automobiles stem from the fact that different automobiles contain different characteristics. The function that relates the value of a composite good to its characteristics is customarily referred to as a hedonic price function. The characteristics included in this function are those that would affect the value of the composite good. For instance, automobile values may be represented as a hedonic price function of automobile characteristics:

$$P = P(Z_1, Z_2, \ldots, Z_n)$$

where: $Z_1, Z_2, \ldots, Z_n$ are n characteristics of an automobile.

Use of Hedonic price Function

Empirically, the hedonic price model may be used (1) to determine how the price of the composite goods varies with the set of characteristics it possesses, and (2) to support the estimation of the demand and supply functions for characteristics of the commodity [Dennis Epple, 1987]. The primary purpose of this research is to relate property prices to property characteristics and then forecast how the property values will change given changes in the characteristics of its location inside or outside an urban growth boundary.

The procedure used to measure the price effects of a change in characteristics of a property can be briefly described as follows: Once the hedonic price function $P(Z_1,Z_2,...Z_n)$ has been estimated, the price of individual properties may also be estimated. Suppose one of the characteristics of this property changed, say Z_1 from level Z_1^0 to level Z_1^1. Now it is possible to estimate the new hedonic price $P(Z_1^1,Z_2^0,...Z_n^0)^1$.

2.3 Formation of the Hedonic Price Function--Bid Curve vs. Offer Curve and Market Equilibrium

The hedonic price function can be shown to be the equilibrium between demand and supply in a market for some composite goods. In this section the relationship among the hedonic price function, the bid curve of the consumers, and the offer curve of the sellers will be illustrated.

Bid Curve

The utility function of a consumer who consumes m undifferentiated goods and one composite good may be expressed as $U(X_1,X_2,...,X_m,Z_1,Z_2,...,Z_n)$, where $X_1,X_2,...,X_m$ are the m undifferentiated goods and $Z_1,Z_2,...,Z_n$ are n characteristics of the composite good. If this utility function $U(X_1,X_2,...,X_m,Z_1,Z_2,...,Z_n)$ can be written as $U(U^*(X_1,X_2,...,X_m),Z_1,Z_2,...,Z_n)$ then goods $X_1,X_2,...,X_m$ are said to be separable from $Z_1,Z_2,...,Z_n$. Given this condition, $X_1,X_2,...,X_m$ may be represented in U by the aggregator $U^*(X_1,X_2,...,X_m)=\mathbf{X}$. Set the price of **X** equal to unity and measure income, y, in terms of units of X:$y=x+P(Z)$ (normalizing the prices) . Also, assume that the consumer purchases one unit of composite good, thus the consumer's problem is to:

$$[Max]U=U(X,Z_1,Z_2,...,Z_n)$$

In other words, the consumer's objective is to maximize utility by choosing the desired combination of characteristics while meeting a budget restriction. Now define the bid function with respect to Z_1 as:

$$B=B(X^*,Z_1,Z_2^*,...,Z_n^*;u^*,y)$$

such that:

$$U(y-B,X^*,Z_1,Z_2^*,...,Z_n^*)=u^*$$

That is, the amount a consumer is willing to pay for alternative values of

Z_1 at an optimal utility level and fixed income is given by $B(Z_1, Z_2^*, \ldots Z_n^*; u^*, y^*)$. It defines a family of indifference surfaces relating the Z_1 with money. Differentiating the utility function, given the condition that U is monotonic in Z_i and **X**, it follows that:

$$B_{Z_i} = U_{Z_i}/U_x > 0; B_u = -1/U_x < 0; B_y = 1$$

$B_1 = B_1 (Z_1, Z_2^*, \ldots Z_n^*; u_1^*)$ (1)

$B_2 = B_2 (Z_1, Z_2^*, \ldots Z_n^*; u_2^*)$ (2)

E is a curve that envelopes B_1 and B_2.

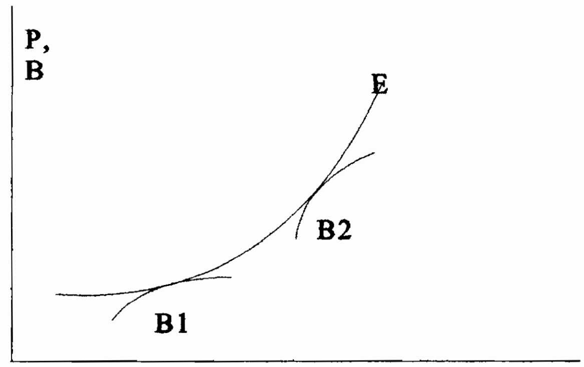


Figure 2.1 Bid Curves

The equation (1) shows that the value of a composite good is increasing in Z_1, if Z_1 is assumed to be a normal good. Equation (2) implies that at fixed income a consumer's utility level will decrease as his bid price on the composite good rises.

As indicated in Figure 2.1, two bid curves, representing two consumers with different income levels, are shown in the B-Z_1 plane. A curve that

[1] Z_1 is assumed to be a normal good.

envelopes these two bid curves is also drawn in this Figure. The consumer with a higher income level will prefer a property with more Z_1, consistent with a higher level of utility.

B. Offer Curve

This discussion of offer curve is primarily based on Rosen's work [Rosen 1974]. To begin, let $P(Z_1,Z_2,...,Z_n)$ denote the hedonic price function for the composite good, which indicates the price that suppliers can receive for the composite good with characteristics $Z_1,Z_2,...,Z_n$. Let $C(Z_1,Z_2,...,Z_n)$ be the cost to the firm of producing the composite good. Now define the profit of suppliers as:

$$\pi = P(Z_1,Z_2,...,Z_n) - C(Z_1,Z_2,...,Z_n)$$

The supplier's or the producer's objective is to maximize his profit by choosing the proper design of vector Z while staying within his budget. The first order condition of the profit function implies that the suppliers' profit is maximized when the marginal cost of Z_i is equal to its marginal revenue.

The offer curve $O(Z_1,Z_2,...,Z_n;\pi)$ is defined as the price a supplier is willing to accept on design $Z_1, Z_2, \ldots, Z_n$ at profit level π. As depicted in Figure 2.2, where

$$O(Z_1, Z_2^*, \ldots, Z_n^*; \pi)$$

defines a family of offer curves on the Z_1-O plane cut through the indifference surface at the optimum values of the other characteristics. Two suppliers with different profit levels are shown in Figure 2.2. A curve that envelopes these two offer curve is also drawn(this enveloping curve is later shown to be the hedonic price function). The curve labeled O^2 refers to a supplier with a different cost function and who can achieve a higher profit level π_2.

$O_1 = O_1(Z_1, Z_2^*, \ldots Z_n^*; \pi_1^*)$

$O_2 = O_2(Z_1, Z_2^*, \ldots Z_n^*; \pi_2^*)$

$P = P(Z_1, Z_2^*, \ldots Z_n^*)$

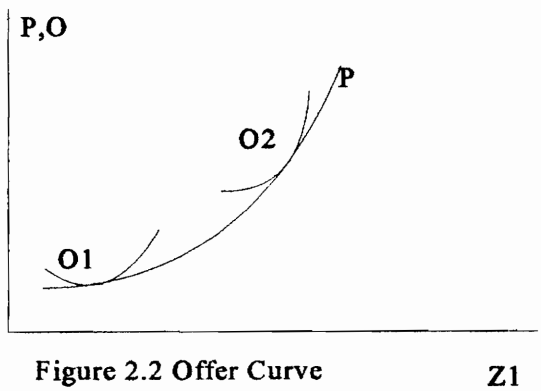


Figure 2.2 Offer Curve

Description of the Market Equilibrium

In the market, every transaction between a consumer and a supplier must happen at the point that is on both the bid curve of that particular buyer and the offer curve of that particular seller. Otherwise the transaction would be infeasible for either one of them. The function that describes these transaction points (or the tangency points between bid curves and offer curves) is the hedonic price function $P(Z_1,Z_2,...Z_n)$. Provided the market is large (many transactions), the hedonic price function can not be affected by any individual's decision. Therefore, the hedonic price function is taken as given by both the buyers and the sellers and depicts the minimum price a consumer must pay to obtain the composite good with characteristics $Z_1,Z_2,...Z_n$ and the maximum price a supplier can get from selling this composite good. So the hedonic price function represents the set of equilibrium points between consumers and suppliers. A hedonic price function is depicted in Figure 2.3.

$$B_1=B_1(Z_1,Z_2^*,...Z_n^*;u_1^*)$$

$$B_2=B_2(Z_1,Z_2^*,...Z_n^*;u_2^*)$$

$$O_1=O_1(Z_1,Z_2^*,...Z_n^*;\pi_1^*)$$

$$O_2=O_2(Z_1,Z_2^*,...Z_n^*;\pi_2^*)$$

$$P=P(Z_1,Z_2^*,...Z_n^*)$$

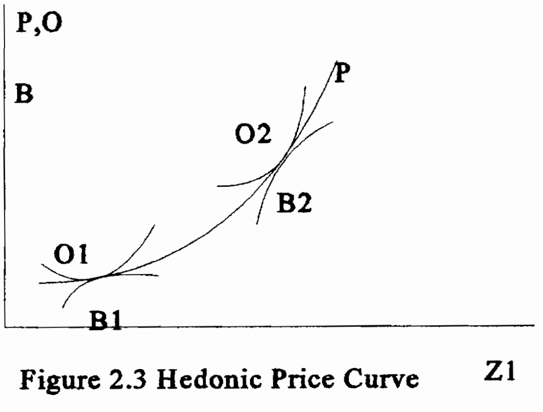


Figure 2.3 Hedonic Price Curve

It is very important to be aware that the hedonic price function in Figure 2.3 is an equilibrium achieved under a particular set of aggregate supply conditions and for particular consumer preferences and incomes. It is prone to shift given a shift in either offer curves or bid curves. Such a shift in the hedonic price function may be brought about by some "non-marginal" change, which is the major topic of next section.

2.4 Marginal and Non-marginal Change

The hedonic model is often utilized to measure the fluctuations in the values of the composite goods caused by some changes in the characteristics of these composite goods. To set up a correct hedonic model, the nature of the changes in the characteristics of the composite goods must be analyzed with caution, which leads to the main topic of this section.

Marginal Change

Marginal change is defined as the changes in the characteristics which only influence few of the composite goods in the market and therefore do not bear enough weight to shift the hedonic price function. For instance, suppose there are a number of properties by a lake, 90% of them have aquatic weeds and the rest 10% do not. Imagine an environmental program aiming at getting rid of the aquatic weeds for some properties, but this program is small-scale and only 0.1% of the properties that had aquatic weeds are included in this program. So after the program is executed, the properties without aquatic weeds will increase by only 0.09%. This change is regarded as a marginal change, because 0.1% increase in properties without aquatic weeds is so small to the whole property market that it does not change the supply conditions of properties without aquatic weeds. In this case the offer curves will remain in their original positions and the hedonic price function will not shift at all. More specifically, in the hedonic price function, the true value of the coefficient associated with the characteristic of presence of aquatic weeds will remain the same and so will the others. The simple method introduced in section 2.1 is therefore applicable to the estimation of the price changes of those properties that are affected by this environmental program.

Non-marginal Change

Non-marginal change is defined as such changes in the characteristics of composite goods that are significant enough to affect the market demand and supply equilibrium and cause the hedonic price to shift. Take the environmental program above for example, if the program affects 50% of the properties that had aquatic weeds, a non-marginal change will happen. Because now the supply of the properties without aquatic weeds increases 45%, which is a substantial increase to the whole property market. Due to this substantial increase in the supply of the properties without aquatic weeds, the prices of these properties will drop. Graphically, in the one dimension figure drawn on the price-PW(presence of aquatic weeds) plane, the offer curves will shift down. New tangency points between bid curves and offer curves will take place somewhere below the original ones. Correspondingly, the hedonic price function will drop, so in the hedonic price function the value of the coefficient associated with PW will no longer remain unchanged, instead it will be diminished in the new hedonic price function.

This situation can be depicted in Figure 2.4 on the Z_1 - P plane (Z_1 is the characteristic of presence of aquatic weeds), P^1 refers to the original hedonic price function and P^2 is the new one lowered by an exogenous change in Z_1.

However in application of the hedonic model, researchers somehow

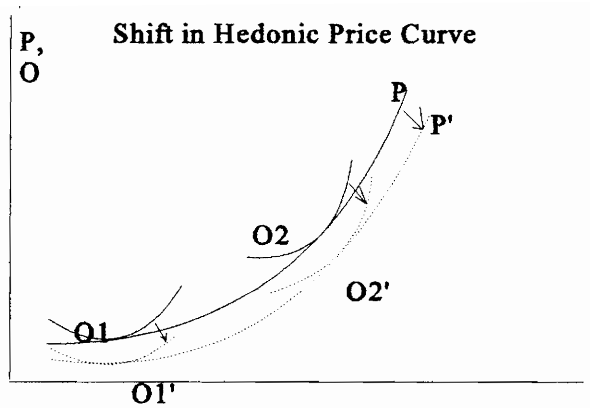


FIGURE 2.4

often fail to recognize the non-marginal change and therefore the shift in the hedonic price function as well. For instance, Ridker and Henning (1967) examined the relationship between air quality and land values by regressing mean property value by Census tract in the St. Lois Metropolitan Statistical Area on a number of explanatory variables, including two measures of air pollution. They derived a significant coefficient of sulfation and then concluded,

This information can be interpreted as meaning that if the sulfation level to which any single family dwelling unit is exposed were to drop by 0.25mg./100cm^2/day, the value of that property could be expected to rise by at least $833 and more likely closer to $245. Using the latter figure and assuming the sulfation levels are reduced by 0.25 mg.

but in no case below 0.49 mg. (taken as the background level) the total increase in property value for the St. Louis metropolitan statistical area could be as much as $82,790,000... If our model of housing market is reasonablely correct, householders should be willing to pay at least this amount for the specified reduction in pollution levels.

Their mistake was initially discovered by Freeman (1971). He pointed out that the second sentence in this paragraph is invalid and concluded " R-H have over-interpreted the regression equation. This equation only purports to explain the variation in mean property values among observations. The air pollution coefficient can be used to predict the difference in property values between two properties within a system under ceteris paribus[1] conditions, and these conditions must include no change in air quality over all other land in the system. But the regression equation can not be used to predict the general pattern of property values or change in the value of any given property when

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Ceteris paribus conditions assume that a demand schedule shows the relation between the nominal price of commodity and the quantity it demanded, all other demand influences held constant, thus when an individual's demand schedule is constructed, his or her preference pattern, nominal money income, and nominal price of related commodity are held constant. Here the commodity and the demand for the characteristics of the commodity can be translated as characteristics of the commodity and demand for the characteristics of the commodity, respectively. Similar description can be given to supply problem.

the pattern of air quality over the whole urban area has changed."

What Freeman noticed is that R-H failed to consider the shift in the hedonic price function caused by a non-marginal change. In fact, after the air quality over the whole urban area has changed, the shift in the hedonic price function will take place and can be described like this: after a overall improvement to the air quality over the whole urban area, the supply of properties with better air quality will increase significantly, and because of this enormous increase in supply, the property owners whose properties already have good air quality before the improvement will have to lower their offering price on their properties. This implies that a property that has good air quality after the improvement will be worth less than a property that has the same level of air quality before the improvement, which means the air quality now bears less importance in the hedonic price function. Like the aquatic weeds example, if we draw a one-dimension figure on the Price-Air quality plane, the offer curves with respect to the air quality will move down and so will the hedonic function. R-H did not realize that changes in supply conditions had happened and resulted in an effect of shifting down the hedonic price function and shrinking the coefficient of air quality. They then overestimated their results by using the old coefficient of air quality obtained from the original hedonic price function.

A summary for R-H's mistake would be they erroneously treated a non-marginal change as a marginal change. Since non-marginal change can cause the shift in the hedonic price function, it is very important to know whether the change in characteristics of composite goods is marginal or non-marginal. If the change is non-marginal the shift in the hedonic price function must be identified and measured.

For this study the change in land available for development caused by the green line policy is considered a marginal change. The area, which is not only in Virginia Beach but also in surrounding counties, affected by this policy is small. The Total area of the Norfolk metropolitan area is 1.1 million acres. The area below the green line is 106,000 acres, or 9.6% of the total area. Also much of the 10,600 acres below the green line is remote from the center of the area and is served by poor roads. Therefore the gross amount of land desirable for development is overstated in the area below the green line. Also after 1979 there were still many vacant land parcels in the north available for unrestricted development. Therefore it is assumed that the green line policy will not cause the hedonic curve to shift, although price effects in both south and north of the green line may be observed.

Chapter 3: Econometrics Issues of estimating Hedonic Price Function

3.1 Problems Involved in Estimation of Hedonic Price Function

There are at least five major issues involved in estimation of the hedonic price function: functional form, multicollinearity, spatial autocorrelation, omitted variables and simultaneity. In this section they will be discussed separately.

3.1.1 The form of hedonic price function

Choice of Functional Form

Selecting a form of the hedonic price function is a fundamental problem of the hedonic model. One well known problem with the hedonic model is that the true form of the hedonic price function is unknown. This may lead to inaccurate estimates of the importance or weight of the characteristics included in the function. Rosen (1974), Freeman(1974,1978) pointed out that the microeconomic theories provided few suggestions for functional form to use in estimating the hedonic price function. This is because the hedonic price function is a reduced-equation resulting from the interaction of supply and demand. In fact, the actual mathematical relationships between various characteristics in the hedonic model are very difficult to derive, if not impossible. However, in practice, the choice of functional form is often based on convenience or simplicity. Relatively simple forms such as the semi-log or double-log have often been used. Five functional forms that are widely used in research are listed below:

$$[linear] P = \beta_0 + \sum_{i=1}^{n} B_i Z_i$$

$$[Semi\text{-}log] lnP = B_0 + \sum_{i=1}^{n} B_i Z_i$$

$$[Double\text{-}log] lnP = \beta_0 + \sum_{i=1}^{n} B_i lnZ_i$$

$$[Quadratic] P = B_0 + \sum_{i=1}^{n} B_i Z_i + \sum_{i=1}^{n} \sum_{j=1}^{n} B_{ij} Z_i Z_j$$

$$[Quadratic\ Box\text{-}Cox] P^{(\gamma)} = \beta_0 + \sum_{i=1}^{n} \beta_i Z_i^{(\alpha)} + \sum_{i=1}^{n} \sum_{j=1}^{n} \beta_{ij} (Z_i Z_j)^{(\alpha)}$$

where in Quadratic Box-Cox function P and Z are the Box-Cox transformations.

The linear function seems to be a poor choice. This is because this function fails to reflect the fact that substitution rate between characteristics is increasing and the marginal price of a characteristic is decreasing. For example, a house that has three bedrooms and one bathroom will have a different price than a house that has one bedroom but three bathrooms, if their other characteristics are the same. But the linear function implies that consumers are willing to trade off bathroom for bedroom at a constant rate, even when there is only one bathroom. In this linear function the increasing difficulty in substitution is not reflected. Therefore, a linear function is not a good choice although it is simple.

Second, although the above problems do not exist in the Semi-log function, past experiences indicate that the results obtained from this function are not as ideal as that of the Double-log function in terms of minimizing the errors in estimating the hedonic function [Maureen L. Cropper, Leland B. Deck and Kenneth E. McConnell, 1988]

The Quadratic and the Quadratic Box-Cox function are suggested by Halvorsen and Pollakowaski (1981) and extended by Maureen L. Cropper (1988) and Maureen L. Cropper, in their research they claim that when all characteristics are observed the linear and quadratic Box-Cox function produce lowest mean percentage errors, when some characteristics are unobserved or are replaced by proxies, linear and quadratic Box-Cox functions perform best. But Cassel and Mendelsohn (1985) mention three substantive arguments against using the Box-Cox function: (1) the transformation, while highly flexible and nonlinear, is obtained at the cost of estimating more parameters (α,γ), which decreases the precision with which each parameter is estimated; (2) there is no assurance that best-fitting functional form for the hedonic price function will yield better estimates of the weights of the characteristics; (3) the computational cost for a Box-Cox model is substantial. Because of these disadvantages, the Box-Cox function was not chosen.

Based on the above analysis, the double-log function, also called Cobb-Douglas function, seems to be the best alternative. It is not only simple and convenient but economically reasonable.

3.1.2 Multicollinearity

The correlation among regressors is called collinearity. Collinearity is a common problem in hedonic models. For example, in a hedonic housing model, a house with larger size always has a larger number of bedrooms. As a matter of fact, in a hedonic model, the collinearity is nearly unavoidable. The consequences of the correlations among the variables in the hedonic function are: (1) large variance and covariance of OLS estimators; (2) wider confidence intervals, lower t-ratios; (3) sensitivity of OLS estimators to small changes in the data. In words, the problem that results from collinear characteristics is that it may be difficult to isolate the individual influence of the regressors on the function values.

There are two widely used solutions to this problem; (1) omit certain variables, or (2) use a large sample. First, omissions of certain important variables in the hedonic function will not solve this problem very well. The reason is that such omissions will make the OLS estimators biased. Another alternative is to use a large pool of data. The variance of the estimator Z_1 in a 3-regressor function is:

$$Var(\beta_1)=\sigma^2/\sum lnZ_{1i}^2(1-r_{1i}^2)$$

where: r_{1i} is the correlation coefficient between Z_1 and Z_i. There are three conditions under which the variance of the estimators will be small; (1) the correlation coefficient for the Z's is small and (2) the variances of the lnZ's are large and, (3) σ^2 is small. So the damage from collinearity among characteristics can be minimized by (1) using a very large sample and (2) selecting a relatively uncorrelated set of characteristics. Since in this study the observations chose for regression are about eight hundred, the collinearity can be significantly abated.

3.1.3 Omitted Variable

There are two common situations for omissions of characteristics; (1) failure to recognize some characteristics because the data on these characteristics are not available, or these characteristics are very difficult to measure and (2) misspecification of the hedonic price function, a characteristic might be omitted simply because the researchers do not believe that it should enter the price function.

Except those two reasons above, in reality, in most hedonic models, such omissions are empirically unavoidable. Because (1) the more characteristics used the more thorough the descriptions of the hedonic price function are. However, it is doubtful that consumers are so attentive to every characteristic or knowledgeable about them; (2) the more characteristics used the more likely the collinearity will happen. Hence some unreasonable results might emerge. For instance, in the vitamin price equation estimated by Jones (1988), the shadow price of calcium, copper, chromium, and iodine are negative. Therefore, although omissions of characteristics will cause typical econometrics misspecification errors, certain characteristics have to be eliminated. On the other hand, if too few characteristics are used, the choice can be too random and may not be representative of the features of the hedonic goods. With these in mind, our purpose is to minimize the damage from omissions by selecting proper set of characteristics through a appropriate statistical procedure.

However for undeveloped vacant land the important characteristics that have significant impacts on price are limited. The price is related to the parcel's acreage, location in the city and the pressure development at the time the parcel was sold. These variables can be obtained either directly from the original data set or created with the help of GIS, so the problem of omitted variable is unlikely to happen.

3.1.4 Simultaneity

In hedonic model, simultaneity bias will arise if the price of the goods can in turn affect the characteristics. For example, in housing market, if the construction of the houses was completed ten years ago, the problem of simultaneity will not appear, because obviously, it is impossible that the current prices will influence the characteristics of the houses, since theses houses have already been built and the characteristics are fixed on these houses. But in the case that there are new houses appear every year, simultaneity may arise, because the house producers, based on current market situation, will reasonably repackage the characteristics of the new houses to satisfy the current demand for various characteristics, so the current price will have impacts on the characteristics of the new houses. But particularly, in land market, the supply of vacant land is fairly fixed. Land parcels are already there and can not be created. So in hedonic land price model, the simultaneity is very unlikely to happen.

Chapter Four: Model and Data

4.1 Data Development and Review

The data used in this study were obtained from individual records of property sales in the Virginia Beach area. The original data were stored on three tapes, which were then read into three computer files. After merging these three files, each observation has 121 variables, which can be classified into four categories:

(1)legal information, containing details like the current legal owner, mortgage information and the zoning code.

(2)characteristics of the property. These characteristics portray the physical features of the property like the acreage of the property, the detailed attributes of the building on it if there is any, utility supplies such as water and sewer supply, etc.

(3)sales information, like the most recent sale price, sales date, sales remarks and new owner etc.

(4)location-related characteristics describe the precise map location of the property and neighborhood this property is located in, which provide the possibility of deriving further information like the distance to city center.

The initial data pool contain 139,620 property observations. They can be classified by its current state of use, which is called class code. The class codes from 100 to 111 are the urban single family residential; 200 to 210 are the suburban single family residential; 301 to 310 are the multi-family residential; 400 to 460 are the commercial and industrial properties; 500 to 605 are the undeveloped agricultural land parcels; and 700 to 720 are the governmental properties with tax exemption.[1] The class codes we use to sort out the undeveloped vacant land are 400 (commercial vacant), 450 (industrial vacant) , 500 (agricultural undeveloped 19 to 99 acres), and 600 (agricultural undeveloped over 99 acres).

Because this was a hedonic study of vacant land parcels the initial data organization process involves three steps. First, delete those properties that are not vacant land by the class code. Second, these vacant parcels are further checked to see if there are buildings on them, if there are then they are deleted. This step is to assure that only the undeveloped vacant land parcels are included. Third, delete those undeveloped vacant land parcels without sale price, sales date or information of acreage. After those three steps there are 799

Refer to appendix A for details of the class codes observations left. They are our final data for regression. The table below lists the frequency of the 799 valid observations by class code.

Table 4.1 Frequency by Class Code

Class Code	Number of Observations
400	45
450	78
500	528
600	148

4.2 Selection of Variables for Model Estimation

The next step is the selection of relevant property characteristics. The process of variable selection is governed by both the land price determination mechanism and the data available. In other words, the factors which have none or very slight impact on determining land price are left out. However for vacant land the important elements are not as many as that of housing, and they can be identified or derived from the original data pool. Following are the variables that are used in the real regression model and the way they are derived.

Sale Price and Sales Date

The very first information about a land parcel we need is its sales price and sales date. Parcels without either one of them are eliminated. The sales prices of parcels sold after 1969 were inflated to the 1994 value by the price index collected from the "Homesales Yearbook". The Homesales Yearbook is a publication of the National Association of Realtors. This book contains an index of Average Single Family Home Sales Prices for the South. The index includes property sales in Alabama as well as Virginia, Tennessee, Mississippi, Georgia, Florida, and the Carolinas. The average single family home sales prices for the Virginia are chosen as the approximation of the general property inflation rate of the larger market of which Virginia Beach is a part. But this price index are only available from 1969 to 1994. The property price index from 1959 to 1968 were obtained from the CPI(consumer price index)'s publication of 1994. The CPI property price index is then used to approximate the inflation rate from 1959 to 1968 of Virginia Beach[2]. Table 4.2 lists the frequencies of different price ranges.

[2] See appendix for price index used.

Table 4.2 Range of Unit Price

Unit Price($/acre)	Number of Parcels in that Price Range
500~2000	43
2000~5000	119
5000~20000	289
20000~50000	215
>50000	130

Acreage

In the original data, the number of acres were stored in the field called PACRES which are integers and are divided by 1,000 to get the real number. But the acreage can also be found in another variables called legal description, and it is used to get the number of acreage for the parcels which are vacant land but don't have acreage in PACRES. The table below lists the frequency of the range of acreage.

Table 4.3 Range of Acreage

Range(acres) of Acreage	Number of Observations
0~2	155
2~5	235
5~10	232
10~20	65
20~50	70
>50	42

Location Variable

Another important characteristics of a land is its location. Two land parcels having similar set of characteristics except for their locations will usually have different prices. The one located in better or more desirable neighborhood will be priced higher. Hence in the model, the impact of location of the land must be considered.

However, in empirical research, the location variable itself can take several forms. The most common is a distance variable, usually the distance to the center of the city. But problem may arise when use this distance variable to explain the price effects of location, if the price effect of the distance to the center of the city on land property is not monotonic, which is very normal in the real world. Few rich people wants to live in the heart of the city, because it is too noisy and crowded as well as insecure. The properties are hence depreciated for that. And as the location moves further the property price goes higher, because the problems existing in the city center abate there, and it is still fairly convenient to travel to the city, the school, shopping center etc. But the property price will go down if the property is too far away from the city, increasing the cost of and the time spending on commuting. Therefore instead of having a steady relationship as depicted in Figure 4.1, the true relationship between the distance and the property price is more like what described in Figure 4.2.

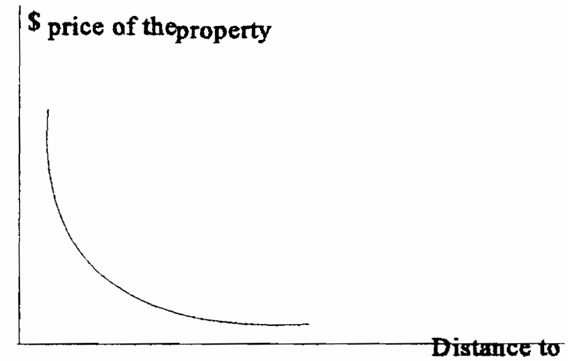


Figure 4.1 Monotonic relationship between Price and Distance

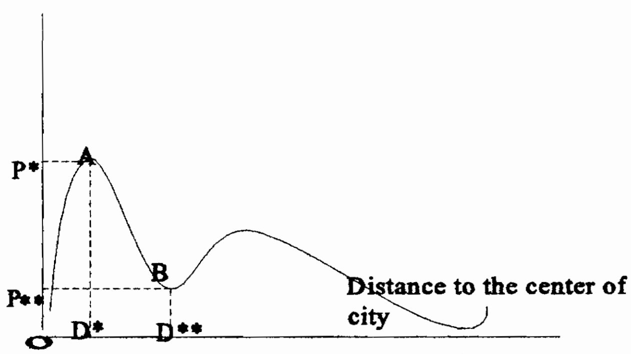


Figure 4.2 Unmonotonic Relationship between Price and Distance

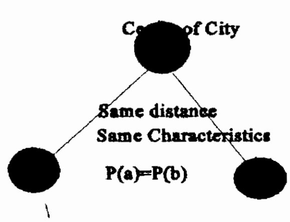


Figure 4.3 Same Distance and Characteristics but Different Prices.

Further more, even if two parcels have exactly the same characteristics including the distance to city center they could still end up with different prices. Like that showed in Figure 4.3. The reason might be the property buyers don't equally evaluate the two neighborhoods where those two parcels are located. One is preferred to the other by the buyers. So the distance variable does not function well to explain the price differences for parcels which locate in differentiated neighborhoods. However, there are one alternatives to solve this problem, that is to divide the whole city into a number of homogenous areas or boroughs and then introduce these borough variables as dummy variables into the model. By this mean, we no longer need to worry about whether the distance is monotonic or not. These can dummies can explain the price differences described above and tell us which neighborhood is more favored than the other.

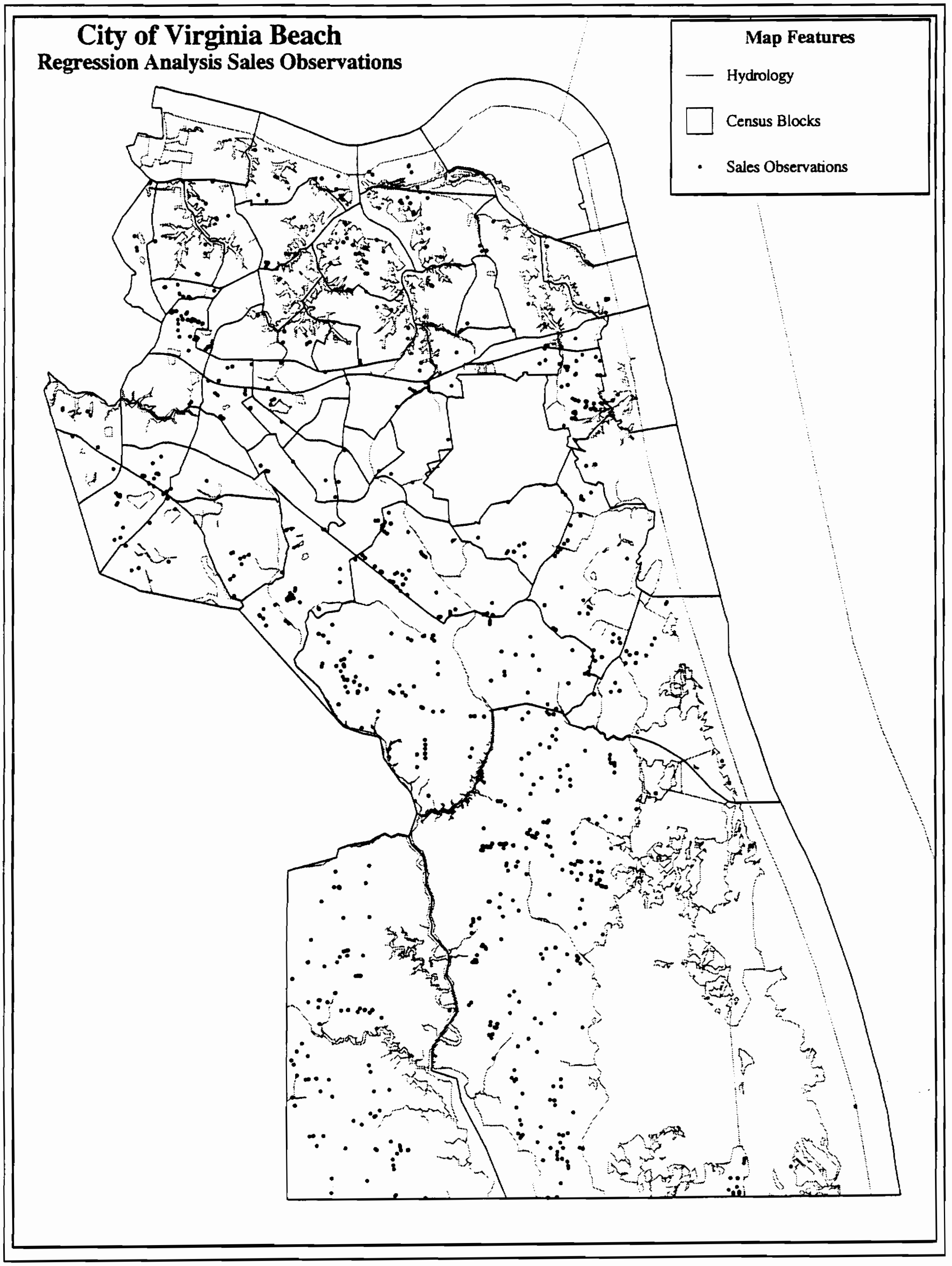
But to divide the neighborhoods correctly, we need a detailed and precise map of this city and a excellent judgement. Fortunately, these borough variables can be easily obtained from the GIS (Geographical Information System). In the original data, the location of each land parcel is depicted by a 14-digit number called pin number, which is, in fact the transformed combination of longitude and latitude codes of the land. The city map has been charted precisely as a computer file by the GIS and every parcel can be pinpointed on this computer map according to its pin number and can be told which census block it is in(the census blocks are defined by the state, they basically are the small neighborhoods). There are 69 census blocks in Virginia Beach area and the land parcels in regression are located in 64 of them. These census blocks that are similar and adjacent are aggregated, the principles for aggravations are explained in chapter 5. Table 4.4 lists the frequencies by these census blocks. Map 4.1 and 4.2 show the outline of the census blocks and the locations of the parcels used for regression.

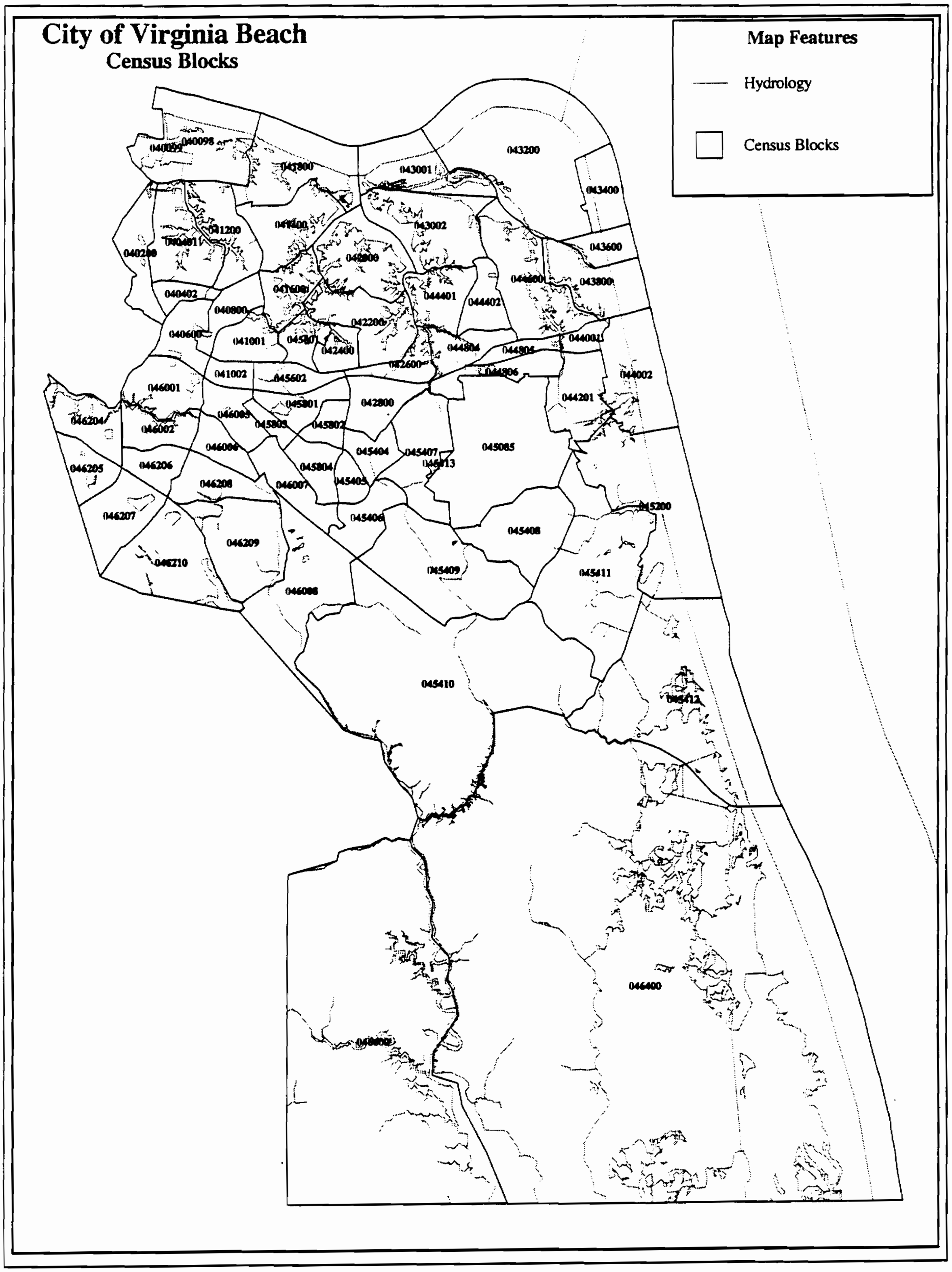
Development Rate

The effects of development pressure on prices must be considered. The reason involves the fact that land parcels might face different development pressure at different time and the development pressure will certainly affect the buyers' willingness to pay to buy a piece of land. Higher development pressure will enhance the demand for vacant land parcels and increase their prices. The change in development pressure is measured in two ways. One measure is the

Table 4.4 Distributions of Observations Over Aggregated Block

Block	No. of Observations
40200	3
40401	5
40402	9
40800	10
41001	1
41002	4
41200	5
41400,41800,42000,45601	40
41600	1
42200,44401	12
42600,42800,44804	9
43001	7
43002	14
43800	5
44001	2
44002	4
44201	36
44402	3
44600	3
44805	4
44806	5
45200	3
45404,45405	7
45406	5
45407,45408	14
45409,45410	129
45411	28
45412	17
45602	3
45804	2
46001,46005,45803,45801,40600	46
46007	5
46008,46208,46209	42
46204,45205,45207	20
46206	9
46210	8
46400	225
46600	87


City of Virginia Beach
Regression Analysis Sales Observations
Map Features
Hydrology
Census Blocks
Sales Observations


City of Virginia Beach
Census Blocks
Map Features
Hydrology
Census Blocks

movements of urban development center. For example, suppose there is one parcel sold in 1970 for $1,000, now the time is 1990 and the development center has been moving closer and a lot of houses have been built since then, then this parcel will be worth more than $1,000 in 1990 regardless of inflation. A second measure is the accumulative development in the whole city over time. Two development rate variables are created to measure the effect of development pressure.

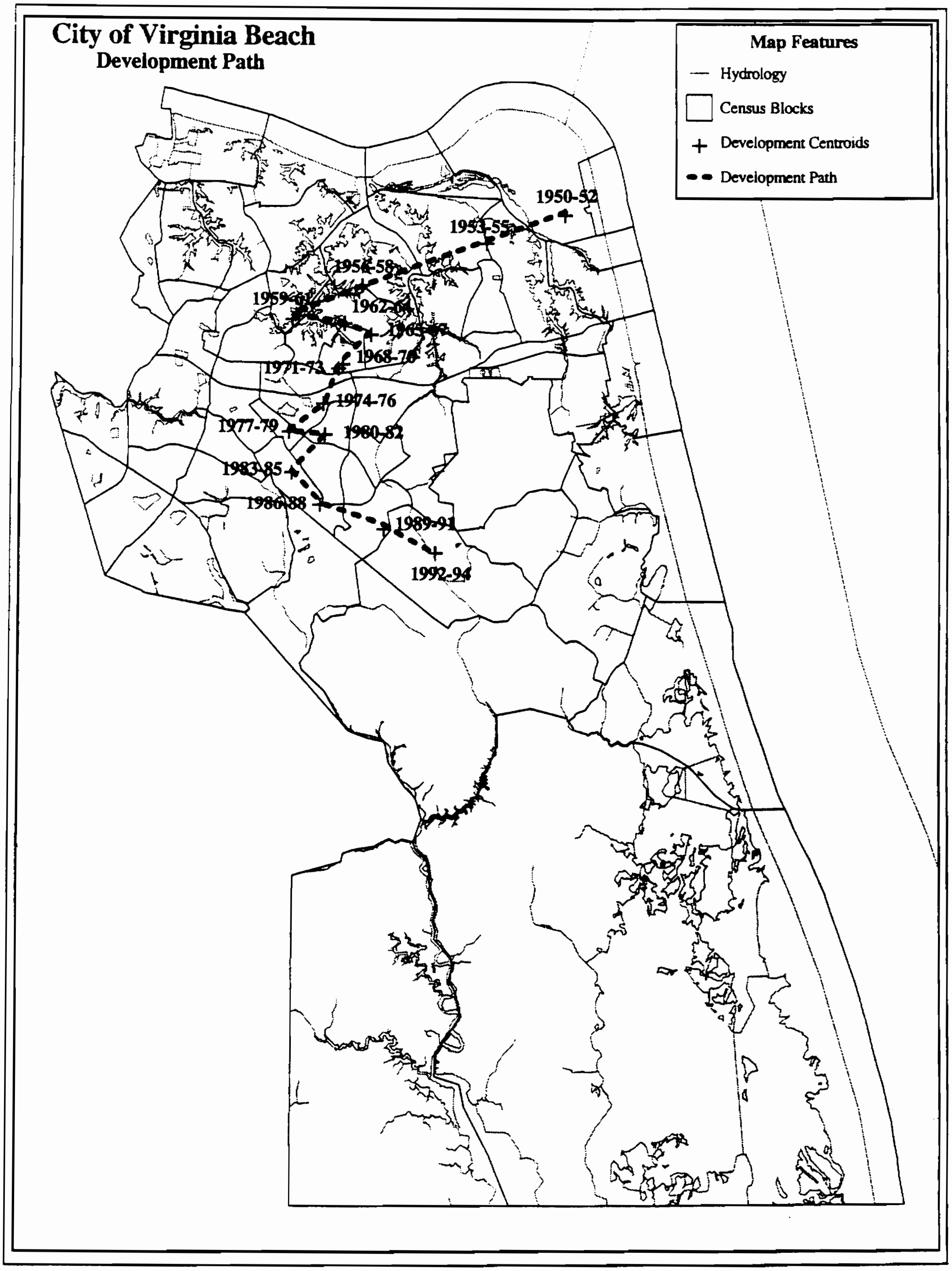
(1)Distance to the construction center. Usually, the precise movements of development center are difficult to find. However, with the help of GIS and computer they can be located. The method is to use computer to sort the new construction of all buildings, commercial and residential, by year and print each new construction location on the map. Using the construction density for each year it is possible to identify the development center for that particular year. The computer will draw the outline of this block and find the center of it, which is regarded as the development center of that time period. Then the distance from each parcel to each development center is calculated using GIS software. The parcels sold after 1959 for regression were chosen, so 1956 was set as the base year and every three years was a period. This results in 14 development centers. Then for each parcel two distance variables are obtained:

distance to the development center for the time of sale and the distance to the development center in previous time period.

These two distance variables were not entered directly into the data base. Instead a transformation was performed. Suppose there is a parcel which was 1 miles away from the construction center in 1960, and 16 miles from that in 1990. The fact that the construction center has moved away should not discount the price of that parcel, because the development that occurred in the past didn't move. This parcel is still 1 mile away from these developments, so the development pressure for this parcel should remain the same. However for the parcels which are closer to the development center the situation is different. Being closer to development center brings higher demand for these parcels. Therefore only the parcels toward which the development is moving should be considered. But these two distance variables are included directly, this difference can not be picked up. So it is necessary to transform them so that the parcels that are further from development center than will not be discounted. The method is if $D_t > D_{t-1}$ then set $D_t = D_{t-1}$ and if $D_{t-1} > D_{t-2}$ then set $D_{t-1} = D_{t-2}$[3]. Map 4.3 shows the development path from 1950 to 1994.

3

D_t is the distance to the development center for the time of sale, D_{t-1} is the distance to the development center in previous time period.


City of Virginia Beach
Development Path
Map Features
Hydrology
Census Blocks
Development Centroids
Development Path
1950-52
1953-55
1956-58
1959-61
1962-64
1965-67
1968-70
1971-73
1974-76
1977-79
1980-82
1983-85
1986-88
1989-91
1992-94

(2)Cumulative construction. For each parcel, the cumulative number of new constructions in the year starts in which the parcels was sold was calculated. The vacant land parcels available are limited and can be considered as a fixed inventory. As new buildings are built, the vacant land parcels are consumed and the inventory decreases. So, cumulative construction can represent the decrease in the supply of vacant land, which is a major determinant land value. Table 4.5 lists the annual construction numbers and cumulative numbers from 1959 to 1994.

Green Line Variables

As stated in the first chapter, the green line policy introduced in 1979 actually divided the whole area into two parts, north and south. The parcels in north and south have been, since then, regulated differently in terms of development rights. One of the objectives of this research is to see if this policy has any effects on the prices of land parcels sold after 1979. So we first create two dummy variables called 'south' and 'north'. If the parcels lies to the north of green line and was sold after 1979 then 'north'=1, or if it's to the south then 'south'=1. In addition, we like to see if this green land policy has changed the

Table 4.5 Annual and Cumulative Construction Numbers

Year Built	Frequency	Percent	Cumulative Number
1951	222	0.2	222
1952	546	0.5	768
1953	770	0.6	1538
1954	615	0.5	2153
1955	1376	1.2	3529
1956	1237	1	4766
1957	1119	0.9	5885
1958	2033	1.7	7918
1959	1554	1.3	9472
1960	2702	2.3	12174
1961	1484	1.2	13658
1962	2959	2.5	16617
1963	1974	1.7	18591
1964	2392	2	20983
1965	1983	1.7	22966
1966	1502	1.3	24468
1967	1779	1.5	26247
1968	2190	1.8	28437
1969	1975	1.7	30412
1970	1323	1.1	31735
1971	2419	2	34154
1972	2830	2.4	36984
1973	2530	2.1	39514
1974	2772	2.3	42286
1975	3418	2.9	45704
1976	2665	2.2	48369
1977	3867	3.3	52236
1978	3833	3.2	56069
1979	3782	3.2	59851
1980	3200	2.7	63051
1981	3125	2.6	66176
1982	4006	3.4	70182
1983	6356	5.3	76538
1984	5733	4.8	82271
1985	7048	5.9	89319
1986	7219	6.1	96538
1987	5678	4.8	102216
1988	4522	3.8	106738
1989	3319	2.8	110057
1990	2023	1.7	112080
1991	1718	1.4	113798
1992	1744	1.5	115542
1993	1832	1.5	117374
1994	1466	1.2	118840

slope of the hedonic price function. Like that in the Figure 4.4, the relationship between acreage and price may be different for parcels in the south and parcels in the north, the price tends to be discounted more for parcels in the south as acreage increases because of the development restrictions. So we introduce two cross-product terms, NLNACRES=LNACRES*NORTH and SLNACRES=LNACRES*SOUTH(LNACRES is log(price)). It is expected that the marginal price acreage should be less in the south than that in the north after 1979 because of the constraints the greenland policy imposed on the parcels in the south, so the coefficient of SLNACRES is expected to be less than that of NLNACRESS.

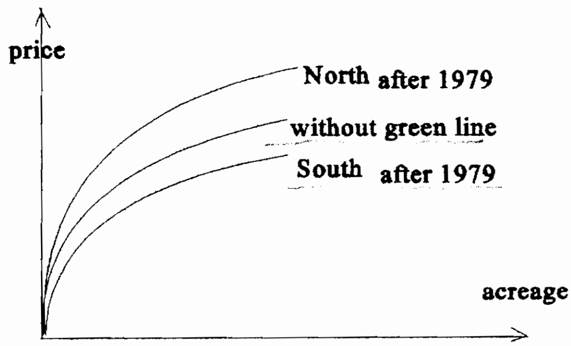


Figure 4.4 Slope Shift after 1979 in North and South

Aggregate Census Block

After variables were selected, a test regression was run. Then some of the 60 census blocks are aggregated according to three rules: (1) the blocks are contiguous, (2) the blocks have similar coefficients, and (3) the coefficients on the blocks are statistically significant.

Regression Equation

So the final regression equation is:

where: pp=the inflated sales price

ACRES=the acreage of the parcel

NLNACRES=the cross-product term of Ln(ACRES) and North

SLNACRES=the cross-product term of Ln(ACRES) and South

B40200...B46213=the census block dummies

North=the north dummy

South=the south dummy

conno=the number of cumulative construction activity

Table 4.6 lists of all the variables used in regression and their expected signs.

Table 4.6 List of Variables Used in the Hedonic Pricing Model

Variable	Symbol	Expected Sign
Inflated Sold Price of Land	PRICE	Regressors
Acreage	ACRES	+
Census Block Dummies[D]		
	B40200	?
	B40401	+
	B40402	?
	B40600	+
	B40800	+
	B41001	+
	B41002	+
	B41200	?
Aggregated with 41800,42000 and 45601	B41400	+
	B42000	-
Aggregated with B44401	B42200	?
Aggregated with B428000,B44804	B42600	+
	B43001	+
	B43002	+
	B43800	+
	B44201	-
	B44402	-
	B44600	?
	B44805	+
	B44806	?
	B45200	+
Aggregated with B45405	B45404	+
	B45406	-
Aggregated with B45408	B45407	?
Aggregated with B45410	B45409	?
	B45411	+
	B45412	+
	B45601	+
	B45602	+
	B45804	+
Aggregated with B46005,B45803 B45801,B46000	B46001	+
	B46007	?
Aggregated with B46208,B46209	B46008	+
Aggregated with B45205,B45207	B46204	+
	B46206	?
	B46210	+
Distance to the Current Development Center	DIST1	-
Distance to the Preceding Development Center	DIST2	-
Cumulative Construction Number	CONNO	+
Parcel Located to the North of Green Line[D]	NORTH	+
Parcel Located to the South of Green Line[D]	SOUTH	-
Slope Shifter after 1979(North)	NLNACRES	a(a>b)
Slope Shifter after 1979(South)	SLNACRES	b(b<a)

[D] are dummy variables the rest are real variables and are put into log form. ? means uncertain.

Chapter 5: Results

5.1 General Statistics of the Variables Used

Table 5.1 describes the mean, standard deviation, minimum and maximum number of each variable. Table 4.2 lists the distributions of these observations over the blocks. There are 799 observations used in the regression. They are located in 40 aggregated census blocks. Most of these land parcels are located in the south area, especially in B46400 and B46400. The developments are concentrated in the north, so there are fewer undeveloped land parcels there. Block 46400 is deleted from the census block dummies. The purpose is to see the comparisons between this block and the other ones.

The range of unit price($/acre) is from $408.13 to $1,901,618.71 and the mean price is $17,541 The range of acreage is from 0.02 acre to 276.95 acres. The mean acreage is 11.25 acres.

Table 5.1 Mean, Standard Deviation, Minimum, and Maximum Value of Variables Used in Hedonic Estimation

Variable	N	Mean	Stdard Deviation	Minimum	Maximum
PRICE	799	197407.09	795464.24	1284.00	12768000.00
UNITPRIC	799	17541.676	158228.94	408.1250000	1901618.71
ARES	799	11.2536944	26.7549768	0.0200000	276.9520000
NLNACRES	799	0.1393296	0.8412044	-3.9120230	4.2413268
SLNACRES	799	0.5300202	1.1604552	-1.9877744	5.6238442
B40200	799	0.0037547	0.0611987	0	1.0000000
B40401	799	0.0062578	0.0789079	0	1.0000000
B40402	799	0.0112641	0.1055990	0	1.0000000
B40800	799	0.0112641	0.1055990	0	1.0000000
B41001	799	0.0012516	0.0353775	0	1.0000000
B41002	799	0.0050063	0.0706218	0	1.0000000
B41200	799	0.0062578	0.0789079	0	1.0000000
B41400	799	0.0463079	0.2102827	0	1.0000000
B41600	799	0.0012516	0.0353775	0	1.0000000
B42200	799	0.0125156	0.1112407	0	1.0000000
B42600	799	0.0112641	0.1055990	0	1.0000000
B43001	799	0.0087610	0.0932474	0	1.0000000
B43002	799	0.0175219	0.1312877	0	1.0000000
B43800	799	0.0062578	0.0789079	0	1.0000000
B44002	799	0.0050063	0.0706218	0	1.0000000
B44201	799	0.0425532	0.2019739	0	1.0000000
B44402	799	0.0037547	0.0611987	0	1.0000000
B44600	799	0.0037547	0.0611987	0	1.0000000
B44805	799	0.0050063	0.0706218	0	1.0000000
B44806	799	0.0062578	0.0789079	0	1.0000000
B45200	799	0.0037547	0.0611987	0	1.0000000
B45404	799	0.0037547	0.0611987	0	1.0000000
B45406	799	0.0062578	0.0789079	0	1.0000000
B45407	799	0.0175219	0.1312877	0	1.0000000
B45409	799	0.1539424	0.3611196	0	1.0000000
B45411	799	0.0350438	0.1840057	0	1.0000000
B45412	799	0.0200250	0.1401735	0	1.0000000
B45602	799	0.0037547	0.0611987	0	1.0000000
B45804	799	0.0025031	0.0499999	0	1.0000000
B46001	799	0.0513141	0.2207759	0	1.0000000
B46007	799	0.0062578	0.0789079	0	1.0000000
B46008	799	0.0500626	0.2182107	0	1.0000000
B46204	799	0.0062578	0.0789079	0	1.0000000
B46206	799	0.0112641	0.1055990	0	1.0000000
B46210	799	0.0100125	0.0996227	0	1.0000000
B46600	799	0.1088861	0.3116914	0	1.0000000
DIST1	799	7.6318773	5.5158064	0.0800000	22.2600000
DIST2	799	8.0103379	5.6671942	0.2100000	22.8400000
CONNO	799	77742.57	33191.65	9472.00	118840.00
SOUTH	799	0.6216521	0.4674029	0	1.0000000
NORTH	799	0.3717146	0.4835654	0	1.0000000

5.2 Regression Result

Effect of Acreage

The coefficient of LNACRES is 0.650471, which means that as the acreage increases by 1% the total price of this parcel will go up by 0.650471%. This coefficient is less than 1 implying a decreasing marginal contribution of acreage to price. The T ratio (25.15) showed this variable is very significant.

Effects of Census Block

The coefficients of the census blocks represent the comparative desirability of these blocks with respect to census block 46400 (see Map 4.1 for its location). In other words, the coefficients of these census blocks indicate which census block is more favored by the vacant land buyers as compared to B46400. From the regression, it appears that almost all the coefficients of the census blocks in the north are positive, which indicates that the vacant land is relatively more expensive in the north than that in the block 46400. The reason might be that the north area are well-developed as compared to the south. The schools, the hospitals, shopping centers, etc. are there, the buyers who take those factors into account are willing to pay more than they would for a similar piece of land in the south. But there are some exceptions, one is block 41600 with coefficient of -2.65 located in the middle of northwest, the other one is block 44402(-1.43) located in the middle of southeast. The land parcels in these two blocks are significantly depreciated. Also there are several census blocks in which the land prices are considerably higher (40401, 43001, 45804 and the blocks in the middle-west). Some census blocks just to the north of green line have negative coefficients(46007, 45406, and 45409).

Effect of Development Pressure

One contribution of this research is to use a distance to development center variable to measure the effects of the development pressure on land prices. The development starts from the northeast, then moved toward west and turned south in the 80's (see Map 5.1 for development path). It is expected that for those parcels in the west and south their price will increase as the development center moves closer to them.

The coefficients of both LNDIST1 and LNDIST2 are negative which

Table 5.2 Estimated Coefficients

Varaibles	parameter Estimate	Standard Error	T ratio	Probability>/T/
INTERCEP	4.424541	0.75875680	5.831	0.0001
LNACRES	0.622309	0.02559022	24.318	0.0001
NLNACRES	0.046446	0.00177954	2.610	0.0097
SLNACRES	-0.071826	0.01996831	-3.597	0.0002
B40200	-0.623379	0.38379223	-1.624	0.1047
B40401	2.578785	0.31244589	8.254	0.0001
B40402	-0.395442	0.24400304	-1.621	0.1055
B40800	0.202325	0.25132790	0.805	0.4211
B41001	3.048874	0.67583602	4.511	0.0001
B41002	0.858970	0.34878685	2.463	0.0140
B41200	-0.600915	0.30737867	-1.955	0.0510
B41400	0.142984	0.19505286	0.733	0.4638
B41600	-3.460704	0.67531111	-5.125	0.0001
B42200	-0.688523	0.26803770	-2.569	0.0104
B42600	1.210517	0.25173757	4.809	0.0001
B43001	1.389468	0.27223192	5.104	0.0001
B43002	-0.077249	0.22898452	-0.337	0.7359
B43800	1.367441	0.31231734	4.378	0.0001
B44002	-0.814614	0.33880200	-2.404	0.0164
B44201	-0.028201	0.14136470	-0.199	0.8419
B44402	-1.974730	0.39185312	-5.039	0.0001
B44600	-0.653937	0.41738559	-1.567	0.1176
B44805	0.659091	0.34294076	1.922	0.0550
B44806	-0.555067	0.30906854	-1.796	0.0729
B45200	2.471001	0.38003063	6.502	0.0001
B45404	0.472851	0.39935961	1.184	0.2368
B45406	-1.673487	0.30798959	-5.434	0.0001
B45407	0.009081	0.18922075	0.048	0.9617
B45409	-0.352497	0.09081015	-3.882	0.0001
B45411	0.768989	0.13976836	5.502	0.0001
B45412	0.117510	0.17013317	0.691	0.4900
B45602	-0.372134	0.41794439	-0.890	0.3735
B45804	1.639992	0.47302301	3.467	0.0006
B46001	0.132912	0.16096671	0.826	0.4092
B46007	-0.826634	0.34518964	-2.395	0.0169
B46008	0.707369	0.14153543	4.998	0.0001
B46204	1.157932	0.30085901	3.849	0.0001
B46206	-0.283121	0.23673828	-1.196	0.2321
B46210	1.839974	0.24440655	7.528	0.0001
B46600	-0.584755	0.08389266	-6.970	0.0001
LNDIST1	-0.736284	0.21477727	-3.428	0.0006
LNDIST2	-0.262415	0.10649951	-2.464	0.0145
LNCONNO	0.675225	0.06693440	10.088	0.0001
SOUTH	-0.246094	0.07396759	-3.327	0.0008
NORTH	0.044803	0.01298637	3.450	0.0007

R^2 0.8314 Adjusted R^2 0.8103 F-Value 65.425 Prob>F-Value 0.0001 N 799 indicates that this expectation is confirmed, a higher development pressure does enhance the land prices. But notice the coefficient of LNDIST1 is more negative than that of LNDIST2, indicating that land price responds more to the current development center than to the preceding one. In other words, the current development pressure has greater impact than the preceding one. The coefficient of LNCONNO is 0.675, indicating as the total construction increases the land prices rise. All of these three variables are very significant, implying that the development rate played a important role in determining the land prices.

Effect of Green line

Primary objective of this study was to see whether the introduction of green line policy in 1979 had any effect on the land prices. Since this policy put some constraints on the land development in south, it is expected that after 1979 the land prices in the south would drop and would be discounted more as the acreage increases. The regression shows that this green line policy did have significant impacts on land prices and signs of the related variables are as expected.

The coefficients of SOUTH and NORTH is -0.2461 and 0.044803, respectively. This indicates that the land prices in the south did fall after 1979 because of this green line policy, but for parcels in the north the prices went up. The explanation is that the development restrictions on parcels in south after 1979 caused a increase in the demand for vacant land in the north, thus increased their prices. The coefficient of SLNACRES is -0.07182(the sum of coefficient of SLNACRES and LNACRES is the marginal price of acreage of parcels in the south, likewise for NLNACRES), indicating that after 1979 the price increases less as acreage increases for parcels in the south. The coefficient of NLNACRES is 0.066446, indicating the increase in the marginal price of acreage after 1979 for the parcels in the north. More specifically, the price effect of green line on a parcel in the north is $100*(e^{0.044803*}(ACRES)^{0.046446}-1)$% increase, for a parcel in the south it is $100*(1-e^{-0.246094*}(ACRES)^{-0.071826)}$% decrease (ACRES is the acreage of this parcel;). Suppose the acreage is equal to 10 acres, the price of a parcel in the south would go up by 10%, for a parcel of the same size the price will fall by 25%. The percentage change in the price depends on the acreage of this parcel.

Simulation of Total Land Value

The second objective of this study was to estimate the effects of the green line on the total value of currently vacant land in Virginia Beach. To achieve this objective a simulation equation model was developed using the estimated coefficients from the regression. The estimated coefficients were used to predict the price for each parcel and these prices were summed up to get the total value. Also, there are 200 parcels that were vacant land in 1994 but were not included in the regression because of the absence of sales price. However they did have an acreage and so were included in the simulation. The estimated coefficients were used to predict the prices of these 200 parcels. The total estimated prices of the 799 parcels and that of these 200 parcels were then added together. The total price showed in Table 5.3 is for the 999 parcels. To get the total price of without the green line, the values of SOUTH, NORTH, and the two cross-product terms were zero, while the others remained the same. Table 5.3 shows the total land prices in the north and in the south with and without green line.

Table 5.3 Total Estimated Land Prices With Green Line

	# of Parcels	Total Acreage	Total Value	Change in Total Value w/o Green Line
North	479	2231.31	110,102,461	
South	520	9272.97	41,607,031	
North(w/o green line)	479	2231.31	105,073,152	-5,029,309
South(w/ot green line)	520	9272.97	52,892,106	+11,285,075

With green line the total value is $105,073,152 for the north, $52,892,106 for the south and $151,709,492 for the whole city. If there were no green linet the total value would be $105,073,152 for the north, 52,892,106 for the south and $157,965,258 in total. So if the green line policy is abolished, the totel land values will go up by about 27% in the south, while in the north the values will fall by 4.56%. However, many vacant parcels in the north were developed after 1979, but the regression didn't take them into account. These parcels affected by the green line had gained value, so the actual total increase in the value of parcels located in the north is underestimated.

Chapter 6: Conclusion

This study has assessed the effect of the green line introduced in 1979 on the price of vacant parcels in Virginia Beach, Virginia. The results were based on a hedonic price model, in which the importance of relevant characteristics of land were included as possible determinants of land price. Among the determinants measures of green line were included in the model. These were a dummy variable for location and a cross-product term with acreage. The theoretical expectation for this green line policy is that it will enhance the price of the unregulated land, while reducing the price of the regulated land.

The other variables included were the acreage of the parcel, census block, cumulative construction and distance to development center. After model estimation, the resulting coefficients were then used to estimate the prices for land parcels that were still vacant in 1994. The prices of all parcels in the north and in the north are summed respectively to get the total land value in the north and in the south. Some parcels that were not used for regression were included in this simulation.

Summary of Results

The regression results showed that the acreage, census block (its location in the city), cumulative construction and the distance variable all played an important role in determining the land price. Also the significance and signs of the coefficients of dummy variables and cross-product terms representing the green line confirm the expectation that after 1979 the prices of land parcels in south dropped and the prices of parcels in the north went up. Despite the fact that the land parcels which were developed between 1959 and 1994 were not included in the regression, a conclusion can be drawn from this study that the green line policy which restrict development in the south after 1979 imposed positive effect on the price of the parcels located in the north and imposed negative effect on the price of the parcels in the south. The abolishment of this policy will result in significant increase in the total price of parcels in the south.

Strength and Weakness

This model used four crucial variables, census blocks and distance to the development center, south and north dummies. These variables are normally difficult to get, so in much research on land valuation they are not considered although they are very important. Fortunately, with the software of GIS and spatial identification number of each parcel, they can be derived precisely. The accurate information on these variables make the results more convincing.

This study did not consider the effect of the change in the expected return of land. As stated in chapter 2, the expected future return has impact on the land price. Therefore, some of the lower prices of parcels in the south after 1979 might have been from a reason other than the green line. Most of the vacant land in the south is zoned as agricultural. If the return to agricultural production fell after 1979, the prices of the agricultural land should go down, This was not considered by the model.

Suggestion for Future Research

The green line was initially introduced in 1979, but some people may have known this policy in advance. This would cause speculation. If this was true, the price structure would start to change before 1979 instead of after 1979. So this research could be extended to test the existence of the speculation.

Another possible extension of this research is to get the information on the parcels that were developed after 1959 and were therefore deleted from the regression data base, and include them in the model.

The possible effects of fallen agricultural return were not considered. A further study needs to be done to encompass the effects of the factors that affect the return of the agricultural land, like the price of the agricultural output and agricultural production cost.

Reference:

Berndt, E.R., 1990, The Practice of Econometrics (Addison-Wesley, Reading, MA)

Court, A.T., 1939, " Hedonic Price Indexes with Automotive Examples" (General Motors Company, New York, NY) 99-117

Cropper, M.L., L.B. Deck, and K.E. McConnell, 1988. " On the Choice of Functional Form for Hedonic Price Functions". *Review of Economics and Statistics*, 668-675

Dunford, W.R., E.C. Marti, and C.R. Mittelhammer. " A Case Study of Rural Land Prices at the Urban Fringe Including Subjective Buyer Expectations." *Land Econ.* 61,1(1985): 10-16.

Epple, Dennis. "Hedonic Prices and Implicit Markets: Estimating Demand and Supply Functions for Differentiated Products". *Journal of Political Economy*. 79(1974):481-507.

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

Feng Xu, Ron C. Mittelhammer, and Paul W. Barkley. " Measuring the Contributions of Site Characteristics to the Value of agricultural Land". *Land*

Economics 69(4):356-369.

Freeman, A.M. " Air Pollution and Residential Property Values: A Methodological Comment." *Review of Economics and Statistics* 53(1971):415-416.

Freeman, A.M. " On Estimating Air Pollution Control Benefits from Land Value Studies." *Journal of Environmental Economics and Management* 1(1974):74-83

Griliches, Z., 1971. " Price Indexes and Quality Change in Zvi Griliches, ed., Studies in New Methods of Measurement (Harvard University Press, Cambridge, MA)

Mendelsohn, R., 1984. " Estimating the Structural Equations of Implicit Markets and Household Production Functions". *Review of Economics and Statistics* 51:673-677

Moore K. C. :Modeling the United States Farmland Market: A test of the Rational Expectations Hypothesis." Selected Paper at the AAEA Annual Meetings, 1987

Moore K. C. and W.H. Myers. "Predictive Economic Modeling of the U.S. Farmland Market: An Empirical Test of the Rational Expectations Hypothesis." *The center for Agricultural and Rural Development*. Iowa State University, 1986

Muellbauer, J., 1974. "Household Production Theory, Quality, and the Hedonic Technique". American Economic Review, 977-994

Ronald E. Grieson and James R. White. " The Effects of Zoning on Structure and Land Markets". *Journal of Urban Economics* 10, 271-285 (1981).

Roren, S. "Hedonic Prices and Implicit Markets: Product differentiation in Pure Competition." *Journal of Political Economy* 82(1974):34-55.

Appendix A: Data Manipulation Process:

The data set was originally stored on three tapes. They were read into computer and then stored on the MVS mainframe under three separate files. The process of organizing the data was to (1). get access to those three raw files, (2) read the variables including unpack the packed numeric variables, (3) merge a number of data sets obtained from the reading into one large file which consists of all the observations and all the variables available, and (4) finally delete the unwanted observations to create a new downsized file for regression.

1. Access to the three files read from the three tapes.

Those three raw files originated separately from the three tapes are manipulated by using sas programs. After execution command, just type the file name. For example, to get into tape1 the following command need to be entered,

```
// EXEC SAS
//TAPE1 DD
DSN=A30E89.LANDTAX.SHABMAN.CRAWFORD.TDP.TAPE1,UNIT=SY
SDA,
//        DISP=(OLD,KEEP)
//        SYSIN  DD *
```

and then enter infile command to read the tape. If want to read tape two, just change the tape1 in the

DSN=A30E89.LANDTAX.SHABMAN.CRAWFORD.TDP.TAPE1,UNIT=SY SDA to tape2. This is the same with tape3.

2. Read the data.

The three tapes were read separately in order to avoid ignorance since there are as many as over one hundred variables. After reading tape1, one data set is generated. But since the data set is very big, trouble of insufficient space will appear when tape2 is read, because tape2 contains too many columns and the data matrix is huge. So, when tape2 was read, it was divided into two parts and read separately. So reading tape2 resulted in two data sets. The tape3 is small enough to be contained in one file. Since the reading process was done on the MVS system, which means none of the data set can be read into the terminal computer's hard drive or floppy disk, a memory space was then created on the MVS under the name

'TAN DD UNIT=SYSDA,DSN=A30E89.LANDTAX.TAN.TDP.SAS,', which functions just like a directory. Every data file was stored in this directory, and can be recalled easily. The name of the file which stores variables tape1 is called Tan.I, the name of the first and second part of tape2 is called Tan.II and Tan.III respectively, and tape3 is stored in Tan.IIII. They can be accessed by enter the following command before a sas program,

```
//TAN DD UNIT=SYSDA,DSN=A30E89.LANDTAX.TAN.TDP.SAS,
//*     DISP=(NEW,CATLG),SPACE=(TRK,(10000,1000,))
//        DISP=(OLD,KEEP),SPACE=(TRK,(10000,1000,))
Data ttt;
set Tan.I; ........ here begins the sas program
```

After this if you want to use Tan.I, you just simply use the file name of I or Tan.I after the "set" command. Remember all the information of tape1, tape2 and tape3 is in file Tan.I, Tan.II and Tan.III, and Tan.IIII respectively.

3. Merge Tan.I, Tan.II, Tan.III and Tan.III

Those four data files Tan.I, Tan.II, Tan.III and Tan.IIII were merged into one big file named Tan.data. They were merged according to the pinnumbers of the observations. After the merging process the data set is completed, every single variable and observations which is in the raw data pool is included. This merged file is still in the same memory space.

4. Data deletion.

The original observations were then truncated according to several rules. Those rules comply with the requirements for the observations we put into the regression model. Those rules are:

a. Observations without a sales price
b. Observations without a sales date
c. Observations which are not vacant lands or are the commercial vacant land parcels but are less than 5 acres
d. Observations without the number of acreage
e. Observations that have buildings on them

Appendix B: Definitions

This tables contains the names of the variables read from the tapes and their definitions.

TAPE1	
PINNMBR	MAP LOCATION
JANOWN	JULY OWNER
BOR	BOROUGH
SUBDIV	SUBDIVISION
LEG1	LEGAL DESCRIPTION 1
LEG2	LEGAL DESCRPTION 2
VAL	LAND VALUE
IMVAL	IMPROVED VALUE
MKTVAL	FARM USE
ATTNTO	ATTN TO:
BLDG	MORTGAGE CO CODE
NAME	LEGAL OWNER
LMADD	MAILING ADDRESS
LMCITY	MAILING CITY
LMZIP	MAILING ZIP
LPADD	PROPERTY ADDRESS
LPZIP	PROPERTY ZIP
CLASS	PROPERTY CLASS CODE
TAPE 2	
PA1TYPE	PROPERTY STREET TYPE
PA2TYPE	STORE THE SECONDARY STREET TYPE
SALEDATE	STORES THE LAST DATE THE PROPERTY WAS SOLD

SALEPRIC	STORES THE LAST SALES PRICE AS RECORDED BY THE CLERK OF COURTS
SALERMKS	STORES ANY REMARKS CONCERNING THE SALE
ZNGCODE1	STORES THE FIRST OCCURANCE OF THE ZONING CODE
ZNGCODE2	STORES THE SECOND ZONING CODE FOR THE PARCEL
ZNGCODE3	STORES THE THIRD ZONING CODE FOT THE PARCEL
ZNGCODE4	STORES THE FORTH ZONING CODE FOR THE PARCEL
YRBUILT	STORES THE ACTUAL YEAR THE BUILDING WAS ERRECTED
YRADTNS1	STORES THE YEAR THE FIRST ADDITION WAS BUILT
YRADTNS2	STORES THE YEAR SUNSEQUENT ADDITIONS WERE MADE
YRRMDLD	STORES THE LAST YEAR AND REMODELING WORK WAS DONE TO THE STRUCTURE
EFFAGE	STORES THE ACTUAL EFFECTIVE AGE OF THE STRUCTURE AS DETERMINED BY THE APPRAISOR
STORYHGH	STORES THE HEIGHT OFTHE STRUCTURE WITH 3 DECIMAL PLACES
FNDTN	STORES THE TYPE OF FOUNDATION USED IN THE STRUCTURE.
EXTR1	STORES THE TYPE OF EXTERIOR USED ON THE STRUCTURE
EXTR2	STORES A SECOND EXTERIOR TYPE WHERE REQUIRED
ROOF1	STORES THE TYPE OF ROOF ON THE STRUCTURE
ROOF2	STORES THE ROOF STYLE ON THE STRUCTURE
CNSTRCTY	STORES THE TYPE OF CONSTRUCTION USED IN THE STRUCTURE
INTR1	STORES THE FIRST TYPE OF INTERIOR
INTR2	STORES THE SECOND TYPE OF INTERIOR
FLOOR1	STORE THE NUMBER OF HARDWOOD FLOORS
FLOOR2	STORES THE NUMBER OF CARPETED FLLORS
FLOOR3	STORES THE NAME OF ANY OTHER TYPE OF FLOOR MATERIAL
NOTES	STORES FREE FORM REMARKS OR NOTES CONCERNING THE PROPERTY OR BUILDING
CHANGES	STORES ANY SHORT COMMENTS CONCERNING THE CHANGE MADE TO THE PARCEL

OBSLSCNC	STORES THE OBSOLESCENCE OF THE BUIDIING AS DETERMINED BY THE APPRAISOR
DEEDBK	STORES THE DEED BOOK NUMBER WHERE THE PROPERTY WAS RECORDED IN THE CLERK OF COURTS OFFICE. THIS IS AN OVERFLOW FIELD FROM THE LAND FILE.
DEEDPG	STORES THE DEED BOOK PAGE NUMBER OF THE PROPERTY WHERE IT WAS RECORDED IN THE CLERKS OFFICE.THIS IS AN OVERFLOW FIELD FROM THE LAND FILE.
MAPBK	STORES THE MAP BOOK NUMBER WHERE THE PROPERTY WAS RECORDED.
MAPPG	STORES THE MAP BOOKPAGE NUMBER WHERE THE PROPERTY WAS RECORDED
BORO	STORES THE BOROUGH CODE AS ENTERED BY THE COMMISSIONER
LEGAL3	STORES THE REMAINDER OF THE LEGAL DESCRIPTION
ATTNTO2	STORES THE SECON FIELD OF THE ATTENTION TO DATA FROM THE LAND SCREEN
CHNGDATE	STORES THE DATE THAT THE RECORD WAS CHANGED IN THE COMPUTER
PCLASSPFX	STORES THE FIRST CHARACTER OF THE PROERTY CLASS FROM THE LAND SCREEN
PSITE	STORES THE SITE CODE FOR THE PARCEL
PSQFT	STORES THE ACTUAL SQUARE FEET OF THE PARCEL
PACRES	STORES THE USER CALCULATED ACREAGE FOR THE PARCEL
PDEPTH1	STORES THE DEPTH FOR THE FRONTAGE AREA OF THE PARCEL
PDEPTH2	STORES THE DEPTH FOR THE FRONTAGE AREA OF THE PARCEL
WTRFRNT	STORES THE NAME OF THE BODY OF WATER THE PROPERTY FRONTS
SEWER	STORES THE FLAG IF THE PROPERTY HAS CITY SEWERS
WATER	STORES THE FLAG IS THE PROPERTY HAS CITY WATER OR NOT
TPGRPHY	STORES THE TOPOGRAPHY FOR THE PARCEL
TXEXCODE	STORES THE TAX CODE FOR THE PARCEL
TXEXEMP1	STORES THE FIRST TAX EXEMPT CODE FOR THE PARCEL
TXEXEMP2	STORES THE SECOND TAX EXEMPT CODE FOR THE PARCEL

PLSTAT	STORES THE STATISTICAL AREA CODE
PLLUSE	STORES THE LAND USE CODE AS USED BY PLANNING. THIS CODE DOES NNOT HAVE HAVE ANYTHING TO DO WITH THE LAND USE CODE USED BY THE ASSESSOR
PLTBAREA	STORES THE ACTUAL AREA OF THE BUILDING FOR THE PLANNING DEPARTMENT
DEFINITIONS FOR TAPE3 ARE NOT AVAILABLE	

Appendix C: SAS program

```
**********************************************************************
This is the program used to read tape 1
**********************************************************************
// EXEC SAS
//TAPE1  DD
DSN=A30E89.LANDTAX.SHABMAN.CRAWFORD.TDP.TAPE1,UNIT=SY
SDA,
//        DISP=(OLD,KEEP)
//TAN  DD UNIT=SYSDA,DSN=A30E89.LANDTAX.TAN.TDP.SAS,

//*       DISP=(NEW,CATLG),SPACE=(TRK,(10000,1000,))

//        DISP=(OLD,KEEP),SPACE=(TRK,(10000,1000,))
//SYSIN  DD *
DATA TAN.I;
 INFILE Tape1;
 INPUT  PINNMBR $ 1-14 JANOWN $ 15-47 BOR $ 48-49 SUBDIV $
50-71
LEG1 $ 72-96
LEG2 $ 97-109 @110 VAL S370FPD6. @116 IMVAL S370FPD6.

@122 MKTVAL S370FPD6. ATTNTO $ 128-160 @161 BLDG S370FPD2.

NAME $ 163-195 LMADD $ 196-220 LMCITY $ 221-240 LMZIP $
241-245
LPADD $ 246-270 LPZIP $ 271-275
@276 CLASS S370FPD2.;RUN;
PROC PRINT DATA=TAN.I(OBS=50);RUN;
```

```
************************************************
This is the program used to read the first half of tape 2
************************************************
// EXEC SAS
//TAPE2  DD
DSN=A30E89.LANDTAX.SHABMAN.CRAWFORD.TDP.TAPE2,UNIT=SY
SDA,
//       DISP=(OLD,KEEP)
//TAN  DD UNIT=SYSDA,DSN=A30E89.LANDTAX.TAN.TDP.SAS,

//*      DISP=(NEW,CATLG),SPACE=(TRK,(10000,1000,))

//      DISP=(OLD,KEEP),SPACE=(TRK,(10000,1000,))
//SYSIN  DD *
DATA TAN.II;
INFILE TAPE2;
INPUT DLTFLAG $ 1 PINNMBR $ 2-15 LUMAPNO $ 16-19 LUMAPSD $
20-21
LUMAPBLK $ 22-26
LUMAPLOT $ 27-29 LUMAPSIT $ 30-33 PA1NMBR 34-39 PA1DIR $
40-41
PA1FNAME $ 42-69 PA1APT $ 70-74
PA2FNAME $ 75-102 PA2NAME $ 75-96 PA2TYPE $ 97-100 PA2PDIR $
101-102
@103 ADZIP1 S370FPD3. @106 ADZIP2 S370FPD3. SALEDATE 109-114

@115 SALEPRIC S370FPD5.
SALERMKS $ 120-126 ZCNEFLG $ 127 ZNGCODE1 $ 128-131
ZNGCODE2 $ 132-135
ZNGCODE3 $ 136-139 ZNGCODE4 $ 140-143 YRBUILT 144-147
YRBUILTF $ 148
@149 YRADTNS1 S370FPD3. @152 YRADTNS2 S370FPD3. @158
EFFAGE S370FPD3.
@155 YRRMDLD S370FPD3. @161 STORYHGH S370FPD3.

FNDTN $ 164-169 EXTR1 $ 170-177 EXTR2 $ 178-185 ROOF1 $ 186-193

ROOF2 $ 194-201
```

```
CNSTRCTY $ 202-209 INTR1 $ 210-217 INTR2 $ 218-225 FLOOR1 $
226-227
FLOOR2 $ 228-230 FLOOR3 $ 231-236 NOTES $ 237-282 CHANGES $
283-293
;
PROC PRINT DATA=TAN.II(OBS=50);RUN;
```

```
***************************************************
This is the program used to read the second part of tape 2
***************************************************
// EXEC SAS
//TAPE2  DD
DSN=A30E89.LANDTAX.SHABMAN.CRAWFORD.TDP.TAPE2,UNIT=SY
SDA,
//        DISP=(OLD,KEEP)
//TAN  DD UNIT=SYSDA,DSN=A30E89.LANDTAX.TAN.TDP.SAS,

//*       DISP=(NEW,CATLG),SPACE=(TRK,(10000,1000,))

//      DISP=(OLD,KEEP),SPACE=(TRK,(10000,1000,))
//SYSIN  DD *
DATA TAN.II;
INFILE TAPE2;
INPUT DLTFLAG $ 1 PINNMBR $ 2-15 LUMAPNO $ 16-19 LUMAPSD $
20-21
LUMAPBLK $ 22-26
LUMAPLOT $ 27-29 LUMAPSIT $ 30-33 PA1NMBR 34-39 PA1DIR $
40-41
PA1FNAME $ 42-69 PA1APT $ 70-74
PA2FNAME $ 75-102 PA2NAME $ 75-96 PA2TYPE $ 97-100 PA2PDIR $
101-102
@103 ADZIP1 S370FPD3. @106 ADZIP2 S370FPD3. SALEDATE 109-114

@115 SALEPRIC S370FPD5.
SALERMKS $ 120-126 ZCNEFLG $ 127 ZNGCODE1 $ 128-131
ZNGCODE2 $ 132-135
ZNGCODE3 $ 136-139 ZNGCODE4 $ 140-143 YRBUILT 144-147
YRBUILTF $ 148
@149 YRADTNS1 S370FPD3. @152 YRADTNS2 S370FPD3. @158
EFFAGE S370FPD3.
@155 YRRMDLD S370FPD3. @161 STORYHGH S370FPD3.

FNDTN $ 164-169 EXTR1 $ 170-177 EXTR2 $ 178-185 ROOF1 $ 186-193

ROOF2 $ 194-201
```

```
CNSTRCTY $ 202-209 INTR1 $ 210-217 INTR2 $ 218-225 FLOOR1 $
226-227
FLOOR2 $ 228-230 FLOOR3 $ 231-236 NOTES $ 237-282 CHANGES $
283-293
;
PROC PRINT DATA=TAN.II(OBS=50);RUN;
```

```
******************************************************
This is the program used to read tape 3
******************************************************
/ EXEC SAS
//TAPE3  DD
DSN=A30E89.LANDTAX.SHABMAN.CRAWFORD.TDP.TAPE3,UNIT=SY
SDA,
//        DISP=(OLD,KEEP)
//TAN  DD UNIT=SYSDA,DSN=A30E89.LANDTAX.TAN.TDP.SAS,

//*        DISP=(NEW,CATLG),SPACE=(TRK,(10000,1000,))

//       DISP=(OLD,KEEP),SPACE=(TRK,(10000,1000,))
//SYSIN  DD *
DATA TAN.IIII;
INFILE TAPE3;
INPUT PINNMBR $ 1-14 DESC01 $ 15-20 DESC02 $ 25-30 DESC03 $
35-40
DESC04 $ 45-50 DESC05 $ 55-60 DESC06 $ 65-70 DESC07 $ 75-80

DESC08 $ 85-90 DESC09 $ 95-100 DESC10 $ 105-110 DESC11 $ 115-120

DESC12 $ 125-130 @21 SQFT01 S370FPD4. @31 SQFT02 S370FPD4.

@41 SQFT03 S370FPD4.
@51 SQFT04 S370FPD4. @61 SQFT05 S370FPD4. @71 SQFT06
S370FPD4.
@81 SQFT07 S370FPD4.
@91 SQFT08 S370FPD4.
; RUN;
PROC PRINT DATA=TAN.IIII(OBS=10);
RUN;
```

```
*****************************************
This is the regression program
*****************************************
// EXEC SAS
//TAN  DD UNIT=SYSDA,DSN=A30E89.LANDTAX.TAN.TDP.SAS,

//       DISP=(OLD,KEEP),SPACE=(TRK,(10000,1000,))
//SYSIN  DD *

DATA TT;
SET TAN.REGDATA2;
IF LENGTH(COMPRESS(BLOCK))<3 THEN DELETE;

A=COMPRESS(YEAR);
IF YEAR<=58 THEN DELETE;

**********************
*INFLATE THE DOLLARS*
**********************


;

IF A='59' THEN PRICE=SALEPRIC*6.87;
ELSE IF A='60' THEN PRICE=SALEPRIC*6.71;
ELSE IF A='61' THEN PRICE=SALEPRIC*6.53;
ELSE IF A='62' THEN PRICE=SALEPRIC*6.42;
ELSE IF A='63' THEN PRICE=SALEPRIC*6.25;
ELSE IF A='64' THEN PRICE=SALEPRIC*6.12;
ELSE IF A='65' THEN PRICE=SALEPRIC*5.99;
ELSE IF A='66' THEN PRICE=SALEPRIC*5.85;
ELSE IF A='67' THEN PRICE=SALEPRIC*5.43;
ELSE IF A='68' THEN PRICE=SALEPRIC*5.37;
ELSE IF A='69' THEN PRICE=SALEPRIC*5.03;
ELSE IF A='70' THEN PRICE=SALEPRIC*4.67;
ELSE IF A='71' THEN PRICE=SALEPRIC*4.25;
ELSE IF A='72' THEN PRICE=SALEPRIC*3.93;
ELSE IF A='73' THEN PRICE=SALEPRIC*3.56;
ELSE IF A='74' THEN PRICE=SALEPRIC*3.26;
```

```
ELSE IF A='75' THEN PRICE=SALEPRIC*3.05;
ELSE IF A='76' THEN PRICE=SALEPRIC*2.89;
ELSE IF A='68' THEN PRICE=SALEPRIC*5.37;
ELSE IF A='69' THEN PRICE=SALEPRIC*5.03;
ELSE IF A='70' THEN PRICE=SALEPRIC*4.67;
ELSE IF A='71' THEN PRICE=SALEPRIC*4.25;
ELSE IF A='72' THEN PRICE=SALEPRIC*3.93;
ELSE IF A='73' THEN PRICE=SALEPRIC*3.56;
ELSE IF A='74' THEN PRICE=SALEPRIC*3.26;
ELSE IF A='75' THEN PRICE=SALEPRIC*3.05;
ELSE IF A='76' THEN PRICE=SALEPRIC*2.89;
ELSE IF A='77' THEN PRICE=SALEPRIC*2.63;
ELSE IF A='78' THEN PRICE=SALEPRIC*2.30;
ELSE IF A='79' THEN PRICE=SALEPRIC*2.00;
ELSE IF A='80' THEN PRICE=SALEPRIC*1.74;
ELSE IF A='81' THEN PRICE=SALEPRIC*1.57;
ELSE IF A='82' THEN PRICE=SALEPRIC*1.50;
ELSE IF A='83' THEN PRICE=SALEPRIC*1.50;
ELSE IF A='84' THEN PRICE=SALEPRIC*1.41;
ELSE IF A='85' THEN PRICE=SALEPRIC*1.33;
ELSE IF A='86' THEN PRICE=SALEPRIC*1.27;
ELSE IF A='87' THEN PRICE=SALEPRIC*1.23;
ELSE IF A='88' THEN PRICE=SALEPRIC*1.17;
ELSE IF A='89' THEN PRICE=SALEPRIC*1.13;
ELSE IF A='90' THEN PRICE=SALEPRIC*1.12;
ELSE IF A='91' THEN PRICE=SALEPRIC*1.09;
ELSE IF A='92' THEN PRICE=SALEPRIC*1.05;
ELSE IF A='93' THEN PRICE=SALEPRIC*1.03;
ELSE IF A='94' THEN PRICE=SALEPRIC*1.00;

UNITPRIC=PRICE/ACRES;
IF UNITPRIC<300 THEN DELETE;
PP=LOG(PRICE);
LNACRES=LOG(ACRES);


***************************************************
* REATE ACCUMULATIVE CONSTRUCTION NUMBER VARIBLE *
```

```
**************************************************
;
IF A='59' THEN conno=9472;
ELSE IF A='60' THEN conno=12174;
ELSE IF A='61' THEN conno=13658;
ELSE IF A='62' THEN conno=16617;
ELSE IF A='63' THEN conno=18591;
ELSE IF A='64' THEN conno=20983;
ELSE IF A='65' THEN conno=22966;
ELSE IF A='66' THEN conno=24468;
ELSE IF A='67' THEN COONO=26247;
ELSE IF A='68' THEN CONNO=28437;
ELSE IF A='69' THEN CONNO=30412;
ELSE IF A='70' THEN CONNO=31735;
ELSE IF A='71' THEN CONNO=34154;
ELSE IF A='72' THEN CONNO=36984;
ELSE IF A='73' THEN CONNO=39514;
ELSE IF A='74' THEN CONNO=42286;
ELSE IF A='75' THEN CONNO=45704;
ELSE IF A='76' THEN CONNO=48369;
ELSE IF A='77' THEN CONNO=52236;
ELSE IF A='78' THEN CONNO=56069;
ELSE IF A='79' THEN CONNO=59851;
ELSE IF A='80' THEN CONNO=63051;
ELSE IF A='81' THEN CONNO=66176;
ELSE IF A='82' THEN CONNO=70182;
ELSE IF A='83' THEN CONNO=76538;
ELSE IF A='84' THEN CONNO=82271;
ELSE IF A='85' THEN CONNO=89319;
ELSE IF A='86' THEN CONNO=96538;
ELSE IF A='87' THEN CONNO=102216;
ELSE IF A='88' THEN CONNO=106738;
ELSE IF A='89' THEN CONNO=110057;
ELSE IF A='90' THEN CONNO=112080;
ELSE IF A='91' THEN CONNO=113798;
ELSE IF A='92' THEN CONNO=115542;
ELSE IF A='93' THEN CONNO=117374;
```

```
ELSE IF A='94' THEN CONNO=118840;
LNCONNO=LOG(CONNO);



*******************************
* CREATE CENSUS BLOCK DUMMIES *
*******************************

;
BBB=COMPRESS(BLOCK);
IF BBB='40200' THEN B40200=1;ELSE B40200=0;
IF BBB='40401' THEN B40401=1;ELSE B40401=0;
IF BBB='40402' THEN B40402=1;ELSE B40402=0;
IF BBB='40800' THEN B40800=1;ELSE B40800=0;
IF BBB='40200' THEN B40200=1;ELSE B40200=0;
IF BBB='41001' THEN B41001=1;ELSE B41001=0;
IF BBB='41002' THEN B41002=1;ELSE B41002=0;
IF BBB='41200' THEN B41200=1;ELSE B41200=0;
IF BBB='41400' OR BBB='41800' OR BBB='42000' OR BBB='45601'

THEN B41400=1; ELSE B41400=0;
IF BBB='41600' THEN B41600=1;ELSE B41600=0;
IF BBB='42200' OR BBB='44401' THEN B42200=1;ELSE B42200=0;

IF BBB='42600' OR BBB='42800' OR BBB='44804' THEN B42600=1;ELSE
B42600=0;
IF BBB='43001' THEN B43001=1;ELSE B43001=0;
IF BBB='43002' THEN B43002=1;ELSE B43002=0;
IF BBB='43800' THEN B43800=1;ELSE B43800=0;
IF BBB='44001' THEN B44001=1;ELSE B44001=0;
IF BBB='44002' THEN B44002=1;ELSE B44002=0;
IF BBB='44201' THEN B44201=1;ELSE B44201=0;
IF BBB='44402' THEN B44402=1;ELSE B44402=0;
IF BBB='44600' THEN B44600=1;ELSE B44600=0;
IF BBB='44805' THEN B44805=1;ELSE B44805=0;
IF BBB='44806' THEN B44806=1;ELSE B44806=0;
IF BBB='45200' THEN B45200=1;ELSE B45200=0;
IF BBB='45404' OR BBB='45405' THEN B45404=1;ELSE B45404=0;
```

```
IF BBB='45406' THEN B45406=1;ELSE B45406=0;
IF BBB='45407' OR BBB='45408' THEN B45407=1;ELSE B45407=0;

IF BBB='45409' OR BBB='45410' THEN B45409=1;ELSE B45409=0;

IF BBB='45411' THEN B45411=1;ELSE B45411=0;
IF BBB='45412' THEN B45412=1;ELSE B45412=0;
IF BBB='45602' THEN B45602=1;ELSE B45602=0;
IF BBB='45802' THEN B45802=1;ELSE B45802=0;
IF BBB='45804' THEN B45804=1;ELSE B45804=0;
IF BBB='46001' OR BBB='46005' OR BBB='45803' OR BBB='45801'

OR BBB='40600' THEN B46001=1;ELSE B46001=0;

IF BBB='46002' THEN B46002=1;ELSE B46002=0;
IF BBB='46007' THEN B46007=1;ELSE B46007=0;
IF BBB='46008' OR BBB='46208' OR BBB='46209' THEN B46008=1;

ELSE B46008=0;
IF BBB='46204' OR BBB='45205' OR BBB='45207' THEN B46204=1;ELSE
B46204=0;
IF BBB='46206' THEN B46206=1;ELSE B46206=0;
IF BBB='46210' THEN B46210=1;ELSE B46210=0;
*IF BBB='46400' THEN B46400=1;*ELSE B46400=0;
IF BBB='46600' THEN B46600=1;ELSE B46600=0;


************************************
* CREATE DISTANCE VARIABLES        *
************************************
;

IF DIST5658>DIST5355 THEN DIST5658=DIST5355;
IF DIST5961>DIST5658 THEN DIST5961=DIST5658;
IF DIST6264>DIST5961 THEN DIST6264=DIST5961;
IF DIST6567>DIST6264 THEN DIST6567=DIST6264;
```

```
IF DIST6870>DIST6567 THEN DIST6870=DIST6567;
IF DIST7173>DIST6870 THEN DIST7173=DIST6870;
IF DIST7476>DIST7173 THEN DIST7476=DIST7173;
IF DIST7779>DIST7476 THEN DIST7779=DIST7476;
IF DIST8082>DIST7779 THEN DIST8082=DIST7779;
IF DIST8385>DIST8082 THEN DIST8385=DIST8082;
IF DIST8688>DIST8385 THEN DIST8688=DIST8385;
IF DIST8991>DIST8688 THEN DIST8991=DIST8688;
IF DIST9294>DIST8991 THEN DIST9294=DIST8991;

IF A='59' OR A='60' OR A='61' THEN DIST1=DIST5961;
IF A='59' OR A='60' OR A='61' THEN DIST2=DIST5658;
IF A='59' OR A='60' OR A='61' THEN DIST3=DIST5355;
IF A='59' OR A='60' OR A='61' THEN DIST4=DIST5052;
IF A='62' OR A='63' OR A='64' THEN DIST1=DIST6264;
IF A='62' OR A='63' OR A='64' THEN DIST2=DIST5961;
IF A='62' OR A='63' OR A='64' THEN DIST3=DIST5658;
IF A='62' OR A='63' OR A='64' THEN DIST4=DIST5355;
IF A='65' OR A='66' OR A='67' THEN DIST1=DIST6567;
IF A='65' OR A='66' OR A='67' THEN DIST2=DIST6264;
IF A='65' OR A='66' OR A='67' THEN DIST3=DIST5961;
IF A='65' OR A='66' OR A='67' THEN DIST4=DIST5658;
IF A='68' OR A='69' OR A='70' THEN DIST1=DIST6870;
IF A='68' OR A='69' OR A='70' THEN DIST2=DIST6567;
IF A='68' OR A='69' OR A='70' THEN DIST3=DIST6264;
IF A='68' OR A='69' OR A='70' THEN DIST4=DIST5961;
IF A='71' OR A='72' OR A='73' THEN DIST1=DIST7173;
IF A='71' OR A='72' OR A='73' THEN DIST2=DIST6870;
IF A='71' OR A='72' OR A='73' THEN DIST3=DIST6567;
IF A='71' OR A='72' OR A='73' THEN DIST4=DIST6264;
IF A='74' OR A='75' OR A='76' THEN DIST1=DIST7476;
IF A='74' OR A='75' OR A='76' THEN DIST2=DIST7173;
IF A='74' OR A='75' OR A='76' THEN DIST3=DIST6870;
IF A='74' OR A='75' OR A='76' THEN DIST4=DIST6567;
IF A='77' OR A='78' OR A='79' THEN DIST1=DIST7779;
IF A='77' OR A='78' OR A='79' THEN DIST2=DIST7476;
IF A='77' OR A='78' OR A='79' THEN DIST3=DIST7173;
IF A='77' OR A='78' OR A='79' THEN DIST4=DIST6870;
```

```
IF A='80' OR A='81' OR A='82' THEN DIST1=DIST8082;
IF A='80' OR A='81' OR A='82' THEN DIST2=DIST7779;
IF A='80' OR A='81' OR A='82' THEN DIST3=DIST7476;
IF A='80' OR A='81' OR A='82' THEN DIST4=DIST7173;
IF A='83' OR A='84' OR A='85' THEN DIST1=DIST8385;
IF A='83' OR A='84' OR A='85' THEN DIST2=DIST8082;
IF A='83' OR A='84' OR A='85' THEN DIST3=DIST7779;
IF A='83' OR A='84' OR A='85' THEN DIST4=DIST7476;
IF A='86' OR A='87' OR A='88' THEN DIST1=DIST8688;
IF A='86' OR A='87' OR A='88' THEN DIST2=DIST8385;
IF A='86' OR A='87' OR A='88' THEN DIST3=DIST8082;
IF A='86' OR A='87' OR A='88' THEN DIST4=DIST7779;
IF A='89' OR A='90' OR A='91' THEN DIST1=DIST8991;
IF A='89' OR A='90' OR A='91' THEN DIST2=DIST8688;
IF A='89' OR A='90' OR A='91' THEN DIST3=DIST8385;
IF A='89' OR A='90' OR A='91' THEN DIST4=DIST8082;
IF A='92' OR A='93' OR A='94' THEN DIST1=DIST9294;
IF A='92' OR A='93' OR A='94' THEN DIST2=DIST8991;
IF A='92' OR A='93' OR A='94' THEN DIST3=DIST8688;
IF A='92' OR A='93' OR A='94' THEN DIST4=DIST8385;

LNDIST1=LOG(DIST1);
LNDIST2=LOG(DIST2);
LNDIST3=LOG(DIST3);
LNDIST4=LOG(DIST4);

IF YEAR<79 OR YEAR=79 THEN SOUTH=0;
IF YEAR<79 OR YEAR=79 THEN NORTH=0;
IF YEAR>79 AND N='Y' OR M='Y' THEN SOUTH=1; ELSE SOUTH=0;

IF YEAR>79 AND S='Y' THEN NORTH=1; ELSE NORTH=0;
SLNACRES=SOUTH*LNACRES;
NLNACRES=NORTH*LNACRES;


MODEL PP=LNACRES NLNACRES SLNACRES
B40200 B40401 B40402 B40800 B41001 B41002 B41200
```

```
B41400 B41600 B42200 B42600 B43001
B43002 B43800 B44002 B44201 B44402 B44600
B44805 B44806 B45200 B45404 B45406 B45407
B45409 B45411 B45412 B45602 B45802
B45804 B46001 B46002 B46007 B46008 B46204
B46206 B46210 B46600
LNDIST1 LNDIST2 LNCONNO SOUTH NORTH
;
RUN;
```

Appendix D: Class Codes

RESIDENTIAL ESTATES CLASS CODE
(This table contains the definition for class codes)

SINGLE FAMILY
RESIDENTIAL(SUBURBAN)
100 Vacant land
101 Residence
102 Outbuildings Only
103 Townhouse
104 Low Rise Condominium
105 High Rise Condominium
106 Homeowners Associations
107 Duplex
108 House & Garage Apartment
109 House and Apartment
110 Historic House
111 Taxable Civic league

SINGLE FAMILY RESIDENTIAL
(SUBURBAN)
200 Vacant
201 Residence
202 Outbuildings
203 Future Use
204 Future Use
205 Future Use
206 Future Use
207 Future Use
208 House and Garage Apartment
209 House and Apartment
210 Historic House

MULTI-FAMILY
301 Apartment Complex
302 Small Apartment
303 Future Use
.
.
310 ......

Tax Exempt
700 Federal Government
701 State Government
702 Regional Government
703 Local Government
704 Local Government-Park Areas
705 Local Government-Utilities
706 Local Government-Schools
707 Volunteer Fire & Rescue
708 Religious(Churches)
709 Religious(Lodges)
710 Charitable(Lodges)
711 Charitable(Others)
712 Educational
713 Cemeteries
714 Future Use
.
720 .....

COMMERCIAL & INDUSTRIAL
400 Vacant Commercial
401 General Commercial
402 Shopping Center/Discount Store
403 Service Stations/Garages
404 Restaurants
405 Fastfood Restaurants
406 Convenience Food Stores
407 Self Storage Warehouse
408 Building Supply
409 Day Care Center
410 Vacant Offices
411 Office Buildings/Multi Tenant
412 Office Condominium
413 Hotel/Motel
414 Hotel Condominium
415 Campground
416 Trailer Parks
417 Marines/Boat Slips
418 Future Use
419 Banks
420 Future Use
421 Office Buildings/Owner Occupied
422 Future Use
.

.
430 ......
450 Industrial Vacant
451 Industrial Improved
452 Industrial Condominium
453 Future Use
.
.
460 ....

AGRICULTURE UNDEVELOPED(19 To 99 ACRES)
500 Vacant
501 Homesite Included
502 Outbuildings Only
503 Future Use
503 ......
504 ......

AGRICULTURAL UNDEVELOPED(> 99 ACRES)
600 Vacant
601 Homesite Included
602 Outbuildings Only
603 Future Use
604 Future Use
605 ......