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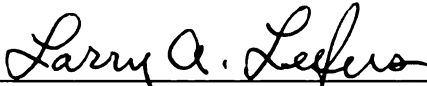
THE IMPACT OF PUBLIC LANDS AND PUBLIC LAND TIMBER
HARVESTING ON PRIVATE PROPERTY VALUES IN MICHIGAN

presented by

David Michael Jones

has been accepted towards fulfillment
of the requirements for

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THE IMPACT OF PUBLIC LANDS AND PUBLIC LAND TIMBER
HARVESTING ON PRIVATE PROPERTY VALUES IN MICHIGAN

By

David Michael Jones

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ABSTRACT

THE IMPACT OF PUBLIC LANDS AND PUBLIC LAND TIMBER HARVESTING ON PRIVATE PROPERTY VALUES IN MICHIGAN

By

David Michael Jones

The influence that publicly-owned land has on nearby private property values has not been studied. Externalities of public land may have an effect on nearby private property values. This study applies hedonic regression analysis to real property transactions of property near public land in Michigan to measure the effect of public land and public land timber harvesting on private property values. The results demonstrate that the percent of public land surrounding private property positively impacts developed property values. The impact of distance to federal public land on private property is found to positively affect vacant property values. The closer that vacant properties are to federal public land, the more they are worth. Adjacent vacant property values are negatively affected by the presence of federal public land relative to state land. Public land timber harvesting is not found to have any statistical impact on adjacent property values.

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CHAPTER ONE: INTRODUCTION

Introduction

Throughout the history of the United States, public land policy has caused controversy and debate. Central to much of the controversy are issues involving property rights, property ownership, and values, both market and non-market, associated with public lands. The property rights and ownership structure, as well as the values associated with public land, have changed significantly over the past 150 years.

From a historical perspective, Dana and Fairfax (1980) suggested three periods into which public land policy can be divided: disposition, reservation, and management. The disposition period occurred approximately between 1775 and 1891, during which Congress disposed of the public domain. The disposition period transferred property, and the associated property rights, from the federal government to, primarily, individuals. Initially the goal of disposition was to accumulate revenue for the ailing Treasury. To this end, Congress attempted to sell the public domain to settlers. After several legislative attempts and failures, Congress changed its policy from raising revenue to settlement and development. The Homestead Act of 1862 was the first “free” land policy in the United States. The Timber Culture Act followed in 1873. Both these acts offered land to individuals for agricultural and forest development of the public domain lands. Both policies were marked with abuses, as the “terms and the spirit” of the “Acts were widely violated” (Dana and Fairfax 1980). The intended development did not occur in

many cases. Much of the land was stripped of its timber and/or acquired for cattle ranges. In the beginning of the disposition period, natural resources were abundant, but as the period drew to a close many natural resources were perceived as becoming scarce.

From the developing perception of scarcity of many natural resources, coupled with growing anti-trust sentiment, the reservation period emerged. The reservation period occurred between approximately 1891 and 1905. This period overlapped in large part with the “Golden Age of American Conservation” (1898-1910), and produced land conservation policy unparalleled in U.S. history. Leaders of the day, such as Theodore Roosevelt and Gifford Pinchot, believed that many of the country’s natural resources, such as timber and minerals, were becoming scarce. Not trusting American capitalism of the time, the “trust-busters” felt it was the duty of the government to provide a long-term supply of scarce natural resources for future generations. The idea of permanent public ownership of land followed. Between 1905 and 1909 President Roosevelt withdrew over 92 million acres from the public domain and established it as public land. By the end of the Roosevelt presidency over 150 million acres of land had been withdrawn for national forests.

Besides the establishment of public land, the reservation period is marked by a split in the conservationist movement. On one side of the split were the utilitarians. Many, including Theodore Roosevelt and Gifford Pinchot, believed the federally owned land should be managed for human use or more appropriately “wise-use”. The wise-use concept is best represented by the popular Pinchot slogan “the greatest good for the

greatest number for the longest time.” The greatest goods under this philosophy were commonly market goods such as timber, minerals, and grazing range. On the other side of the split were the preservationists, led by John Muir. The preservationists believed no “use” should occur on the public lands. The basis of their belief was that much of the public land contains spiritual values, not just the market values associated with human use. The preservationists marked the first large movement that emphasized the existence of non-market goods associated with public lands. The conservation split gave rise to many debates over the years surrounding how certain public lands should be managed and what values they should contain. Developing from the split were two different and incompatible management philosophies: multiple use and preservation.

The last, and debatably the most controversial, period of public land policy is the management period. This period began in 1905 and continues to the present. The management period has repeatedly dealt with issues that formed land policy in previous periods. One of the issues revisited in the management period concerns the values included in the differing management philosophies. Another issue, that of public ownership, has provided almost continuous conflict.

The period began with the formal establishment of the National Forest system, followed by the National Park system. These federal public lands were managed for multiple use and single use, respectively. The split system, which now includes among others the Bureau of Land Management and the U. S. Fish and Wildlife Service, has been the government’s answer to the split in the conservation philosophies. The single-use land

management philosophy has evolved to provide many non-market values such as non-game species of wildlife and aesthetic beauty. The multiple-use management philosophy has continued to provide market goods as well as some non-market values. The evolution of non-market values in the differing management philosophies demonstrates a demand for such goods and intangibles.

Another land policy issue, public ownership, has been questioned several times in the management period. Challenges to federal ownership of land have occurred in four notable movements. Interestingly, three challenges deal with grazing rights on public lands. The first challenge followed the establishment of the first grazing fee in 1906 by Gifford Pinchot, then the head of the new Forest Service. A charge was made for all livestock grazed on the forest reserves (Dana and Fairfax 1980). A storm of protest followed. From 1907-1915, six public land conferences were held in the western states providing a forum for ranchers demanding a change in federal management policy. The ranchers invoked claims of states' rights. Unanimous support never appeared and the first organized attempt to limit or stop federal control of lands ended.

The 1940's held the second challenge against federal land ownership. From 1940-1943, Senator Patrick McCarren of Nevada held committee hearings due to angered stockmen. Stockmen were angered by proposed reductions in grazing on federal lands, and they felt that too much regard was given to wildlife and that it might threaten established cattle and sheep grazing rights. The ranchers wanted to buy the public land with offers ranging from \$0.09 to \$2.80 per acre. In October, 1946, the Joint Livestock Committee on Public

Lands developed a legislative program. The proposals called for legislation that would allow Forest Service grazing permittees to purchase the property allotted to them under the Taylor Grazing Act. Also, the operators wanted the Forest Service administered grazing lands turned over to the Department of Interior for disposition under the same scheme. “Within months the opposition to the idea was so great that it was withdrawn” (Dana and Fairfax 1980).

In more recent years, animosity over public land rights and non-market values led to the third movement challenging federal ownership of land. In 1979 the Sagebrush Rebellion erupted. The rebellion, a conservative western movement, centered primarily on property rights issues related to public lands. Short (1989) stated “most observers agree that the conservation movement’s crowning success, the Federal Land Policy and Management Act of 1976, represented the last straw for many western ranchers, miners, and loggers.” “In July, 1979, the Nevada State Legislature passed a resolution demanding the transfer of 49 million acres of federal land to state control” and “Senator Orrin Hatch of Utah introduced a national sagebrush rebellion bill into the U.S. Senate...” (Short 1989). The transfer of the land was justified, by rebellion leaders, based on the perception that the states will be better land managers. The rebellion leaders felt the economic growth in the west was stifled by restrictive federal land management and that the states had the right to control the land in their borders. “Some rebels even maintained that the state ownership was only temporary and that sales to private individuals would soon follow” (Short 1989). The Reagan administration developed policies that were sympathetic towards the western sentiment. Notably, the United States Department of Agriculture’s (USDA)

Asset Management Program (AMP) demonstrated the emerging federal government's pro-development stance demanded by the rebellion. The objectives of the AMP, as noted by Douglas MacCleery (Deputy Assistant Secretary of Agriculture for Natural Resources and Environment) were threefold: (1) to sell excess federal property and some public lands that would have a higher and better use in private ownership, (2) to improve the efficiency of government by selling lands that are costly and inefficient to manage and are not necessary to serve public objectives, and (3) to utilize sale revenues to pay off a portion of the national debt (MacCleery 1984). The Sagebrush Rebellion soon lost constituency, which was small in numbers but strong in interest group support, and ended without any transfer of federal lands.

The Sagebrush Rebellion was immediately followed by the fourth movement to challenge federal ownership: the privatization movement. The privatization movement, led by "economists" John Baden and Steven Hanke, emphasized that private markets, not public bureaucrats, are the most efficient managers of land (Short 1989). Their conclusion, therefore, was that the public lands should be sold to private parties. Baden and Hanke held that an economically efficient allocation of land resources was more likely to occur under private ownership than under public ownership. Utilization of the market values on public land played a heavy hand in the privatization argument. Though the privatization movement emphasized a more "scientific" basis than the emotional Sagebrush Rebellion, it too soon disappeared from the policy spotlight without transfer of public land.

Both the recent movements brought the issues of values, public ownership, and private rights associated with public land back into the policy arena. From a historical perspective, public ownership, private rights on public land, and the values emphasized on public lands have been consistently active land policy issues. History provides evidence that discontent over public ownership of land, over values emphasized on public land, and over associated private rights has existed and is likely to continue. The ebb and flow of the continuous change of political climate coupled with the previously mentioned discontent is likely to provide a platform for the same issues to resurface in the future.

Problem Statement

Baden and Lueck (1984) provided arguments for privatization, in which several economic aspects are addressed. They noted “economic theory states that when property rights to resources are well defined, enforced, transferable, and privately held, owners will tend to allocate the resources efficiently...”. Among others, one fault of their defense lies in their interpretation of the above statement. As Runge (1984) stated “economists always stress that the technical argument assumes strict caveats -- perfect information and foresight, the absence of monopoly power, and none of the interdependencies or third party effects called externalities.” The privatization argument, as presented by Baden and Lueck, ignores externalities as well as associated welfare implications. Public lands may offer several externalities such as congestion associated with recreation and amenities (or disamenities) offered to local residents. Many

externalities and associated welfare implications of public lands are not well understood, and therefore are not included in the privatization efficiency defense.

As stated above, public land may have associated externalities. These externalities take the form of amenities or disamenities. Amenities such as recreational opportunities, wildlife, and forested or pasture land are provided by public land. The amenities can have positive local effects such as aesthetic beauty, increased wildlife viewing, and increased recreational opportunities. The disamenities can have negative local effects such as congestion, wildlife damage, and timber harvesting impacts. Because these effects are local, these amenities (disamenities) may affect nearby property values. The economically efficient allocation of public land requires the internalization of such externalities. Internalization would require some type of agreement between those affected and those who emit the externality.

Not only do externalities have efficiency implications, they also carry welfare implications. An externality that is not internalized may have positive or negative effects upon public land users and local residents. Using the above example of timber harvesting, the nearby residents may receive a negative impact on their utility. This impact could be reflected in decreased property values. The local resident may realize a decreased property value, while a non-resident will not see a property value decrease. The possible impact on local property values may then have welfare implications for local residents.

In order to understand the full implications of privatization of public land, or cessation of federal land to the states, the associated externalities must be examined. Externalities related to public land may have large welfare and efficiency implications on local residents.

Objectives

It would be a logical assumption to believe that people are willing to pay a premium to live near public land. Real estate advertisements commonly describe the existence of nearby or abutting public land as a positive attribute. This premium would be equal to the monetary value of the excess of benefits over costs (or amenities over disamenities) from the nearby public land. It would also be logical to further assume that timber harvesting on the nearby public land could have a temporal negative impact on property values. If a person bought a home near public land, and paid a premium, the possible negative impact of future timber harvesting may temporally negate this premium. It is important to examine the possible premium as well as the possible negative impacts of timber harvesting on varying public lands.

The objectives of this research are: (1) to estimate the impact of Michigan's public lands on sales prices of adjacent private lands, (2) to estimate the impact of proximity (distance) to public lands on private land sales values, (3) to compare impacts of various types of public land use (ownership) on nearby private land values, and (4) to estimate the impact of public land timber harvesting on adjacent private property values.

Significance and Assumptions

In order for an efficient level of public land to exist, the externalities associated with these lands need to be examined. Externalities in the form of amenities (or disamenities) and timber harvesting may have large effects on local property values and associated property taxes. The sale or accumulation of public land may not be efficient without consideration for all the externalities involved. Taxation of nearby residential property may not be efficient, or equitable, without the consideration of all externalities.

Furthermore, any change in public land ownership, whether sold or given to the states may involve widespread welfare changes. The sale of public land may have large impacts on local property values and exhibit large welfare effects. If state and federal land have different levels of impacts on property values or different tax subsidy policies, the simple transaction of turning federal land over to states may also have large welfare effects.

This research uses hedonic price regression models, which will be discussed in depth in Chapter 2. By using hedonic price models, a researcher must accept two assumptions. First, it is assumed that all property buyers are homogenous. Second, it is assumed that all sellers are homogenous.

Unrelated to the models, further assumptions are made. Property owners are assumed to be aware of nearby public land. It is assumed that property buyers and sellers are aware of the amenities and disamenities provided by nearby public land and timber harvesting on nearby public land. It is further assumed that buyers and sellers are aware of which governing agency owns the nearby public land. Lastly, the data that was collected from various government offices is assumed to be accurate and all-inclusive. None of these assumptions are tested.

Buyers and sellers perceptions concerning the existence of public land, the distance from public land, the ownership of public land, and timber harvesting on public land are not the emphasis of the hedonic models in this study. Rather, the actual behavior of the buyers and sellers is the emphasis. The perceptions are assumed but not detrimental to the conclusions of the models with regard to actual behavior. The statistical significance of the public land related variables might be reduced due to a lack of awareness of both buyer and seller when compared to buyers and sellers that are completely aware. The purpose of this study is to model the actual behavior of all buyers and sellers near public lands in Michigan, not specific subsets of different perception levels.

The purpose of hedonic models is to measure the implicit price of an attribute on the sales price of a group of specific properties. The purpose of constructing hedonic models is not for prediction. They should not be used for predicting property prices. Creating predictive parsimonious models is not a goal of hedonic modeling and is not pursued in this study.

Organization of Study

The second chapter reviews non-market valuation techniques. In particular, the hedonic price model is reviewed extensively as this is the non-market valuation technique most appropriate for addressing the objectives of this study. The methods used in this study are covered in Chapter three. Chapter four provides and interprets the hedonic model results. Chapter five offers conclusions and policy implications of the model results.

CHAPTER 2: LITERATURE REVIEW

To address the study objectives, a review of theoretical and empirical literature was conducted. The objectives require the measurement of non-market goods. This literature review therefore focuses on topics related to theoretical and empirical non-market valuation.

Chapter 2 begins with a review of common techniques used to place a monetary value on non-market goods. Through this review, hedonic regression analysis is selected as the preferred technique. The following section explains the theoretical framework of hedonic regression theory. A review of applied hedonic models then follows. The final section of Chapter 2 reviews other literature related to this dissertation.

Non-Market Valuation

Economists have developed several techniques for placing a monetary value on non-market goods. Each technique measures consumer willingness to pay for a specific non-market resource. Three techniques in particular have been employed in the majority of environmental valuation studies: contingent valuation, travel cost, and hedonic pricing (Freeman 1986, and Anderson and Bishop 1986).

The first technique - the contingent valuation method (CVM) - is often referred to as a "stated-preference" method. CVM "employs personal interviews, telephone interviews,

or mail surveys to ask people about the values they would place on environmental commodities if ideal markets did exist or other means of payment such as taxes were in effect” (Anderson and Bishop 1986). Consumers are, therefore, asked about their willingness to pay for a good *contingent* on the existence of a market or other means of supply. The CVM approach offers a broad framework to measure various non-market values. CVM is unique in that it is the only non-market valuation technique that can estimate existence values (i.e., “values people place on resources quite apart from any desire they personally have to consume them or enjoy them in any conventional use”) (Anderson and Bishop 1986).

The remaining two approaches, the travel-cost method and the hedonic-price method, are often termed “market-related approaches”, “transaction-evidence” methods, and “revealed preference” methods. Both these approaches attempt to form a linkage between market transactions of private goods and services and non-market goods and services.

The travel cost (TC) method measures consumers’ willingness to pay for a recreational service. This method is “based on the premise that travel expenditures and travel time ration access to some environmental commodities such as recreation sites” (Anderson and Bishop 1986). Consumers are surveyed on the costs and time associated with their trip to the recreation site. From the costs, time, user income, and user proximity from the site, consumers’ willingness to pay for the recreation services of the particular site can be inferred. The TC method is restricted primarily to valuation of recreational services.

The TC method is based on users traveling to a specific recreational site. Many environmental goods, including recreation, can, in some cases, be accessed in close proximity to one's home. Local landowners therefore incur little or no travel expense to benefit from the amenities (disamenities) associated with nearby public goods. Though local landowners do not pay explicit travel expenses for public benefits, they may pay related costs in the form of land premiums. "Households often pay substantial premiums to acquire homes that afford access to these amenities" (Anderson and Bishop 1986).

The hedonic price method attempts to measure consumers' willingness to pay for these public goods by measuring the premium inherent in their property values. The term hedonic refers to pleasure, in economic language this is utility. Hedonic price, therefore, refers to the price one is willing to pay for a specific level of utility or pleasure. Hedonic price models estimate the marginal price the average person is willing to pay for an additional unit of utility. Hedonic price models dissect real market prices and statistically measure the hedonic price associated with each contributing factor and amenity (disamenity).

Based on the objectives presented in Chapter 1, the appropriate non-market valuation technique to be utilized in this study is the hedonic price method. The travel cost method can not measure the impact of a resource on private property values, and therefore can not address any of the objectives presented in Chapter 1. The CVM and the hedonic price method can both address each of the four objectives of this study. The primary

difference between the CVM and hedonic regression approaches is that hedonic regression requires actual market transactions while CVM does not.

With the hedonic regression approach the transactions are real, and consumers have to determine their willingness to pay for the resources related to the nearby public land. Consumers then have to weigh their willingness to pay against a premium, if any, on property values. If the premium is less than or equal to their willingness to pay, the consumers then actually make the transaction. If the CVM technique were used, the consumer would be put through a choice exercise and asked to determine what their willingness to pay without having to pay any of their own money. The hedonic price model is more than a choice exercise for the consumer, it is an actual choice that requires a large amount of money. An actual choice that requires large sums of money is more likely to reflect consumers' willingness to pay than a choice exercise that does not. As a result, hedonic regression analysis is the better technique for addressing the objectives in this study. The theoretical foundations of the hedonic price method are presented next.

Hedonic Model Theory

Hedonic price theory develops arguments for determining the prices of implicit characteristics of a class of highly differentiated products under perfect competition. The implicit characteristics do not, generally, have explicit markets. In general, markets exist only for the bundle of implicit characteristics sold together as a single market good. The

hedonic price theory described here closely follows the work of Rosen (1974) and Anderson and Bishop (1986).

In order to describe the existing hedonic price theory, some structure and notation must first be presented. Consider a class of goods or products that are completely defined by an n -dimensional vector of product characteristics, $Z = (Z_1, Z_2, \dots, Z_n)$. Each Z_i measures the amount of the i th characteristic contained in each product. It is assumed that the characteristics are perfectly divisible, and that they are positive. Because the vector Z perfectly describes the products characteristics, one can assume a price function, $P(Z)$ exists, where $P(Z) = P(Z_1, Z_2, \dots, Z_n)$. $P(Z)$ is the hedonic or implicit price function. One goal of hedonic modeling is to generate the implicit price function. As mentioned earlier, the class of goods, Z , are assumed traded in a perfectly competitive market. In order to generate an implicit price function, it must be assumed that demand and supply meet for each characteristic. The theoretical derivation of demand and supply for the implicit characteristics is described below. Following the demand-supply derivation are the market equilibrium conditions.

Demand

The derivation of consumer demand begins at the basic level of utility maximization. The consumer maximizes utility, $U(X, Z)$, where Z is the bundle of characteristics of the good purchased from the class of differentiated goods and X is the consumption of all other goods measured in dollars. The maximization of utility is constrained by the

consumer income, Y . If one assumes, for simplicity, the price of the X goods equals unity, and that the consumer buys one unit of Z , then the income constraint becomes: $Y = X + P(Z)$, where $P(Z) = P(Z_1, Z_2, \dots, Z_n)$. The problem, in turn, becomes:

$$\begin{aligned} \text{Max } & U(X, Z) \\ \text{s.t. } & Y = X + P(Z) \end{aligned}$$

where the first order condition can be expressed as:

$$\frac{\partial U}{\partial X} \bigg/ \frac{\partial U}{\partial Z_i} = \frac{\partial P(Z)}{\partial Z_i} = P_i(Z) \quad (1)$$

The first differential in equation (1) is the marginal rate of substitution (MRS) of good Z_i for X . The MRS is the rate that a consumer is willing to trade, or substitute, one good for the other. The MRS holds Z_j constant, for all $j \neq i$. The first order condition finds the MRS equal to the partial differential of the implicit price function, $P(Z) = P(Z_1, Z_2, \dots, Z_n)$, with respect to Z_i . The partial differential of $P(Z)$ with respect to Z_i is equal to $P_i(Z)$, by construction. Therefore the MRS of Z_i for X is equal to the price of Z_i , $P_i(Z)$. The first order conditions listed in equation (1) fulfill the conditions often referred to as consumption efficiency.

Because Z is a differentiated product containing n implicit characteristics, none of which may have an explicit market, consumer bid functions for the characteristics must be formed. Assume a bid function in the form

$$\theta = \theta(Z; u, Y)$$

The consumer bid function for the implicit characteristics is a function of the quantity of implicit characteristics in the differentiated product, Z , as well as utility (u) and income

(Y). As Rosen states, $\theta(Z;u,Y)$ represents “the expenditure a consumer is willing to pay for alternative values of $(Z_1, \dots, Z_n)$ at a given utility index and income” where u is any given utility level (Rosen 1974). The bid function, $\theta(Z;u,Y)$, represents a family of indifference type curves relating the level of each characteristic, Z_i , to money. Figure 1 depicts two bid functions for one consumer. The bid function $\theta^1(Z_1, Z_2, \dots, Z_n, u_1)$ describes consumer 1’s willingness to pay for alternative values of Z_1 at the level u_1 . The bid function $\theta^1(Z_1, Z_2, \dots, Z_n, u_2)$ describes the same consumer’s willingness to pay, but at a lower utility level, u_2 . The behavior of the bid function is assumed increasing and concave in the characteristics, and decreasing in the given utility level.

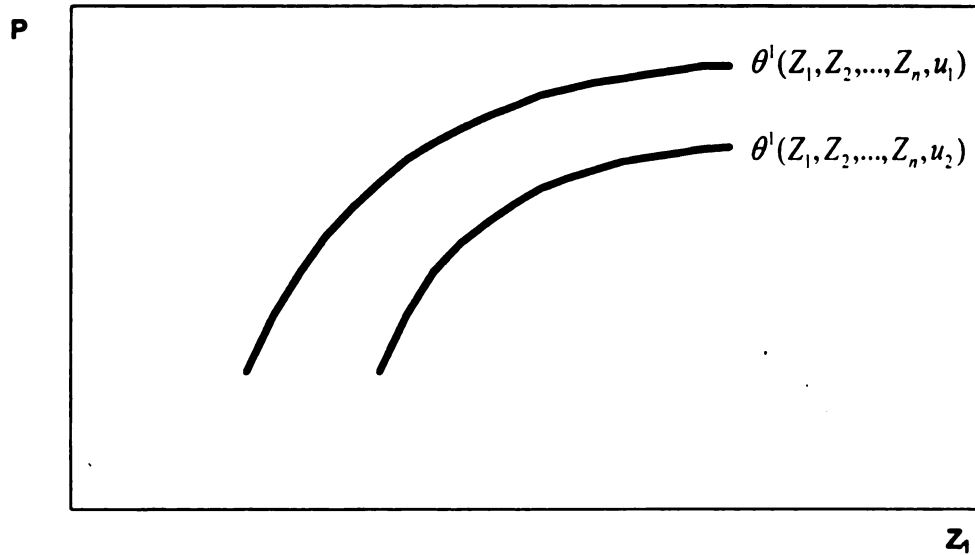


FIGURE 1. CONSUMER BID FUNCTIONS FOR THE Z_1 CHARACTERISTIC AT DIFFERENT UTILITY LEVELS.

Implicitly, θ is defined

$$U(Y - \theta, Z) = u$$

where $Y - \theta$ is income minus the expenditure for the differentiated good, Z . Therefore, $Y - \theta$ represents the remaining income available for purchase of other goods, X .

The consumer maximization problem can be resolved with the inclusion of the bid function. The bid function is substituted in the budget constraint for $P(Z)$. The first order conditions with respect to X and Z yield

$$\theta_{z_i}(Z^*; u^*, Y) = \frac{\partial U_{z_i}}{\partial U_X} \text{ for all } i, \quad (2)$$

where Z^* and u^* are optimum quantities. Condition (2) states that the marginal bid for the Z_i th characteristic must equal the marginal rate of substitution. The combination of equations (1) and (2) provides an interesting result. As stated in equation (1), the MRS is equal to the implicit price at the optimum, equation (2) states that the MRS is equal to the marginal bid at the optimum. Combining equations (1) and (2) yields

$$\frac{\partial U_{z_i}}{\partial U_X} = \frac{\partial P(Z)}{\partial Z_i} = P_i(Z) = \theta_{z_i}(Z^*; u^*, Y) \quad (3)$$

Therefore, as depicted in equation (3), the MRS is equal to the implicit price and the marginal bid. After solving for all θ_{z_i} , then the results yield

$$\theta(Z^*; u^*, Y) = P(Z^*) \quad (4)$$

Condition (4) states that the optimal bid, at optimal utility and Z , must equal the optimal price vector.

A graphical depiction of the demand-side derivation of the implicit price function is illustrated in Figure 2. Figure 2 displays two consumers' bid curves for Z_1 holding utility and $Z_2^*, \dots, Z_n^*$ constant at the optimal levels. The bid curves $\theta^1(Z_1, Z_2^*, \dots, Z_n^*, u^*)$ and $\theta^2(Z_1, Z_2^*, \dots, Z_n^*, u^*)$, represent two consumers, the latter of which demands more Z_1 at their respective optimum quantities of Z^* and u^* . From the two bid functions, one can imagine several consumers bid functions in the Z_1 - P space. The numerous bid functions lay out or trace the optimal price path, or implicit price function, for Z_1 . The implicit price function, $P(Z_1, Z_2^*, \dots, Z_n^*)$, is tangent to the bid curves at the optimal levels of $Z_2^*, \dots, Z_n^*$ and u^* . This tangency is the result of the equation (3) described above.

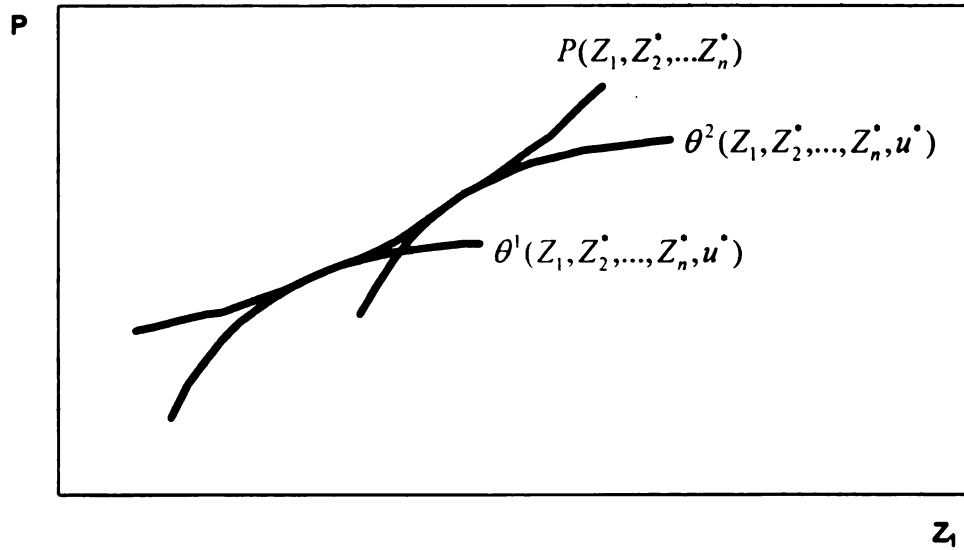


FIGURE 2. CONSUMER BID FUNCTIONS AND THE IMPLICIT PRICE FUNCTION FOR CHARACTERISTIC Z_1 .

A similar analysis of bid curves can be conducted for all Z_i . From these analyses demand-side implicit price functions for all Z_i can be formed. The implicit price function formed from consumer bid functions complete the demand side of the market. In order for the market to clear, producers must have implicit price functions for the same characteristics in bundle Z .

Supply

The analysis of the supply side is symmetric in many ways to the demand-side analysis. Let M denote the number of units of differentiated product, Z , produced by a firm. Firms are assumed independent of each other. The total cost function, $C(M, Z; \beta)$, is derived by minimizing factor costs subject to a joint production constraint relating M , Z , and factors of production. β is a shift parameter reflecting factor prices and production function parameters. Three cost function assumptions should be presented at this point: (i) C is convex and $C(0, Z) = 0$, (ii) $C_M > 0$, and (iii) $C_{Z_i} > 0$. Assumption (i) states that no production indivisibility's exist. Assumption (ii) states that marginal costs of production are positive and increasing. Lastly, (iii) assumes that the marginal costs of increasing each characteristic, Z_i , are positive and non-decreasing.

The economic objective of the firm is to maximize profit,

$$\pi = M * P(Z) - C(M, Z_1, \dots, Z_n; \beta), \text{ where } M \text{ and } Z \text{ are the variables chosen for}$$

optimality and unit revenue is given by the implicit price function for all characteristics, $P(Z)$. The optimal choice of Z and M for a firm require

$$P_i(Z) = C_{z_i}(M, Z_1, \dots, Z_n) / M, \text{ for all } i, \quad (5)$$

$$P(Z) = C_M(M, Z_1, \dots, Z_n) \quad (6)$$

At the optimum, marginal revenue from additional characteristics equals their marginal cost of production per unit sold, as depicted in equation (5). Equation (6) states that quantities are produced up to the point where unit revenues equal marginal production costs. Equations (5) and (6) fulfill the conditions of production efficiency for good Z .

For simplicity, assume that the production of all other goods, X , fulfill the efficiency conditions that are described above for Z_i . It has already been assumed that the price of X was unity. Based on these assumptions the Rate of Product Transformation (RPT) of good Z_i for X can be determined. RPT (Z_i for X) is equal to the ratio of their marginal costs (MC). The MC of Z_i , determined by equation (5), is equal to $P_i(Z)$, while the MC of X is P_X , which is equal to one. Therefore the RPT is equal to $P_i(Z)$. This fulfills the conditions for production efficiency for all goods.

Similar to the demand bid curve, assume a supply offer function, $\phi(Z_1, \dots, Z_n; \pi, \beta)$, exists. Let $\phi(Z_1, \dots, Z_n; \pi, \beta)$ be defined as a function indicating the unit prices a firm is willing to accept for production of various characteristic levels, Z_i . The offer function assumes a constant profit and the quantities produced, M , are optimal. Figure 3 depicts

two offer curves for the production of the implicit Z_1 characteristic. The offer curves are for the same firm at different profit levels, where the profit level π_1 is greater than π_2 .

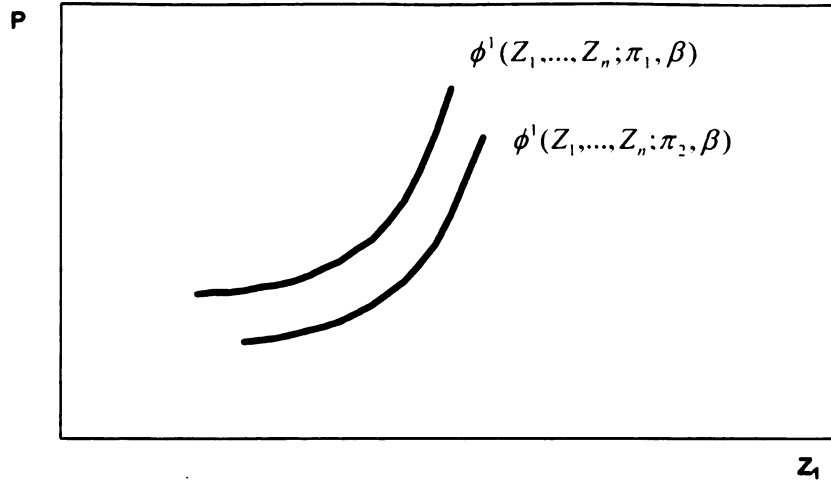


FIGURE 3. PRODUCER OFFER CURVES FOR CHARACTERISTIC Z_1 AT DIFFERENT PROFIT LEVELS.

The profit maximization can be resolved after inclusion of the offer function. By substituting $\phi(Z_1, \dots, Z_n; \pi, \beta)$ for $P(Z)$ in the profit maximization problem, the first order conditions produce

$$\phi_i(z) = C_{z_i}(M, Z_1, \dots, Z_n) / M, \text{ for all } i, \quad (7)$$

$$\phi = C_M(M, Z_1, \dots, Z_n) \quad (8)$$

It follows from equation (7) that the marginal offer from additional characteristics is equal to the marginal cost of production per unit sold. An important conclusion can be drawn for equation (7). As determined earlier, the RPT (Z_i for X) is equal to the MC of Z_i . Equation (7) states that the MC of Z_i is equal to the marginal bid. Therefore the RPT (Z_i for X) is equal to the marginal bid. Equation (8) finds the offer equal to the marginal production cost at the optimum.

The combination of equations (5) and (7) find the marginal offer and marginal price of additional characteristics are equal at the optimum, or

$$P_i(Z^*) = \phi_{z_i}(Z_1^*, \dots, Z_n^*; \pi^*, \beta) \quad (9)$$

In addition, equations (6) and (8) find, at the optimum, the offer is equal to the price, or

$$P(Z^*) = \phi(Z_1^*, \dots, Z_n^*; \pi^*, \beta) \quad (10)$$

Figure 4 depicts the implicit price function for characteristic Z_1 traced by two offer functions. The offer function $\phi^1(Z_1, Z_2^*, \dots, Z_n^*; \pi^*)$ describes a firm's production and cost conditions for Z_1 while optimizing $Z_2, \dots, Z_n$, while $\phi^2(Z_1, Z_2^*, \dots, Z_n^*; \pi^*)$ describes another firm's offer function. The production and cost conditions described by ϕ^1 make that firm better suited to produce lower levels of Z_1 than the firm described by ϕ^2 . In a competitive market many firms exist, and many ϕ^i describing the many firms will trace out the producers' implicit price function for each characteristic inherent in the good Z .

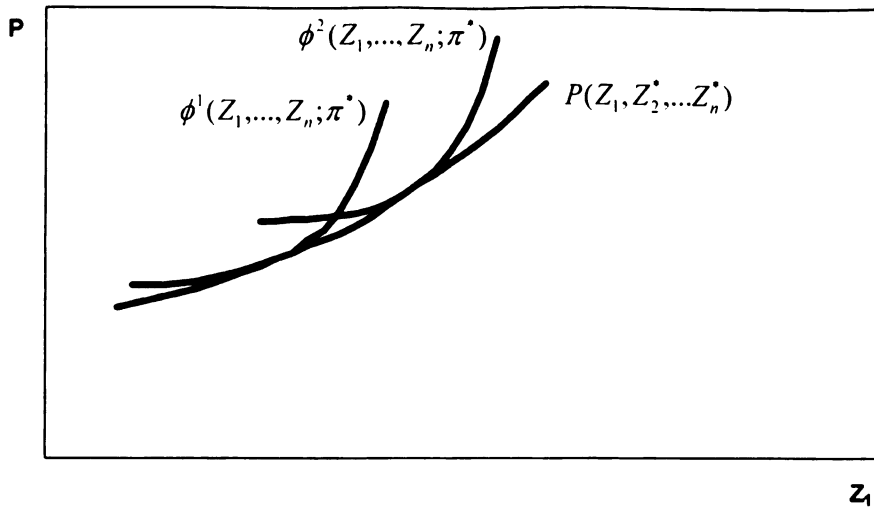


FIGURE 4. PRODUCER OFFER CURVES AND THE IMPLICIT PRICE FUNCTION FOR CHARACTERISTIC Z_1 .

Market Equilibrium

The theoretical basis for the demand and supply for implicit characteristics of a market good has assumed the existence of a market equilibrium. Assuming a market equilibrium, the price vector $P(Z)$ can be considered to be determined by the market process rather than a consumer and producer set of parameters. The equilibrium implicit price function is determined through the interaction of consumers and producers. Profit-maximizing firms seek to reach the highest offer function. Utility maximizing consumers seek the lowest bid function. Consumers and producers must now be assumed to meet in the implicit Z_i market.

Conditions for an efficient market find that the MRS is equal to the RPT. Through the consumers' maximization process, the MRS (Z_i for X) was found to equal the marginal

bid for Z_i as well as the price of Z_i , $P_i(Z)$. These conditions were depicted in equation (3). Through the producers' maximization process, the RPT (Z_i for X) was found to equal the marginal cost of Z_i as well as the marginal offer for Z_i both of which are equal to the price of Z_i , $P_i(Z)$. By equating the MRS (Z_i for X) and RPT (Z_i for X) the marginal bid is found equal to the marginal offer and both are equal to the price, as presented in equation (11)

$$MRS = \theta_{Z_i}(Z; u, y) = P_i(Z) = \phi_{Z_i}(Z; \pi, \beta) = RPT \quad (11)$$

If the conditions stated in equation (11) occur then the conditions for market efficiency are fulfilled. Through the demand and supply analysis provided above, the conditions of equation (11) have been met.

Equation (11) requires the marginal offer to equal the marginal bid. Therefore, the slopes of the offer and bid curves have to be tangent or equal. The various points at which this occurs establishes the implicit price vector for characteristic Z_i , $P_i(Z)$. A graphical example of market equilibrium for the Z_i characteristic is presented in Figure 5. Two points of tangency are displayed in Figure 5. Many offer and bid curves can be imagined in the Z_i - P space and therefore many points of tangency.

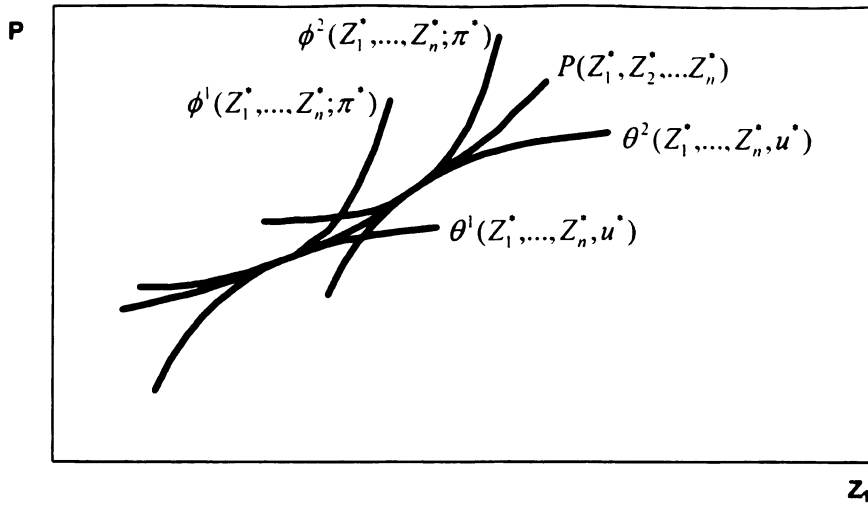


FIGURE 5. CONSUMER-PRODUCER EQUILIBRIUM AND THE IMPLICIT PRICE FUNCTION FOR CHARACTERISTIC Z_1 .

A similar analysis of offer and bid curves can be constructed for all Z_i characteristics. From the analysis of all characteristics the entire implicit price function, $P(Z)$, can be derived.

Through hedonic price theory, the implicit price function for differentiated goods can be assumed to exist and therefore estimated. Many studies have utilized this theoretical structure and estimated various implicit price functions. The next section describes a portion of the hedonic literature that is relevant to this study.

Applied Hedonic Models

The existing applied literature consists of a wide range of hedonic price studies. Hedonic studies have been applied to numerous topics including labor wages (Clark and Nieves 1994), automobile prices (Arguea and Hsiao 1993), and computer services (Chow 1967). In forestry, hedonic price models have been used to estimate how timber sale attributes affect sales prices (see for example Bare and Smith 1999).

The largest segment of hedonic literature concentrates on land and housing values. The hedonic land value studies can be divided into two broad topics: amenity (disamenity) valuation and growth control and land use impact valuation.

Amenity and Disamenity Valuation

One frequent use of the hedonic framework has been to measure the influence that amenities and disamenities have on property values. Environmental amenities such as open green space (Correl et al. 1978), mature trees (Dombrow et al. 2000), and proximity to Lake Michigan (Diamond 1980) and other urban water bodies (Brown and Pollakowski 1977) have been found to positively affect property values through the use of hedonic modeling. The hedonic price method has also measured the impacts of numerous disamenities. Disamenities such as aircraft noise (Abelson 1979), crime rates (Smith 1978 and Diamond 1980), noxious facilities (Clark and Nieves 1994), and hazardous waste sites (Kiel and McClain 1995, and Kiel 1995) were all found to have

negative impacts on local property values. Some perceived disamenities such as proximity to high voltage electric lines (Hamilton and Schwann 1995) and proximity to housing for the severe mentally disabled (Galster and Williams 1994) were found to have no impact on nearby property values.

The hedonic amenity and disamenity literature has found that various factors can influence property values. It is important for any hedonic study to take amenities/disamenities into consideration. Amenities found in Michigan such as the Great Lakes and other water bodies must be controlled for in this study.

Of all the amenities and disamenities measured in the literature, none are fully comparable with those that may occur due to the presence of public land. The objectives of this study, in part, focus on possible local amenities and disamenities provided by public land. Public land offers amenities such as esthetic beauty and wilderness to local residents. Public forestland may also produce possible disamenities such as timber harvesting or trespass by public land hunters and other users. The amenity and disamenity literature does provide evidence that public lands, and the activities on public land, may affect nearby property values. The literature does not provide any concrete evidence that property values are, in fact, affected by the associated amenities/disamenities.

Growth Control and Land-Use Impact Valuation

The effect that land-use or growth control regulations have on property values has been extensively studied. The growth control studies of land-use policies in Chesapeake Bay (Beaton and Pollock 1992), San Francisco (Katz and Rosen 1987), and Portland (Knaap 1985) have utilized the hedonic framework. Land-use restrictions in California (Frech and Lafferty 1984) have been found to increase residential home values. A study of New Jersey Pinelands land use policies found that developed residential property values went up while vacant land values went down in some cases (Beaton 1991). The Chesapeake Bay land-use restrictions were found to increase residential property values and have no effect on vacant land values (Beaton and Pollock 1992). Environmental protection zoning on selected rivers in Michigan (Leefers and Jones 1996) exhibited, post-zoning, value increases for property with housing and no effect on vacant land.

The literature covering land use policy has demonstrated that growth control and land use regulations do in fact impact land values. Therefore, hedonic studies need to control for land use and growth control regulations when modeling land values.

Past hedonic land value studies provide much guidance with respect to relevant variables and methods. The literature demonstrates the need to control for a variety of amenities/disamenities and land-use regulations. It also provides a vast array of parcel specific factors that influence property values. These factors are some of the variables that the hedonic regression model requires to estimate the implicit price function. The

variables are, in essence, required data for hedonic modeling. This study also requires various public land data. The next chapter, Methods, describes the sampling frame used to determine where data were collected as well as a description of the type of analyses conducted.

The aforementioned studies use several multivariate regression techniques relating (dis) amenities, growth control measures, and land-use restrictions to property values.

Generally, cross-sectional and pooled cross-sectional/temporal data are used. Most of the studies estimated regressions with sample sizes ranging between 100 and 1500 observations. The developed property models' adjusted R^2 's varied widely, generally between 0.30 and 0.70. Vacant property models' adjusted R^2 's are generally lower, ranging from 0.20-0.50. Common variables in the studies include: land area, distance from central business district, distance from interstate highways, age of house, existence of garage, exterior house material, and date of sale. Other variables used are study specific such as distance from a hazardous waste site, distance from Chesapeake Bay, and dummy variables identifying if the property is located within a zoned area.

Other Related Literature

Two objectives of this research are to measure the impact public land has on private property values, and to measure the impact of timber harvesting on public land on private property values. Public lands may affect private property values if differences exist between the immediate public land and the surrounding private land and if property

buyers recognize the differences, or at least perceive that they exist. One difference that may exist is vegetative treatment, or timber harvesting.

Daniel et al. (1973) studied whether observers could reliably discriminate between various vegetative treatments. Further, Daniel et al. (1973) studied if observers have different esthetic responses to the various vegetative treatments. Six different vegetative treatments were tested in ponderosa pine forest areas. The treatments used were: (1.) a uniform stripcut, (2.) an irregular stripcut, (3.) a clearcut, (4.) a heavy thin, (5.) a conventional harvest, which was an area selectively logged 15 years previous, and (6.) a relict area, which represented an uncut natural area. They found that all treatments were perceived as treated, with the uniform stripcut the least detectable followed by the conventional logging. The raw “Perceived Esthetic Value” of each treatment was adjusted to be relative to that of the relict. The adjusted “Perceived Esthetic Values” of the heavy thin, irregular stripcut, and clearcut were all lower than the relict, thus less pleasing. The uniform stripcut and conventional harvest were surprisingly perceived as more pleasing than the relict. We may assume therefore that property buyers will be able to detect treated areas, and that the type of treatment will determine the esthetic impact.

How important an esthetic value is relative to the several factors that people consider when buying property can not be determined from Daniel et al.’s work. The research in this dissertation incorporates the type of timber harvesting on public lands as an explanatory variable of the sales price for property adjacent to public land. The

coefficient sign and statistical significance reveal whether different types of timber harvesting affect property values.

Summary

From the theoretical literature, a foundation exists such that the market sales price of a good can be dissected. Using multivariate regression, the sales price of a good, such as a property sales price, can be broken into its' various attributes. Estimation of the regression provides implicit prices in the coefficients for all attributes. This method assumes that the housing market is competitive and that all markets clear.

The empirical literature provides an array of modeling techniques as well as attributes that are used as variables in the hedonic regression. The modeling techniques and variables from previous studies guide the data collection and methods used in this research.

CHAPTER 3: METHODS

This chapter describes the methods used for this dissertation. The data were gathered from randomly selected regions in the State of Michigan. Within each randomly selected region, every arms-length property transaction was recorded. The methods consist of three general parts. The first part of methods required a process for randomly selecting regions in the state. This is presented in the first section of this chapter, Sampling Frame. The second part involved determining required sales and property data and the collection of that data. The second section of this chapter discusses this part. Analysis of data is the final part of methods and is presented in the third section of this chapter.

Sampling Frame

The framework that determines the selection process of areas to be studied is often referred to as the sampling frame. The sampling frame for this dissertation was determined through four steps. First, the public lands for the study were chosen. The second step involved the determination of the sample areas, or regions from which a random selection is made. Next, methods for controlling effects that have been determined to influence property values were devised. Together, the first three steps determine the sample areas. The last step involved the determination of the specific study areas from the available sample areas. All property sales observations within each study area were collected. The four steps noted here are described in detail below.

Determination of Public Lands

Possible public lands considered for the purposes of this study include: all National and State forests, National and State wildlife refuges, National and State parks, and State game areas in the state of Michigan. These lands represent the majority of publicly owned land in the State excluding correctional facilities, military installations, and township and county level properties. Table 1 presents the acres and distribution of the public lands in Michigan. The largest portion of Michigan's public land, 87.8 %, is National and State forest.

TABLE 1. ACRES AND PERCENT DISTRIBUTION OF PUBLIC LANDS IN MICHIGAN.		
Public Land Type	Acres (000)	Percent of Total Public Land in Michigan
National forests	2,797	36.9
National parks and lakeshores	225	3.0
National wildlife refuges	111	1.5
State forests	3,857	50.9
State game and wildlife areas	299	3.9
State parks and recreation areas	261	3.4

Source: Travel and tourism in Michigan: A statistical profile. 1991. Travel, Tourism, and Recreation Resource Center. Michigan State University.

Determination of Sample Areas

Multiple factors contributed to the determination of sample areas. Data availability, the objectives of this study, and data collection efficiency are just a few of these factors. To best summarize the influence of these factors, the data that is available is described first.

Private property sales data in Michigan is generally available from two sources. At the county level, the Equalization Department records all sales transactions within the county for usually the past ten years. Within the Equalization Department rolls, various pieces of information are available. The county rolls state whether the sale is considered “arms-length”, being a fair market transaction. The county rolls give the date and amount of all fair market transactions. They also contain information on whether the property is a primary residence or a secondary home. The second source of information is at the township level. The township Assessor’s office records information on various property specific attributes. The lot size, house size, assessor’s ranking, exterior material, and the existence of a garage are but a few pieces of information available at the Assessor’s office. To record all required data, visits to both the county Equalization Department and the township Assessors office are needed.

The objectives of this study require data on private properties that vary in distance from public land. Therefore, the geographical size of the sample areas is an issue. The sample areas should demonstrate a consistent size, which will help assure that no weight or bias is introduced which may favor particular sample areas. Besides being consistent, the size

should be large enough to capture the effects that this study attempts to measure. Three units of boundary distinction are used in Michigan, they are: the county, the township, and the section. Counties are the largest, generally they measure 36 miles by 36 miles. Townships are the second largest and are found within counties. Generally, there are 36 townships per county, measuring six miles by six miles. The last and smallest area is the section. Usually thirty-six sections make up one township. Each section is one mile by one mile in dimension.

The county, as the sample unit, provides a distance from public land from 0 to 36 miles. Thirty-six miles may be too large. The possible impact of public land on private property values is more likely to occur at distances nearer public land rather than farther. The county as a sample unit may also be too large for another reason. The size of the county restricts data to be collected from one, possibly two counties. Each county requires up to thirty-six visits at the township level for data collection. Discussed later in this chapter, ten townships were visited for data collection reasons. Therefore, sampling at the county level greatly restricts the data to come from one or two counties, and this in turn restricts the geographic regions.

In general, townships in Michigan measure 36 square miles. Due to the general symmetry of township sizes, the township unit provides a fairly consistent sample area. Though not all townships in the State are 36 square miles, the majority of townships are consistent in size. The possible bias introduced using the township as the sample area is negligible.

The township unit is likely to be large enough to capture the possible impact of public lands, and timber harvesting on public lands, on private property values. The size of the township allows the models to incorporate a proximity measure (i.e., distance of private property from public property) ranging from zero up to six miles. This range is likely to be adequate to determine the impact of proximity of public lands on private property values. The range in size for a section is probably too small.

The township also provides a data collection efficiency over that of the section. With one visit to an Assessor's office, sales from thirty-six sections were collected. If the section were the sample area, then more visits to more Assessors offices would have been required for a similar sample size.

All of the objectives for this study could have been addressed using either county, township, or section as sample units. Each possible sample unit would likely provide adjacent private property sales, required by all objectives. Each possible sample unit would provide differing distances of private parcels from public lands, though the county unit has the potential for the distance range to be too wide while the section unit has the potential for the distance range to be too small. Each geographic region could provide differing public land ownership, as required for objective 3. Each sample unit measure could provide occurrences of timber harvesting near adjacent private properties, required for objective 4.

Due to the data collection efficiencies and the ability to best capture the data required to address the objectives the township was determined the best sample area from which the study areas were drawn. The sample areas for this study consists of nearly all townships that abut or contain public land. Some townships have been omitted from the sample areas due to certain attributes. Townships exhibiting attributes such as nearness to Metropolitan Statistical Areas and the Great Lakes were excluded. The consideration and treatment of such attributes, or influential effects, are described in more detail next.

Control of Influential Effects

Past studies have determined that proximity of private property from specific land features has influenced property values. Features such as the Great Lakes, metropolitan areas, inland lakes, rivers, and wetlands have demonstrated impacts on private property values. Two of the five features noted above, namely the Great Lakes and metropolitan areas have been controlled for in the sampling frame of this study. A reason for controlling for such land features in the sampling frame, rather than in the hedonic model, is simplicity. Fewer explanatory variables will need to be included in the models.

Diamond (1980) demonstrated that Lake Michigan could have a positive impact on private property values at a distance of up to five miles. Frech and Lafferty (1984) found that the California coast from a distance of 13 miles affected housing prices. One important difference between these studies involves the topography of the respective study areas. The topography typically found in Michigan is not nearly as mountainous as

that of California. The view of a waterbody in California can, generally, take place at a much farther distance than in Michigan. Therefore, all sample areas in this study will lie at least five miles inland from Lake Michigan and other Great Lakes. A five-mile distance from the Great Lakes should greatly reduce the probability of their influence on property values.

Land studies have demonstrated the positive influences that proximity to metropolitan areas has on property values (see for example Beaton and Pollock (1992)). Proximity to metropolitan areas serves as a proxy for various attributes including consumption and labor activities. To control for the influence of large metropolitan areas, all the sample areas should lie some distance from such an area. Metropolitan Statistical Areas (MSA), as defined by the U.S. Census Bureau, are areas that have populations greater than 150,000. Sample areas within 35 miles from MSA's were omitted. The 35-mile distance is somewhat arbitrary. Evidence suggests 20 miles is the average commute distance in Michigan. Thirty-five miles should dispose of a majority of any impact that MSA's may have on property values.

Past land-use literature has found that zoning may impact property values. Due to the multitude of types of zoning in Michigan, it is not feasible to classify all types of zoning and include all classifications in the hedonic models without further congesting the models with variables. Incorporated villages and cities generally administer more specific and more inclusive zoning regulations than those not incorporated. Therefore,

properties that lie within incorporated villages and cities were excluded during data collection.

As mentioned above waterbodies such as inland lakes and rivers have been determined to affect private property values. For reasons related to the efficiency of data collection, proximity to inland lakes and rivers was not controlled for in the sampling frame. Though not controlled for in the sampling frame, the influence of inland lakes and rivers is accounted for in the hedonic models. This issue is addressed further in the Data Analysis section at the end of this chapter.

Selection of Study Areas

The total number of sample areas, excluding the omitted areas, exceeded 300. Due to time and monetary considerations the list of areas to be used in this research was reduced. The areas to be used in this research are referred to as study areas. Study areas were randomly selected from the sample areas. Twenty-five potential study areas were randomly selected from the list of over 300 sample areas. The sequential list of potential study areas is presented in Table 2.

All arms-length property sales within ten of the randomly chosen study areas were collected. Data collection began at the top of the list and proceeded downwards with no *a priori* knowledge of the number of sales within individual townships. Data were collected from August 1998 through May 1999. Some townships were excluded from the

potential study areas due to data recording methods at the county level. Some counties' recording methods were inconsistent with the methods used by the rest of the state. The primary inconsistency was that these counties did not record private property sales over the entire study period. Townships located within these counties were therefore excluded. The exclusion of townships from the list of 25 potential study areas is further described in the Data Collection section. Due to time and monetary considerations, the list was not fully exhausted. The study areas used for this dissertation are presented in Table 3. These 10 townships located in 10 different counties provided a good geographic dispersal and mirrored the primacy of state forestlands, followed by national forestlands. A map of the counties in which the study areas lie is presented in Figure 6.

TABLE 2. RANDOMLY SELECTED LIST OF 25 TOWNSHIPS IN MICHIGAN THAT CONTAIN PUBLIC LAND, BY COUNTY.					
Random No.	County	Township	National Forest	State Forest	Other
1	IOSCO	Alabaster		X	
2	CHEBOYGAN	Benton		X	
3	GOGEBIC	Bessemer	X		X
4	SCHOOLCRAFT	Hiawatha	X	X	
5	MENOMINEE	Cedarville		X	
6	DICKINSON	Sagola		X	
7	LAKE	Cherry Valley		X	
8	NEWAYGO	Barton	X		
9	PRESQUE ISLE	Krakow		X	
10	WEXFORD	Slagle	X		
11	OSCEOLA	Hersey		X	
12	ONTONAGON	Rockland	X	X	
13	CHIPPEWA	Pickford		X	
14	CHARLEVOIX	Chandler		X	
15	CHIPPEWA	Rudyard	X	X	
16	MISSAUKEE	Pioneer		X	
17	GRAND TRAVERSE	Union		X	
18	MONTCALM	Evergreen		X	
19	PRESQUE ISLE	Bismark		X	

Table 2. (continued).					
20	GRAND TRAVERSE	Whitewater		X	
21	BENZIE	Weldon	X		
22	OTSEGO	Otsego Lake		X	
23	WEXFORD	Selma	X		
24	CHIPPEWA	Raber		X	
25	HOUGHTON	Laird	X	X	

TABLE 3. STUDY AREAS, BY COUNTY.					
Random No.	County	Township	National Forest	State Forest	Other
3	GOGEBIC	Bessemer	X		X
4	SCHOOLCRAFT	Hiawatha	X	X	
6	DICKINSON	Sagola		X	
7	LAKE	Cherry Valley		X	
10	WEXFORD	Slagle	X		
11	OSCEOLA	Hersey		X	
12	ONTONAGON	Rockland	X	X	
14	CHARLEVOIX	Chandler		X	
15	CHIPPEWA	Rudyard	X	X	
16	MISSAUKEE	Pioneer		X	

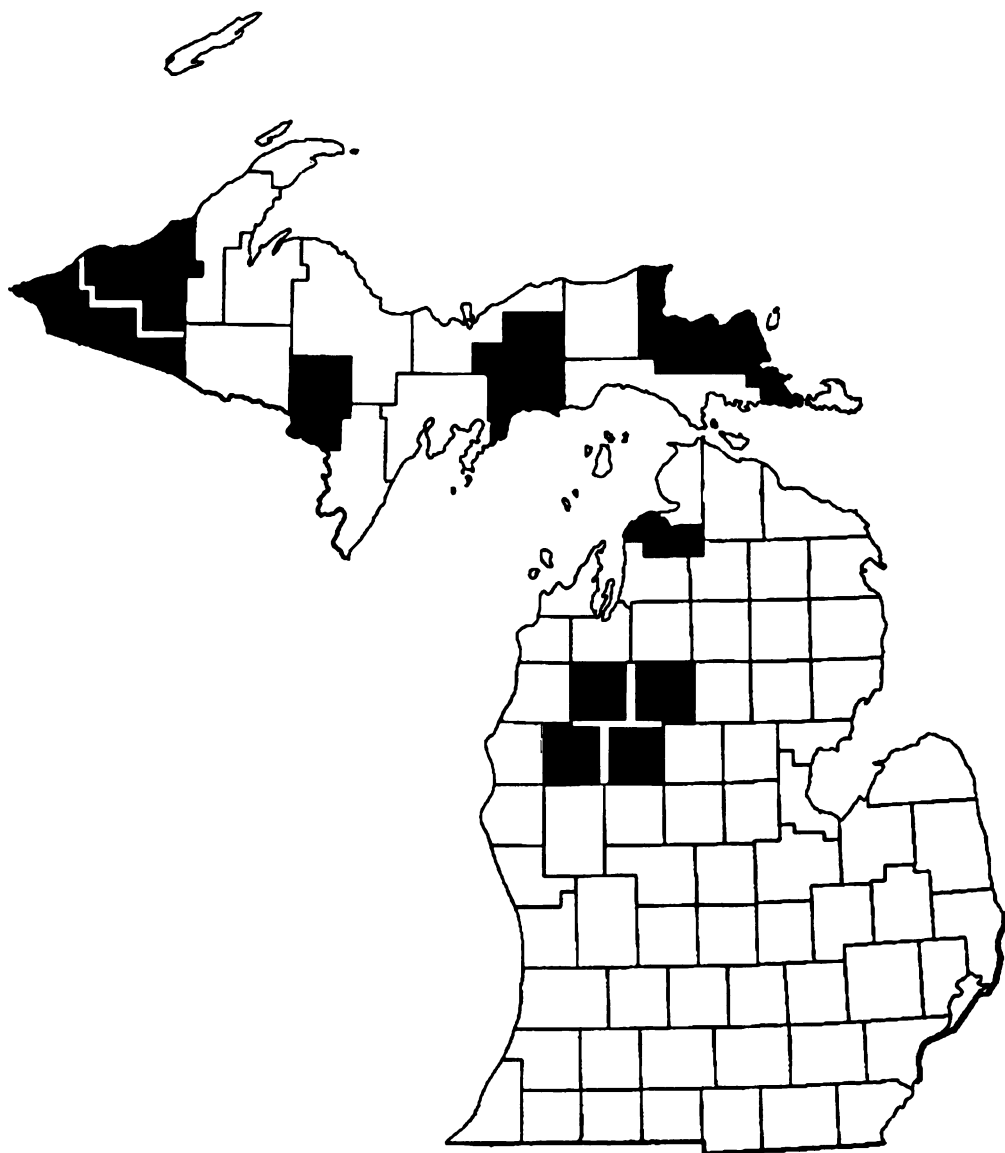


FIGURE 6. MAP OF STUDY AREAS, BY COUNTY.

Data Collection

This research required data that was available from several sources. The first source was various County Equalization Departments throughout the State of Michigan. Each County Equalization Department recorded arms-length property transactions within the respective county for the past ten years. Each County Equalization Department also recorded whether each parcel was a primary residence or a secondary home. Some County Equalization Departments did not record sales for the ten previous years. These counties only had the sales from less than ten previous years available. The townships located within these counties were excluded from the study areas. Inclusion of these townships would have introduced some problems related to the study's time period. These townships would be represented in the hedonic models by only the latest year's sales while all other townships would be represented by the past ten year's sales. A possible bias could have occurred in the early years of the study period because the models would not accurately reflect all the study areas over the entire study period. Rather, the models would have represented only the study areas with complete sales data in the earlier time periods, and then accurately represent all the study areas in the latter years of the study period. The reliability of the earlier years of the hedonic models would have been in question and all of the hedonic model results would have been questionable.

The second source of data was the Township Assessors office. Each assessor's office has a parcel record for each property in the respective township. The parcel records contain

information such as the square footage of a home, the acreage of the property, existence of a garage, the exterior material of the home, and many other parcel specific attributes.

The third source of data was the United States Forest Service (USFS) Field Offices and the State of Michigan Department of Natural Resources (MDNR) Field Offices. These offices provided the forest types and harvesting activities of all the public land areas researched in this study. The forest types information included descriptions of forest species composition and density of all public forests located within the study areas. The harvesting activities information included the type of harvest and the year the harvest was completed for all public land located within all the study areas.

The last source of data was a variety of maps. Proximity of properties from public land, highways, and urban centers were measured from township maps. Township maps also provided the identification and proximity of inland lakes and rivers. County maps allowed for density of public land measures to be calculated. USFS and MDNR maps were used to measure proximity of properties from timber harvesting on public land.

Data Analysis

The first part of this section provides a complete description of the data collected. The second part of this section provides a general form of the models that are estimated. The last part describes this studies approach to the problems related to functional form. All regression analysis is estimated with Ordinary Least Squares (OLS). OLS is the

estimator of choice because of the desired properties under the assumptions of the classical linear regression model (see Kennedy 1996). Under these conditions, OLS produces the smallest sum of squared residuals, unbiased coefficients with the smallest variance, and asymptotically efficient coefficients.

Description of Data

The literature review, dissertation guidance committee suggestions, and data availability were the guiding factors for identifying data collected. The empirical literature demonstrated that various parcel specific attributes, such as square footage, lot size, existing zoning, and existence of a garage contributed to property values. To the extent possible, all available parcel specific data were collected. Other possible influences, such as proximity to prisons, forest type on public lands, and the density of public land were thought to possibly affect property values by committee members. Data for these variables were also collected. These variables are divided into three categories: Property Attributes, Public Land Attributes, and Forest and Timber Harvesting Attributes. The variable name is followed by a brief description.

Property Attributes:

PRICE	The nominal U.S. dollar sales price of the property.
HOUSE	The square footage of the home at the time of the sale.
LOT	The size in acres of the property at the time of the sale.
DATE	The year the property sold. All sales are between 1988 and 1997.

CITY	Proximity in miles from nearest metropolitan area with a population of 10,000 or more. This was measured from plat maps with a scale of 1 ¼ inch equals one-mile.
HWY	Proximity in miles from nearest State or Federal highway. This was measured from plat maps with a scale of 1 ¼ inch equals one-mile.
R_INT	The 30-year interest rate at the time of the sale.
GSP	The Gross State Product at the time of the sale.
REGEUP	A dummy variable indicating the property is located in the Eastern Upper Peninsula.
REGWUP	A dummy variable indicating the property is located in the Western Upper Peninsula.
REGNLP	A dummy variable indicating the property is located in the Northern Lower Peninsula.
VACANT	A dummy variable indicating that the property is vacant, not developed.
GARAGE	A dummy variable indicating that a garage exists on the property.
PRISON	A dummy variable indicating that a prison is located within 30 miles.
ZONED	A dummy variable indicating that the property is zoned at either the township or county level.
BR	A dummy variable indicating that the home has a brick exterior.
B	A dummy variable indicating that the home has received the highest quality ranking by the township assessor.

D	A dummy variable indicating that the home has received the lowest quality ranking by the township assessor.
MH	A dummy variable indicating that the home is a mobile home.
PAVE	A dummy variable indicating that the road the property abuts is paved.
HOME	A dummy variable indicating that the home is a primary residence.
PLAT	A dummy variable indicating that the property is platted.
H2O	A dummy variable indicating that the property abuts a river or lake.
UTIL	A dummy variable indicating that the home has publicly provided electricity.

Public Land Attributes:

FED	A dummy variable indicating that the nearest public land is federally owned.
STATE	A dummy variable indicating that the nearest public land is state owned.
COU	A dummy variable indicating that the nearest public land is county owned.
F_DIS	Proximity, in feet, of the property boundary from the federal land boundary if federal land is the nearest public land. This distance was measured off plat maps with a scale of 1 ¼ inch equals one-mile. The distance measures were made along a straight line from nearest boundary point to nearest boundary point.

S_DIS	Proximity, in feet, of the property boundary from the state land boundary if state land is the nearest public land. This distance was measured from plat maps with a scale of 1 ¼ inch equals one-mile. The distance measures were made along a straight line from nearest boundary point to nearest boundary point.
PUBDIS	Proximity, in feet, of the property's nearest boundary from the nearest public land boundary.
ABUT	A dummy variable indicating that the property is adjacent to public property.
FEDA	A dummy variable indicating that the property is adjacent to federally owned public property.
STATEA	A dummy variable indicating that the property is adjacent to state owned public property.
COUA	A dummy variable indicating that the property is adjacent to county owned public property.
PERPUB	The percent of area within the property's township and the surrounding eight townships that is publicly owned. This was measured from plat maps with a scale of 1 ¼ inch equals one-mile.
PERADJ	The percent of the property that abuts public property.
PERDIS	An interaction variable that is the product of PERPUB and the proximity, in feet, of the property from public land. The greater the percent of public land, the less that proximity may affect the sales price of the property.

Forest and Timber Harvesting Attributes:

CONIFER Dummy variable indicating that the nearest forest is predominantly coniferous.

HARDWOOD Dummy variable indicating that the nearest forest is predominantly hardwoods.

HARVEST A dummy variable indicating that timber harvesting has occurred on adjacent public property within one-quarter mile and within the ten years previous to the sale of the property.

FEDH A dummy variable indicating that timber harvesting has occurred on adjacent federal public property within one-quarter mile and within the ten years previous the sale of the property.

STATEH A dummy variable indicating that timber harvesting has occurred on adjacent state public property within one-quarter mile and within the ten years previous the sale of the property.

COUH A dummy variable indicating that timber harvesting has occurred on adjacent county public property within one-quarter mile and within the ten years previous the sale of the property.

CC A dummy variable indicating that a clear-cut has taken place within one-quarter mile from adjacent property and within ten years previous to the sale of the property.

CC_P	An interaction variable that is the product of CC and PER_PUB. The greater the percent of public land, the less the effect that a clear-cut may have on the sales price of the property.
SEED	A dummy variable indicating that a seed tree cut has taken place within one-quarter mile from adjacent property and within ten years previous to the sale of the property
SEED_P	An interaction variable that is the product of SEED and PER_PUB. The greater the percent of public land, the less the effect that a seed tree cut may have on the sales price of the property.
REM	A dummy variable indicating that a removal cut has taken place within one-quarter mile from adjacent property and within ten years previous to the sale of the property
REM_P	An interaction variable that is the product of REM and PERPUB. The greater the percent of public land, the less the effect that a removal cut may have on the sales price of the property.
SEL	A dummy variable indicating that a selective cut has taken place within one-quarter mile from adjacent property and within ten years previous to the sale of the property
SEL_P	An interaction variable that is the product of SEL and PERPUB. The greater the percent of public land, the less the effect that a selective cut may have on the sales price of the property.

THIN	A dummy variable indicating that a thinning has taken place within one-quarter mile from adjacent property and within ten years previous to the sale of the property
THIN_P	An interaction variable that is the product of THIN and PER_PUB. The greater the percent of public land, the less the effect that a thinning may have on the sales price of the property.

The harvesting variables were not recorded for all properties, only adjacent properties. The recording of harvesting variables for non-adjacent properties would have to include a proximity measure. The decision of how many and which nearby timber harvesting activities to include as attributes for each non-adjacent property would increase the number of variables in the already congested hedonic models. It is likely that the price of adjacent properties would experience the brunt of timber harvesting activities relative to non-adjacent properties based on proximity alone. A simpler dummy variable for adjacent property should provide evidence as to whether the specific harvesting activity has any impact. Statistical information of each variable is provided in the next chapter.

General Form of Model

Given the data described above, it is now possible to represent the hedonic models in a general form. The general linear form of a hedonic model is:

$$PRICE_i = \beta_0 + \sum_j \beta_j * X_j + \varepsilon_i$$

where $PRICE_i$ is the sales price of private property i , β_0 is the intercept, $\sum_j \beta_j * X_j$ is the sum of all coefficients multiplied by the respective property attributes for each attribute j , and ε_i is the error for each property sale i .

Four hedonic models were estimated. The first two included the entire data set, and are referred to hereafter as the full models. One estimated a hedonic model for developed private property while the other estimated a hedonic model for vacant or undeveloped private property. Three reasons exist for dividing vacant and developed property models. First, past studies have demonstrated that the relationship between developed property and vacant property prices and the property attributes behave differently (see for example Beaton and Pollock 1992). Second, the dependent variable (PRICE) mean values and variances differ greatly between vacant and developed samples. Finally, there is no reason to believe that public land and timber harvesting on public land will have similar impacts, if any, on vacant and developed properties. Therefore, models of developed and vacant property were estimated independently. The last two models included only the properties that are adjacent to public land, and are referred to hereafter as the adjacent models. As with the full models, the adjacent models have two separate models, one for developed and another for vacant property.

The full models are used primarily to address the first, second, and third objectives of this research. The adjacent models are used to address the fourth objective. Discussion of the relationship between specific models and objectives are discussed next.

The first objective of this research is to estimate the impact of Michigan's public lands on sales prices of adjacent private lands. This objective is addressed with two full models, which contain all observations for either developed property or vacant property. The full model coefficients of the F_DIS and S_DIS variables determine if a statistically significant impact exists at increasing distances from public land. The distance variables F_DIS and S_DIS will be replaced with FEDA and STATEA providing a simpler model but with less information. The coefficients to FEDA and STATEA will determine if any impact caused by public land exists due to adjacency. Additionally, another variable, PER_PUB will explain the effects that the amount or density of public land has on private property. The coefficient of the PER_PUB term in both the full models and adjacent models indicate if the density of public land has any impact on private property. The coefficient of the PER_DIS term in the full models indicates if distance from public land interacts with the percent of public land in the surrounding area to influence property values.

The second objective of this research is to estimate the impact of proximity (distance) to public lands on private land sales values. Full models, with all observations, are used to address this objective. The coefficients of the variables F_DIS and S_DIS from the full models determine if any statistical significance exists between proximity of public land and private property values.

The third objective of this research is to compare impacts of various types of public land use (ownership) on nearby private land values. Full models are used to address this

objective. The full model coefficients of the F_DIS and S_DIS variables determine if any statistical significance exists between proximity of federal and state public land and private property values.

The last objective of this research is to estimate the impact of public land timber harvesting on adjacent private property values. Two adjacent models, with only adjacent property observations, for developed and vacant properties are estimated to address this objective. The coefficients of the adjacent model CC, CC_P, SEED, SEED_P, REM, REM_P, SEL, SEL_P, THIN, and THIN_P variables will determine if the respective forms of timber harvesting have any statistically significant impact on private property values. The same variables are included in the full model, but the coefficients are of lesser importance there. The variables are included to control for the possible impacts of timber harvesting, adding additional information to the model. Since the non-adjacent observations do not have the timber harvesting information the comparison of these variables between adjacent and non-adjacent observations is not as robust as that in the adjacent model. The coefficients of these variables in the full models represent the above comparison between the adjacent and non-adjacent observations. An additional variable, PERADJ, is included to control for the possible impact that the amount of public land frontage may have.

Functional Form Considerations

The hedonic theory presented in Chapter 2 provided the framework of multivariate regression as the analysis tool for hedonic pricing. Keen observers will note that the theory does not provide any insights into the functional form relationship between price and the attributes of the differentiated product. The specified functional form may have an impact on the coefficients of the variables of interest, especially if multi-collinearity exists. Therefore, it is important to specify the models functional form as theoretically and empirically sound as possible.

Several steps were undertaken in this research to provide an adequate assessment and specification of the functional form of the dependent and independent variables. The steps are outlined in Table 4.

TABLE 4. OUTLINE OF STEPS USED TO ASSESS AND IDENTIFY THE FUNCTIONAL FORM OF EACH MODEL.	
Step A	Estimate all models with linear price and cubic continuous independent variables.
Step B	Estimate all models with logarithmic price and cubic continuous variables. Compare to model results from Step A. Determine proper dependent variable form.
Step C	Correct models for heteroscedasticity where needed.
Step D	Test the quadratic forms of the independent variables. Determine "best" cubic form models.
Step E	Test the logarithmic forms against "best" cubic forms for independent variables.
Step F	Determine "best" functional forms.

In Step A, the model is estimated with a linear dependent variable, PRICE, and cubic continuous independent variables, such as house size, lot size, and proximity distances. The Step A models are presented in the respective sections for both the Full Developed

Model and the Full Vacant Model. Step B estimates nearly the same model as Step A except the dependent variable is the logarithm of price. The results of the Ramsey RESET comparisons determine the form of the dependent variable in Step A and Step B. The logarithmic price variable is used for all further steps in all models. The models are then re-estimated in Step B using a logarithmic dependent variable. Several model test statistics (i.e., Ramsey's RESET, F, and LM heteroscedasticity) of the Step A models are compared to the Step B models. The Ramsey RESET test estimates the model with the fitted dependent variable squared and the fitted dependent variable cubed as additional independent variables. The statistical significance of the additional squared and cubed fitted dependent variable terms coefficients reveal whether additional systematic curvature exists and is not being accounted for. The F-test jointly tests the significance of all independent coefficients equal to zero. The LM (Lagrange Multiplier) heteroscedasticity test is computed by regressing the squared residuals on the squared fitted values of the regression. Then the slope of the log-likelihood function with respect to the coefficient vector is tested to be significantly different from zero. Step C corrects for any heteroscedasticity present in the Step B estimates. The models exhibiting heteroscedasticity were corrected using White's variance-covariance matrix.

Once the functional form of the dependent variable up through Step C was determined to be logarithmic, the functional form of the independent variables needed to be decided. Step D tests the statistical significance of the squared and cubed terms of the quadratic form of the independent variables. This step determines the "best" functional form for the case of the logarithmic-cubic functional form. Step E challenges the functional form

of the “best” logarithmic-cubic model from Step D. In Step E, an artificial regression is estimated which contains all the variables from the “best” logarithmic-cubic model as well as logarithmic forms of all the continuous independent variables. In essence, the artificial regression is attempting to capture all curvature between the logarithmic price and each independent variable as explained by both logarithmic and cubic forms. Step E then tests the statistical significance of the logarithmic forms jointly and cubic forms jointly. These statistical tests determine if one form, logarithmic or “best” cubic, accounts for a majority or all of the curvature between the independent and dependent variables. Step F then estimates the model determined in Step E to be the better fit.

The method provided by Steps A-F has not been conducted in any of the empirical literature. This method offers two advantages over popular methods. First, the method here allows for a more flexible functional form that is less arbitrary than the methods used in the current literature. Second, the method results here have a wider and more useful interpretation compared to the method results that exist in the literature.

The first advantage of the methods presented in Steps A-F, compared to the empirical literature, is the more flexible and less arbitrary functional form. Kiel (1995) uses a hedonic model with a logarithmic price dependent variable and an arbitrary mixture of quadratic, linear, and logarithmic independent variables. Beaton and Pollock (1992) estimate a log-log functional form with one linear independent variable. Galster and Williams (1994) estimate a log-linear functional form. Milon, Gressel, and Mulkey (1984) estimate several functional forms. They estimate a Box-Cox flexible functional

form, which restricts all continuous independent variables to have the same functional form with the dependent variable. They also estimate linear, logarithmic, semilog, inverse semilog, quadratic, inverse exponential, and simple Box-Cox functional forms for comparison to the Box-Cox using a likelihood ratio.

As seen from the literature, several functional forms have been estimated. Most of these forms are either linear, log-linear, log-log, or some mixture of the three. The decision to use these specific functional forms in the existing literature is usually arbitrary. The flexible Box-Cox is less arbitrary, but offers problems of its own. The arbitrary nature of selecting functional form applies a restriction to the relationship between independent and dependent variables. This may rule out the form that best fits the data. The method used here allows for variations of all of the four forms mentioned above with the addition of the cubic form. The choice of functional form used here is not arbitrary but relies on a series of statistical tests. The preferred log-cubic model (which is actually a mixture of cubic and linear independent terms) is statistically determined. This model is then statistically compared to a log-log model using an artificial regression. The result provides a unique relationship between each independent variable and the dependent variable. The Box-Cox form is restricted here. It assumes that all independent variables have the same functional form with the dependent variable. As mentioned above, the Box-Cox has a further problem, which is discussed below.

The second advantage of the method provided in Steps A-F is that the results are more interpretable than those from some of the other functional forms. Milon, Gressel, and

Mulkey (1984) point out, when using the Box-Cox transformation, that the implicit price of amenities is dependent upon the levels of all other characteristics. This causes a difficulty of attempting to “untie” amenities and therefore interpreting coefficients. Hamilton and Schwann (1995) mistakenly dismiss both log-linear and linear functional forms. They then resort to a Box-Cox translog functional form. They make conclusions on the absolute average level of impact of several characteristics without informing the reader how they came up with these figures and what assumptions they made while they “untied” amenities. Because each characteristic’s impact on price is dependent upon the level of other characteristics, the correlation of independent variables is important. The problems associated with collinearity of independent variables, omitting relevant variables, and including of irrelevant variables may be compounded in the Box-Cox form. Collinearity is clearly a problem in all other functional forms, but the other problems may have much more of an impact in the Box-Cox.

CHAPTER 4: ANALYSIS

This chapter describes the analysis of the data. The first section reviews the descriptive statistics of the data. Descriptive statistics of the entire data set are first reviewed. Next, data used in the Full Models and the Adjacent Models are reviewed. The second section covers the model estimation and parameter testing of Steps A-F, outlined in the previous chapter, for the Full Models. The third section does the same for the Adjacent Models. The last section covers the removal of outliers.

Descriptive Statistics

Descriptive statistics provide useful insights pertaining to the data used to estimate any model. This section provides a review of the data in several fashions. First, the entire data set is reviewed. Then a review of subsets of the data follows. The breakdown of the data into subsets is relevant to further analysis conducted in this chapter. The subsets are first divided into two primary sets: Full Model Data and Adjacent Model Data. The Full Model Data subset contains all observations. The Adjacent Model Data contains only observations that are adjacent to public land. These subsets are then further divided into Developed Model Data and Vacant Model Data which, respectively, contain only developed properties or vacant properties. The four subsets are those used in the four hedonic models. A review of the data for each of the four subsets is provided after the review for the entire data set.

Entire Data Set

The entire data set contains 1,339 property sales, with mean sales price (PRICE) of \$22,769, average lot size (LOT) of 15.63 acres, and the mean year of sale (DATE) of 1993 (Table 5). One half of the data consists of vacant property (VACANT), while the other is developed. The average distance of the properties from a city with a population of 10,000 or more (CITY) is 38 miles. The average distance to a highway (HWY) is 2.58 miles.

TABLE 5. DESCRIPTIVE STATISTICS FOR HOUSING AND MARKET VARIABLES FROM THE ENTIRE DATA SET (N=1339).				
Variable (unit)	Mean	St. Dev.	Min.	Max.
PRICE (\$)	22769	23227	625	215000
HOUSE (sq ft)	435	504	0	2930
LOT (acres)	15.63	32.40	0.06	640.00
DATE (year)	1993	3	1988	1997
CITY (miles)	38.35	36.97	8.75	193.60
HWY (miles)	2.58	4.52	0	19.35
R_INT (%*100)	8.75	1.01	7.40	10.45
GSP (\$)	223.61	32.36	175.70	272.61
VACANT (0,1)	0.50	0.50	0	1
GARAGE (0,1)	0.22	0.41	0	1
PRISON (0,1)	0.29	0.45	0	1
ZONED (0,1)	0.53	0.50	0	1
BR (0,1)	0.01	0.11	0	1
B (0,1)	0.00	0.04	0	1
D (0,1)	0.22	0.41	0	1
MH (0,1)	0.07	0.26	0	1
PAVE (0,1)	0.29	0.45	0	1
HOME (0,1)	0.26	0.44	0	1
PLAT (0,1)	0.33	0.47	0	1
H20 (0,1)	0.13	0.34	0	1
UTIL (0,1)	0.36	0.48	0	1
REGEUP (0,1)	0.29	0.45	0	1
REGWUP (0,1)	0.18	0.38	0	1
REGNLP (0,1)	0.53	0.50	0	1

Approximately 53% of all properties are under some form of housing or property zoning (ZONED). A minority of the properties, 26%, are primary residences (HOME). This is not a surprise considering the amount of vacant property in the data set and is also a function of the sampling. Most of the properties, 53%, are located in the northern Lower Peninsula (REGNLP), while 29% are located in the eastern half of the Upper Peninsula (REGEUP) and the remaining are located in the western half of the Upper Peninsula (REGWUP). This result is also a function of the sampling, since most of the southern Lower Peninsula was omitted from the sample due to the influence of large metropolitan areas.

Table 6 presents descriptive statistics for public land and timber harvesting related variables for the entire data set. Of these properties, 23% abut public land (ABUT). Eight percent abut federal land (FEDA), while 16% abut state land (STATEA). Eight percent of the properties abutted public land that experienced timber harvesting within a quarter mile of the private property previous to the sale date, as seen in the HARVEST variable statistics. This average, though, is slightly misleading. The HARVEST variable, among others, was recorded only for abutting properties. For non-abutting properties, the HARVEST variable is zero. Therefore, the statistical description of the HARVEST variable for all data reflects a mean and standard deviation lower than those found for abutting properties and positive for non-abutting properties. Other variables that were only recorded for abutting properties are: CONIFER, HARDWOOD, BRUSH OPEN, CC, CC_P, SEED, SEED_P, THIN, THIN_P, SEL, SEL_P, REM, REM_P, and

PERADJ. The relevant statistical descriptions for these variables are found in the Adjacent Model Statistics section.

TABLE 6. DESCRIPTIVE STATISTICS FOR PUBLIC LAND AND TIMBER HARVESTING VARIABLES FROM THE ENTIRE DATA SET (N=1339).				
Variable (unit)	Mean	St. Dev.	Min.	Max.
ABUT (0,1)	0.23	0.42	0	1
HARVEST (0,1)	0.08	0.28	0	1
FED (0,1)	0.36	0.48	0	1
FEDA (0,1)	0.08	0.26	0	1
FEDH (0,1)	0.02	0.15	0	1
STATE (0,1)	0.62	0.49	0	1
STATEA (0,1)	0.16	0.36	0	1
STATEH (0,1)	0.06	0.24	0	1
COU (0,1)	0.02	0.15	0	1
COUA (0,1)	0.00	0.05	0	1
COUH (0,1)	0.00	0.00	0	0
CONIFER (0,1)	0.09	0.28	0	1
HARDWOOD (0,1)	0.18	0.38	0	1
BRUSH (0,1)	0.02	0.12	0	1
OPEN (0,1)	0.02	0.13	0	1
CC (0,1)	0.04	0.20	0	1
CC_P (0,1)	0.02	0.10	0	0.76
SEED (0,1)	0.00	0.05	0	1
SEED_P (0,1)	0.00	0.03	0	0.47
THIN (0,1)	0.02	0.15	0	1
THIN_P (0,1)	0.01	0.07	0	0.76
SEL (0,1)	0.01	0.11	0	1
SEL_P (0,1)	0.00	0.05	0	0.76
REM (0,1)	0.01	0.09	0	1
REM_P (0,1)	0.00	0.05	0	0.76
PUBDIST (feet)	5840	6968	0	35571
F_DIS (feet)	2116	4665	0	35571
S_DIS (feet)	3526	6454	0	35571
PERADJ (%)	0.07	0.17	0.00	1.00
PERPUB (%)	0.41	0.19	0.08	0.76

The average distance from the nearest public land is 5840 feet, as seen in the mean of PUBDIST. The descriptive statistics of the distance from federal land, F_DIS, and from

state land, S_DIS, variables in Table 6 are misleading. The mean values contain values for proximity to their respective public land, and zeros otherwise. For instance, F_DIS has proximity values for only those properties that are closer to federal land than state land. F_DIS has zeros for all other properties. Therefore, because of the additional zeros, F_DIS and S_DIS are not directly comparable to PUBDIST. F_DIS, for only those properties that are nearer federal land (477 properties) has a mean of 5941 feet and standard deviation of 6198. Similarly, S_DIS, for only those properties (833 properties) nearer state land has a mean of 5668 feet and a standard deviation of 7405. These numbers are directly comparable to PUBDIST. An average of 41% of the surrounding nine-township area (PERPUB) is public land.

As reported above, 1339 total sales observations were collected. The sample size is primarily a function of monetary resources. As much data was collected as possible, given monetary considerations. The sample size was not predetermined.

Full Model Statistics

The Full Models use all observations in the respective developed or vacant category. The data used in the Full Developed Model is presented first, followed by the data used in the Full Vacant Model.

Developed Full Model Data

Table 7 provides descriptive statistics for the Developed Full Model subset of the data.

This subset consists of all developed property in the entire data set. The Developed Full Model subset contains 667 property sales. The average selling price for this data is \$31,044 (PRICE), with a smaller standard deviation compared to the entire data set. The homes vary greatly in size (HOUSE) from 208 to 2930 square feet, with an average of 875 square feet. The average lot size is 11 acres with a large standard deviation of 21.29. The variable averages for DATE, CITY, and HWY are similar to the entire data set means.

TABLE 7. DESCRIPTIVE STATISTICS FOR HOUSING AND MARKET VARIABLES FROM THE DEVELOPED FULL MODEL SUBSET (N=667).				
Variable (unit)	Mean	St. Dev.	Min.	Max.
PRICE (\$)	31044	24920	1200	210000
HOUSE (sq ft)	875	354	208	2930
LOT (acres)	11.03	21.29	0.06	176.00
DATE (year)	1993	3	1988	1997
CITY (miles)	39.64	39.42	8.75	193.60
HWY (miles)	2.59	4.74	0	19.35
R_INT (%*100)	8.75	0.99	7.40	10.45
GSP (\$)	222.73	31.83	175.70	272.61
VACANT (0,1)	0.00	0.00	0	0
GARAGE (0,1)	0.42	0.49	0	1
PRISON (0,1)	0.26	0.44	0	1
ZONED (0,1)	0.54	0.50	0	1
BR (0,1)	0.03	0.16	0	1
B (0,1)	0.00	0.05	0	1
D (0,1)	0.44	0.50	0	1
MH (0,1)	0.15	0.35	0	1
PAVE (0,1)	0.36	0.48	0	1
HOME (0,1)	0.52	0.50	0	1
PLAT (0,1)	0.39	0.49	0	1
H2O (0,1)	0.15	0.35	0	1

Table 7 (continued).				
UTIL (0,1)	0.67	0.47	0	1
REGEUP (0,1)	0.26	0.44	0	1
REGWUP (0,1)	0.22	0.42	0	1
REGNLP (0,1)	0.52	0.50	0	1

Approximately 42% of homes have a garage, as shown in the mean of GARAGE. Three percent have brick exterior (BR). Forty-four percent are ranked in the lowest housing quality category of D. Fifteen percent of the developed properties have mobile homes (MH). A small majority of these properties are primary residences (HOME). The geographical distribution of these properties throughout the State resembles that from the entire data set but with a slightly smaller percent of properties located in the eastern Upper Peninsula and northern Lower Peninsula.

The timber harvesting related variables descriptive statistics are provided in Table 8. The most notable differences of this data subset from the entire data set are found in the ABUT, HARVEST, PUBDIST, F_DIS, and S_DIS variables. Fewer developed properties abut public land than vacant, as shown by the mean of ABUT. The mean percent of developed properties that abut public land is 20%, down three percentage points from the entire data set. The percent of developed properties experiencing timber harvesting (HARVEST) is 7%, one percentage point lower than the entire data set.

The distance variables differ from the entire set. The developed properties are farther from public land than vacant properties. Developed properties are an average of 6,614 feet (PUBDIST) away compared to 5,846 for all properties. The related variables, F_DIS

and S_DIS show higher mean values for developed property relative to the entire data set means, but again, these values are misleading. F_DIS has an average of 7031 feet and standard deviation of 6723 for only those properties (222 properties) nearer federal land than other public land. S_DIS averages 6201 feet, with a standard deviation of 7685, for those properties nearer state land (424 properties).

TABLE 8. DESCRIPTIVE STATISTICS FOR PUBLIC LAND AND TIMBER HARVESTING VARIABLES FROM THE DEVELOPED FULL MODEL SUBSET (N=667).				
Variable (unit)	Mean	St. Dev.	Min.	Max.
ABUT (0,1)	0.20	0.40	0	1
HARVEST (0,1)	0.07	0.26	0	1
FED (0,1)	0.33	0.47	0	1
FEDA (0,1)	0.07	0.25	0	1
FEDH (0,1)	0.02	0.15	0	1
STATE (0,1)	0.64	0.48	0	1
STATEA (0,1)	0.13	0.34	0	1
STATEH (0,1)	0.05	0.21	0	1
COU (0,1)	0.03	0.17	0	1
COUA (0,1)	0.00	0.05	0	1
COUH (0,1)	0.00	0.00	0	0
CONIFER (0,1)	0.08	0.27	0	1
HARDWOOD (0,1)	0.15	0.36	0	1
BRUSH (0,1)	0.01	0.09	0	1
OPEN (0,1)	0.02	0.13	0	1
CC (0,1)	0.03	0.17	0	1
CC_P (0,1)	0.01	0.07	0	0.76
SEED (0,1)	0.00	0.04	0	1
SEED_P (0,1)	0.00	0.02	0	0.47
THIN (0,1)	0.02	0.15	0	1
THIN_P (0,1)	0.01	0.06	0	0.47
SEL (0,1)	0.01	0.12	0	1
SEL_P (0,1)	0.01	0.05	0	0.76
REM (0,1)	0.01	0.08	0	1
REM_P (0,1)	0.00	0.03	0	0.41
PUBDIST (feet)	6614	7326	0	35571
F_DIS (feet)	2340	5098	0	35571
S_DIS (feet)	3942	6814	0	35571
PERADJ (%)	0.06	0.15	0.00	1.00
PERPUB (%)	0.41	0.19	0.08	0.76

Vacant Full Model Data

This section summarizes the data used to estimate the Vacant Full Model. Table 9 provides the descriptive statistics for housing and market variables in this model. The average vacant property sales price (PRICE) is \$14,555. The standard deviation of the sales price (\$17,993) is larger than the mean price, demonstrating a large variation in vacant land prices. The proportionately larger variation in price probably contributes to lower R^2 values for the vacant models compared to developed models.

TABLE 9. DESCRIPTIVE STATISTICS FOR HOUSING AND MARKET VARIABLES FROM THE VACANT FULL MODEL SUBSET (N=672).				
Variable (unit)	Mean	St. Dev.	Min.	Max.
PRICE (\$)	14555	17993	625	215000
LOT (acres)	20.19	40.01	0.06	640.00
DATE (year)	1993	3	1988	1997
CITY (miles)	37.08	34.34	8.75	192.00
HWY (miles)	2.56	4.29	0	18.74
R_INT (%*100)	8.75	1.02	7.40	10.45
GSP (\$)	224.49	32.87	175.70	272.61
VACANT (0,1)	1.00	0.00	1	1
GARAGE (0,1)	0.02	0.14	0	1
PRISON (0,1)	0.32	0.47	0	1
ZONED (0,1)	0.52	0.50	0	1
PAVE (0,1)	0.22	0.41	0	1
HOME (0,1)	0.00	0.00	0	0
PLAT (0,1)	0.27	0.44	0	1
H2O (0,1)	0.11	0.32	0	1
UTIL (0,1)	0.05	0.22	0	1
REGEUP (0,1)	0.32	0.47	0	1
REGWUP (0,1)	0.14	0.35	0	1
REGNLP (0,1)	0.55	0.50	0	1

Vacant lot sizes (LOT) also demonstrated a large variation, ranging from 0.06 to 640 acres, with an average of approximately 20 acres. This proportionately larger variation

may help to explain the large variation in price. The variables DATE, CITY, and HWY are similar to the entire data set and the developed model data. Approximately 2 % have a structure, such as a barn, shed, or garage, as found in the GARAGE variable statistics. Slightly more vacant property is in the eastern Upper Peninsula (REGEUP) and northern Lower Peninsula (REGNLP), while fewer in the western Upper Peninsula (REGWUP) relative to the entire data set.

Table 10 provides descriptive statistics for vacant property timber harvesting related variables. Twenty-seven percent of all vacant property abuts public land (ABUT), four percentage points higher than the entire data set, seven percentage points higher than developed model data. Vacant properties experienced a one percentage point higher level of harvesting activities (HARVEST) than did the data set as a whole. The mean distance from federal land (F_DIS) is 1,894 feet and 3,114 feet from state land (S_DIS). F_DIS for only those properties nearer federal land has a mean of 4,993 feet with 255 observations. Similarly, S_DIS has a mean of 5,116 with 409 observations. The mean distance from public land, 5071 feet, is smaller than the entire data set mean, 5840 feet, and much smaller than the full model data mean of 6614 feet. The relatively smaller distance from public property that the vacant property exhibits compared to the developed property isn't surprising since the percentage of abutting property is much higher.

TABLE 10. DESCRIPTIVE STATISTICS FOR PUBLIC LAND AND TIMBER HARVESTING VARIABLES FROM THE VACANT FULL MODEL SUBSET (N=672).				
Variable (unit)	Mean	St. Dev.	Min.	Max.
ABUT (0,1)	0.27	0.44	0	1
HARVEST (0,1)	0.09	0.29	0	1
FED (0,1)	0.38	0.49	0	1
FEDA (0,1)	0.08	0.28	0	1
FEDH (0,1)	0.02	0.15	0	1
STATE (0,1)	0.61	0.49	0	1
STATEA (0,1)	0.18	0.38	0	1
STATEH (0,1)	0.07	0.26	0	1
COU (0,1)	0.01	0.11	0	1
COUA (0,1)	0.00	0.04	0	1
COUH (0,1)	0.00	0.00	0	0
CONIFER (0,1)	0.10	0.30	0	1
HARDWOOD (0,1)	0.20	0.40	0	1
BRUSH (0,1)	0.02	0.15	0	1
OPEN (0,1)	0.02	0.13	0	1
CC (0,1)	0.06	0.23	0	1
CC_P (0,1)	0.03	0.12	0	0.76
SEED (0,1)	0.00	0.07	0	1
SEED_P (0,1)	0.00	0.03	0	0.47
THIN (0,1)	0.02	0.15	0	1
THIN_P (0,1)	0.01	0.08	0	0.76
SEL (01,)	0.01	0.10	0	1
SEL_P (0,1)	0.00	0.04	0	0.76
REM (0,1)	0.01	0.10	0	1
REM_P (0,1)	0.01	0.06	0	0.76
PUBDIST (feet)	5071	6508	0	31124
F_DIS (feet)	1894	4184	0	28901
S_DIS (feet)	3114	6052	0	31124
PERADJ (%)	0.08	0.18	0.00	1.00
PERPUB (%)	0.42	0.19	0.08	0.76

Overall, not many differences exist between the developed full model data and the vacant full model data. The largest differences are found in the variation around the sales price, the distance from public land, and the percentage abutting public land. Vacant properties exhibit a higher variation around the sales price, a shorter distance from public land, and a higher percentage abutting public land as compared to developed properties. Slight

regional differences also exist. A higher percent of vacant properties are located in the eastern Upper Peninsula and northern Lower Peninsula as compared to developed properties.

Adjacent Model Statistics

This section reviews the descriptive statistics for the data used to estimate both the Adjacent Models. First, the data used to estimate the Adjacent Developed Model is reviewed. The Adjacent Vacant Model data review then follows.

Adjacent Developed Model Data

Table 11 presents the descriptive statistics for Adjacent Developed Property data. The mean sales price (PRICE), \$28,363, and the mean house size (HOUSE), 777 square feet, are both smaller than the same means, \$31,044 and 875 square feet respectively, for the Full Developed Model data. The standard deviations of the two variables are fairly consistent across the two subsets. The average lot size (LOT), 21 acres, is almost twice as large as the mean lot size of all developed property, 11 acres. The relatively larger lot size is accompanied by a larger, but proportionately smaller, standard deviation. The distance to a city (CITY) is shorter while the distance to a highway (HWY) is further relative to all developed property. Fewer adjacent developed properties have garages (GARAGE), compared to all developed property. Adjacent developed properties demonstrate an increase in the D housing rating and the number of mobile homes (MH).

TABLE 11. DESCRIPTIVE STATISTICS FOR HOUSING AND MARKET VARIABLES FROM THE DEVELOPED ADJACENT MODEL SUBSET (N=134).				
Variable (unit)	Mean	St. Dev.	Min.	Max.
PRICE (\$)	28363	24071	1400	130000
HOUSE (sq ft)	777	352	208	1750
LOT (acres)	21.29	27.05	0.16	160.00
DATE (year)	1993	3	1988	1997
CITY (miles)	30.51	26.17	14.25	192.40
HWY (miles)	5.27	6.61	0	19.35
R INT (%*100)	8.78	1.01	7.40	10.45
GSP (\$)	219.01	32.02	175.70	272.61
GARAGE (0,1)	0.33	0.47	0	1
PRISON (0,1)	0.12	0.33	0	1
ZONED (0,1)	0.48	0.50	0	1
BR (0,1)	0.01	0.09	0	1
B (0,1)	0.00	0.00	0	0
D (0,1)	0.51	0.50	0	1
MH (0,1)	0.21	0.41	0	1
PAVE (0,1)	0.16	0.37	0	1
HOME (0,1)	0.36	0.48	0	1
PLAT (0,1)	0.06	0.24	0	1
H20 (0,1)	0.12	0.33	0	1
UTIL (0,1)	0.42	0.50	0	1
REGEUP (0,1)	0.12	0.33	0	1
REGWUP (0,1)	0.09	0.29	0	1
REGNLP (0,1)	0.79	0.41	0	1

Compared to all developed property, adjacent developed properties have considerably fewer paved roads (PAVE), and primary residences (HOME). The adjacent developed properties geographic locations are heavily skewed relative to all developed property. Seventy-nine percent of adjacent developed property is in the northern Lower Peninsula (REGNLP), compared to 52% of all developed property. Twelve percent of the adjacent developed property is located in the eastern Upper Peninsula (REGEUP) with 9% in the western half (REGWUP), compared to mean values for all developed property of 26% and 22%, respectively.

Table 12 presents the adjacent developed property public land and timber harvesting-related variables' statistical descriptions. The timber related variables in Table 12 are not directly comparable to those in Table 6 (Entire data set) or Table 8 (Developed Full Model data set). As stated earlier, many of these variables were recorded only for adjacent properties.

TABLE 12. DESCRIPTIVE STATISTICS FOR PUBLIC LAND AND TIMBER HARVESTING VARIABLES FROM THE DEVELOPED ADJACENT MODEL SUBSET (N=134).				
Variable (unit)	Mean	St. Dev.	Min.	Max.
HARVEST (0,1)	0.36	0.48	0	1
FED (0,1)	0.33	0.47	0	1
FEDA (0,1)	0.33	0.47	0	1
FEDH (0,1)	0.12	0.33	0	1
STATE (0,1)	0.66	0.48	0	1
STATEA (0,1)	0.66	0.48	0	1
STATEH (0,1)	0.24	0.43	0	1
COU (0,1)	0.01	0.12	0	1
COUA (0,1)	0.01	0.12	0	1
COUH (0,1)	0.00	0.00	0	0
CONIFER (0,1)	0.38	0.49	0	1
HARDWOOD (0,1)	0.75	0.43	0	1
BRUSH (0,1)	0.04	0.21	0	1
OPEN (0,1)	0.09	0.29	0	1
CC (0,1)	0.14	0.35	0	1
CC P (0,1)	0.06	0.16	0	0.76
SEED (0,1)	0.01	0.09	0	1
SEED P (0,1)	0.00	0.04	0	0.47
THIN (0,1)	0.11	0.32	0	1
THIN P (0,1)	0.05	0.14	0	0.47
SEL (0,1)	0.07	0.25	0	1
SEL P (0,1)	0.03	0.11	0	0.76
REM (0,1)	0.03	0.17	0	1
REM P (0,1)	0.01	0.06	0	0.41
PERADJ (%)	0.27	0.22	0.00	1.00
PERPUB (%)	0.44	0.10	0.08	0.76

As seen in Table 12, thirty-six percent of all adjacent property experienced timber harvesting (HARVEST) over the study period. Most occurred on state land (STATEH). Hardwood forests dominate the public land (HARDWOOD), seventy-five percent of all adjacent developed property has a public hardwood stand within a quarter mile. Clearcutting (CC) and thinning (THIN) are the primary harvesting activities.

Various large differences exist between the Developed Full Model data and the Developed Adjacent Model data. Large differences in sales price, house size, lot size, distance to city, distance to highway, and geographic locations exist. The vast differences between the subsets implies that the behavior of the sales price may be very different between the data sets.

Adjacent Vacant Model Data

The descriptive statistics for adjacent vacant property are provided in Table 13. Just as in the case of the two developed property subsets, the vacant property subsets demonstrate vast differences. Both the mean selling price (PRICE) of adjacent vacant land and the average lot size (LOT) are higher relative to the respective averages over all vacant land. The mean adjacent vacant property selling price, \$16,218, is \$1,663 higher than the mean selling price of all vacant land. The standard deviation of adjacent property price is actually smaller than that of all vacant property. The average lot size, 28.46 acres, is 8.37 acres larger than the average of all vacant property. The larger average lot size is

accompanied by a much larger standard deviation. Adjacent vacant properties are farther, 3.99 miles, from highways than are all vacant properties, 2.56 miles. Adjacent vacant properties demonstrate noticeably smaller percentages in other variables compared to all vacant property. Nearness to prisons, local zoning, paved roads, platted properties, and publicly provided water and utilities are less likely to occur for adjacent vacant properties relative to all vacant properties. A smaller percent of adjacent vacant properties are located in the Upper Peninsula (REGEUP and REGWUP) than all vacant properties. This is also reflected in the higher percentage of Lower Peninsula adjacent properties (REGNLP) relative to all vacant properties.

TABLE 13. DESCRIPTIVE STATISTICS FOR HOUSING AND MARKET VARIABLES FROM THE VACANT ADJACENT MODEL SUBSET (N=179).				
Variable (unit)	Mean	St. Dev.	Min.	Max.
PRICE (\$)	16218	17133	1000	130000
LOT (acres)	28.46	61.75	0.14	640.00
DATE (year)	1993	3	1988	1997
CITY (miles)	36.68	29.47	15.25	183.00
HWY (miles)	3.99	5.13	0	18.74
R_INT (%*100)	8.83	1.06	7.40	10.45
GSP (\$)	221.12	33.15	175.70	272.61
GARAGE (0,1)	0.04	0.19	0	1
PRISON (0,1)	0.25	0.43	0	1
ZONED (0,1)	0.41	0.49	0	1
PAVE (0,1)	0.11	0.31	0	1
HOME (0,1)	0.00	0.00	0	0
PLAT (0,1)	0.14	0.35	0	1
H20 (0,1)	0.08	0.27	0	1
UTIL (0,1)	0.01	0.07	0	1
REGEUP (0,1)	0.25	0.43	0	1
REGWUP (0,1)	0.06	0.23	0	1
REGNLP (0,1)	0.70	0.46	0	1

Table 14 presents the statistics for the public land and timber harvesting related variables of the adjacent vacant properties. The percent of adjacent vacant property experienced slightly lower timber harvesting activities (HARVEST) than did adjacent developed properties as seen in Table 12. Thirty-five percent of adjacent vacant properties incurred timber harvesting within one-quarter mile on public land, compared to 36% of developed properties. The percent of adjacent vacant property abutting federal (FEDA), 32%, is similarly lower than the percent of adjacent developed property, 33%. Related, the percent of vacant property abutting state (STATEA) public land is 68%, which is two percentage points higher than developed property.

Less timber harvesting took place near vacant property on federal land than did near developed property. Nine percent of vacant property experienced timber harvesting on federal land (FEDH) compared to 12% of developed property. Conversely, more timber harvesting took place on state land near vacant property than did near developed property. Twenty-six percent of vacant property experienced nearby timber harvesting on state land (STATEH) compared to 24% of developed property. The percent of coniferous and hardwood forests did not vary much between adjacent vacant land and adjacent developed land. The percent of brush on public land (BRUSH) is twice as high for vacant properties than for developed properties, 8% compared to 4%. Clearcutting occurred much more frequently near adjacent vacant property compared to adjacent developed property. Twenty-one percent of vacant properties (CC) experienced clearcutting compared to 14% of developed properties. Seed tree cuttings (SEED),

thinnings (THIN), selective cuts (SEL), and removal cuts (REM) all differed slightly between vacant and developed properties.

The percentage of adjacent properties land that abuts public land (PERADJ) is slightly higher for vacant properties, 29%, than for developed properties, 27%. Similarly, the percent of public land that makes up the surrounding area (PERPUB) is higher for vacant properties, 48%, than for developed properties, 44%.

TABLE 14. DESCRIPTIVE STATISTICS FOR PUBLIC LAND AND TIMBER HARVESTING VARIABLES FROM THE VACANT ADJACENT MODEL SUBSET (N=179).				
Variable (unit)	Mean	St. Dev.	Min.	Max.
HARVEST (0,1)	0.35	0.48	0	1
FED (0,1)	0.32	0.47	0	1
FEDA (0,1)	0.32	0.47	0	1
FEDH (0,1)	0.09	0.29	0	1
STATE (0,1)	0.68	0.47	0	1
STATEA (0,1)	0.68	0.47	0	1
STATEH (0,1)	0.26	0.44	0	1
COU (0,1)	0.01	0.07	0	1
COUA (0,1)	0.01	0.07	0	1
COUH (0,1)	0.00	0.00	0	0
CONIFER (0,1)	0.37	0.49	0	1
HARDWOOD (0,1)	0.75	0.43	0	1
BRUSH (0,1)	0.08	0.28	0	1
OPEN (0,1)	0.06	0.24	0	1
CC (0,1)	0.21	0.41	0	1
CC_P (0,1)	0.10	0.21	0	0.76
SEED (0,1)	0.02	0.13	0	1
SEED_P (0,1)	0.01	0.06	0	0.47
THIN (0,1)	0.09	0.29	0	1
THIN_P (0,1)	0.04	0.15	0	0.76
SEL (0,1)	0.04	0.19	0	1
SEL_P (0,1)	0.02	0.08	0	0.76
REM (0,1)	0.04	0.19	0	1
REM_P (0,1)	0.02	0.11	0	0.76
PERADJ (%)	0.29	0.24	0.00	1.00
PERPUB (%)	0.48	0.13	0.25	0.76

As is the case with the developed property data, the adjacent vacant property differed from all vacant properties in numerous ways. The adjacent vacant properties demonstrate a higher mean price, lot size, and distance from highway when compared to all vacant properties. Fewer adjacent vacant properties were in the vicinity of prisons, zoned, and platted as compared to all vacant properties. Geographic location differences are also found between the two vacant subsets. The large differences between adjacent and developed data imply that the implicit prices, as a function of sales price, will behave differently between adjacent and full models.

Full Models

This section describes the Full Developed and Vacant Models. As described previously, the following steps are used to assess and identify the functional form of each model:

- | | |
|--------|--|
| Step A | Estimate all models with linear price and cubic continuous independent variables. |
| Step B | Estimate all models with logarithmic price and cubic continuous variables. Compare to model results from Step A. Determine proper dependent variable form. |
| Step C | Correct models for heteroscedasticity where needed. |
| Step D | Test the cubic forms of the independent variables. Determine “best” cubic form models. |

- Step E Test the logarithmic forms against “best” cubic forms for independent variables.
- Step F Determine “best” functional forms.

All regressions presented in this dissertation are estimated using the Ordinary Least Squares procedure. The models and tests used in Steps B-E are not presented in this chapter, rather they are discussed in this chapter and the actual model estimates are provided in Appendix A. The same information for Adjacent Models is presented in Appendix B. Models for Step A and Step F are presented in this chapter.

Developed Property Full Models

The Step A, or linear-cubic, estimation results for the Developed Full Model are presented in Table 15. The Developed Full Model contains 667 observations of all developed property. The F-statistic, testing all coefficients jointly equal to zero, is 12.61, finding that not all coefficients jointly are zero. The R-squared and Adjusted R-squared terms are 0.53 and 0.49 respectively. The Ramsey RESET test statistic is 50.33, indicating, within the 95% confidence interval, that additional curvature exists than is accounted for in this particular model. The Lagrange-Multiplier test for heteroscedasticity is 80.27, indicating the presence of heteroscedasticity within the 95% confidence interval.

TABLE 15. LINEAR DEVELOPED FULL MODEL ESTIMATION RESULTS.				
Dependent Variable:	Price			
F-statistic:	12.6068	D-W:	1.9239	
R-squared:	.5316	RESET:	50.3314	
Adj. R-squared:	.4894	LM Het. Test:	80.2653	
N:	667			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	156832.3000	1367379.0000	0.1147	[.909]
HOUSE	-27.5295	15.6342	-1.7608	[.079]**
HOUSE2	0.0411	0.0132	3.1126	[.002]*
HOUSE3	0.0000	0.0000	-3.4474	[.001]*
LOT	324.0123	175.8247	1.8428	[.066]**
LOT2	1.4706	3.5772	0.4111	[.681]
LOT3	-0.0131	0.0166	-0.7866	[.432]
CITY	-172.2364	713.9981	-0.2412	[.809]
CITY2	5.0140	7.2614	0.6905	[.490]
CITY3	-0.0195	0.0233	-0.8355	[.404]
HWY	658.4475	1415.8510	0.4651	[.642]
HWY2	65.6394	227.7525	0.2882	[.773]
HWY3	-2.9792	9.3411	-0.3189	[.750]
GARAGE	6148.5790	1666.8590	3.6887	[.000]*
UTIL	10643.6700	2564.0620	4.1511	[.000]*
PRISON	-21236.2000	10863.7300	-1.9548	[.051]**
ZONED	-2653.7280	4976.2680	-0.5333	[.594]
BR	8579.0310	4596.4240	1.8665	[.062]**
B	26410.7000	13313.7600	1.9837	[.048]*
D	-14672.1800	1760.2210	-8.3354	[.000]*
MH	-18326.2600	2472.3250	-7.4126	[.000]*
PAVE	-292.0996	1893.9290	-0.1542	[.877]
HOME	3304.8500	1622.2440	2.0372	[.042]*
PLAT	2322.1690	2107.5450	1.1018	[.271]
H20	5344.0290	2590.8590	2.0626	[.040]*
R_INT	-288754.1000	341739.9000	-0.8450	[.398]
R_INT2	31554.4600	38649.1000	0.8164	[.415]
R_INT3	-1131.9350	1446.5540	-0.7825	[.434]
GSP	9889.6000	8604.0840	1.1494	[.251]
GSP2	-43.1703	37.2766	-1.1581	[.247]
GSP3	0.0640	0.0535	1.1970	[.232]
REGNLP	-1619.1720	5537.9530	-0.2924	[.770]

* significant at 95% level, ** significant at 90% level

Table 15 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
PERPUB	-511518.7000	426094.3000	-1.2005	[.230]
PERPUB2	1493342.0000	1272581.0000	1.1735	[.241]
PERPUB3	-1121776.0000	1029156.0000	-1.0900	[.276]
CC	5866.5340	40558.1700	0.1446	[.885]
CC_P	-11501.2700	94541.2400	-0.1217	[.903]
SEED	-22490.2500	18630.5100	-1.2072	[.228]
THIN	100147.0000	45148.2600	2.2182	[.027]*
THIN_P	-234923.5000	105082.4000	-2.2356	[.026]*
SEL	15564.1300	35978.3600	0.4326	[.665]
SEL_P	-2422.0040	93100.1900	-0.0260	[.979]
REM	17786.9700	101493.6000	0.1753	[.861]
REM_P	-35845.4000	270232.2000	-0.1326	[.895]
F_DIS	-0.0350	1.2901	-0.0272	[.978]
F_DIS2	0.0000	0.0001	-0.3178	[.751]
F_DIS3	0.0000	0.0000	0.3372	[.736]
S_DIS	-0.6980	1.1095	-0.6291	[.530]
S_DIS2	0.0001	0.0001	1.2752	[.203]
S_DIS3	0.0000	0.0000	-1.5433	[.123]
PERDIS	0.4292	0.9999	0.4292	[.668]
PERADJ	-8817.2340	32689.1000	-0.2697	[.787]
PERADJ2	63715.4100	100804.1000	0.6321	[.528]
PERADJ3	-56436.7700	79066.9400	-0.7138	[.476]
CONIFER	-854.6598	3625.8780	-0.2357	[.814]
HARDWOOD	-1315.8210	3188.6870	-0.4127	[.680]

* significant at 95% level, ** significant at 90% level

Due to near perfect collinearity with the GSP variable, the time trend variable, DATE, was dropped from all models. The collinearity was severe enough to cause a singular X'X matrix and prevent estimation. The GSP variable has a strong time trend component, as seen with the collinearity, and also has the economic trends from year to year, which the DATE variable does not have. Therefore, the GSP variable is more likely to account for more variation than the DATE variable and is left in the models.

Along with the highly significant RESET and heteroscedasticity test statistics, many coefficient estimates are problematic. The HOUSE coefficients, which are statistically significant, have a negative relationship with PRICE for values of 881 square feet and below. The same coefficients have a positive relationship for all values greater than 881. The average house size for this data is 875 square feet. Therefore this model has a negative relationship between price and house size for the average house. The ZONED coefficient is also negative, though not statistically significant, implying that developed zoned properties are worth less on average than non-zoned properties. This finding is counter to most existing literature on zoning's effect on property values. The REGNLP is negative, implying that developed Lower Peninsula properties are worth less on average than Upper Peninsula properties. These problems present a suspect model that could be improved.

Though several problems exist with the linear model, a few variable coefficients demonstrate expected signs and statistical significance. LOT, GARAGE, UTIL, BR, B, D, MH, HOME, and H2O coefficients have *a priori* expected signs. These variable coefficients all have positive signs indicating a positive relationship with price. The three variables are also statistically significant. The PRISON coefficient is negative and statistically significant. No *a priori* expectation was held for the sign or statistical significance of this variable. Prisons are generally viewed as necessary but "not in my backyard" institutions. The "not in my backyard" attitude would lend credence to a negative relationship with price. On the other hand, certain communities would probably not exist without the local prison. This would have a positive impact with price. Which

impact is greater in absolute value has not been studied and is not known. The overall relationship would likely change over time and geographical location.

Other variables have expected signs, but are not statistically significant. The coefficients for HWY, PLAT, GSP, and PERDIS all have expected positive signs while CITY, F_DIS, S_DIS, and R_INT have expected negative signs.

Still other coefficients have unexpected signs and are not statistically significant. The PAVE, REGNLP, PERPUB, and PERADJ coefficients are negative and insignificant.

The coefficient estimates for the public land and timber related variables provide little evidence as to any impact on developed property values in this model. Because the timber related data were only recorded for abutting properties, conclusions should not be drawn from the Developed Full Models. These variables were included in the Full Models to control for the possible effects they may have on adjacent property.

The Developed Full Models contain 667 observations, 134 of which are abutting properties. Vegetation type (CONIFER, HARDWOOD), percent adjacent (PERADJ), and harvesting variables (CC, SEED, THIN, SEL, REM) were included as additional explanatory variables to control for the possible effects of these variables on abutting properties. One harvesting term, SEED_P, was not included in any models. Due to the extremely small variance in the variable, the coefficient continuously demonstrated near

perfect collinearity with the intercept term. This caused singularity and prohibited estimation. The variable was therefore dropped from all models.

With respect to the variables of concern, no conclusions can be inferred at this point. The model is plagued with heteroscedasticity and poor functional form. Until remedies to these problems are attempted, no conclusions should be drawn. The proximity (F_DIS, S_DIS), percent public land (PERPUB), and interaction of proximity and percent public land (PERDIS) variables are the only public land and timber related variables that conclusions should be formed with this model. Other important variables related to timber harvesting can not be correctly interpreted in this model because the variables do not offer a complete comparison. The timber harvesting variables were only recorded for adjacent properties. Their inclusion here serves to control for the possible effects on adjacent properties.

The impact of the amount of surrounding public land, PERPUB, is negative and insignificant in this model. The coefficients of the proximity variables, F_DIS and S_DIS, are both found to be negative and insignificant. The coefficient of the interaction between percent public land and proximity to public land (PERDIS) is positive and statistically insignificant.

The Step B Developed Full Model, (Table A1 in Appendix A), are similar to the model presented in Table 15, except the dependent variable is transformed to the logarithm of PRICE. The logarithmic transformation brought the Ramsey RESET test statistic and the

Lagrange-Multiplier heteroscedasticity test statistic down drastically. The RESET test statistic dropped from 50.33 to 3.71 with the logarithmic transformation, with a P-value of 0.06. The Lagrange-Multiplier heteroscedasticity test statistic fell from 80.27 to 0.89, with a P-value of 0.346. The logarithmic transformation of the dependent variable removed heteroscedasticity and reduced some missing curvature of the linear model from Step A. Since the transformation greatly improved the model, the dependent variable for all succeeding steps was the logarithm of price.

Since heteroscedasticity is no longer present, Step C was not needed in the Developed Full Model process. Step D tested the significance of the squared and cubed terms of all continuous independent variables (Table A2 in Appendix A). Two tests were conducted in Step D. First, for each continuous independent variable, the squared and cubed terms were tested together for significance (independent tests in Table A2). Second, all squared and cubed terms for all independent variables were tested jointly and are referred to as joint tests. All independent tests can be rejected at the 95% confidence level, meaning that the coefficients of all squared and cubed independent variables are not significantly different from zero independently. The only independent test that can not be rejected within the 90% confidence interval was the test of the squared and cubed terms of percent of public land of the surrounding area (PERPUB). Both joint tests for all squared and cubic terms together can be rejected within the 95% confidence interval, as reflected by the Chi-squared and F-test statistics.

The model with all squared and cubed terms removed, except for those of PERPUB, was then estimated (Appendix A, Table A3). The removal of the insignificant quadratic and cubic terms improved the RESET test statistic, Langrange-Multiplier heteroscedasticity test statistic, and F-statistic, without affecting the adjusted R-squared term. Therefore, removal of the quadratic and cubic terms further improved the model. This model is now referred to as the “best” cubic model.

Step E began by estimation of an artificial regression. The artificial regression model estimated the “best” cubic model from Step D (Table A3) with the addition of logarithmic forms of all continuous independent variables (Table A4 in Appendix A). Specific features of the artificial regression are not of interest here, so the discussion will be limited to the tests related to functional form. The tests performed on the artificial regression were similar to those in Step D. First, the coefficients of the “best” cubic model continuous independent variables were tested independently and then jointly to see if they are equal to zero. Second, the coefficients of the logarithmic form of the independent variables are tested independently and jointly to see if they are equal to zero.

The independent tests for the LOT and HWY coefficients are significant within the 95% confidence interval, while none of the other independent tests are (Table A5). The joint test of all the continuous variables from “best” cubic model must be rejected. The joint test Chi-squared and F statistics carry P-values of 0.006. We can therefore conclude that the Step D model explains the curvature between the independent variables and the $\log(\text{PRICE})$ significantly better than a log-log model would.

Only the independent test of the log(LOT) is statistically significant within the 95% confidence interval (Table 6 in Appendix A). The joint test that all coefficients of logarithmic form independent variables are equal zero can not be rejected. The P-values of the Chi-squared and F statistics of the joint test are both 0.37. Therefore, the logarithmic forms of the independent variables do not explain the functional form any better than the Step D model. The functional form of the “best” cubic model is considered the preferred and final model for the Full Developed Data. The results of the final model are replicated in Table 16.

TABLE 16. FINAL DEVELOPED FULL MODEL ESTIMATION RESULTS.				
Dependent Variable:	Log(Price)			
F-statistic:	17.9966	D-W:	2.1181	
R-squared:	0.5142	RESET:	2.6659	
Adj. R-squared:	0.4857	LM Het. Test:	0.7864	
N:	667			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	8.7221	0.7374	11.8284	[.000]*
HOUSE	0.0003	0.0001	3.6168	[.000]*
LOT	0.0112	0.0014	8.2618	[.000]*
CITY	0.0012	0.0015	0.7876	[.431]
HWY	0.0353	0.0076	4.6319	[.000]*
GARAGE	0.3166	0.0555	5.7073	[.000]*
UTIL	0.3788	0.0839	4.5172	[.000]*
PRISON	-0.6406	0.2874	-2.2289	[.026]*
ZONED	0.1589	0.1158	1.3722	[.170]
BR	0.1009	0.1533	0.6580	[.511]
B	0.3407	0.4371	0.7795	[.436]
D	-0.5375	0.0581	-9.2552	[.000]*
MH	-0.7670	0.0816	-9.4054	[.000]*
PAVE	0.0053	0.0612	0.0859	[.932]
HOME	0.1428	0.0532	2.6827	[.007]*

* significant at 95% level, ** significant at 90% level

Table 16 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
PLAT	-0.0288	0.0618	-0.4666	[.641]
H2O	0.2735	0.0852	3.2079	[.001]*
R_INT	0.0034	0.0366	0.0923	[.926]
GSP	0.0069	0.0012	5.9469	[.000]*
REGNLP	0.0157	0.1383	0.1136	[.910]
PERPUB	-12.2285	5.5863	-2.1890	[.029]*
PERPUB2	32.0225	16.1273	1.9856	[.048]*
PERPUB3	-21.4172	12.4046	-1.7266	[.085]**
CC	0.0004	1.3381	0.0003	[1.00]
CC_P	0.3983	3.1202	0.1277	[.898]
SEED	-0.2012	0.6207	-0.3240	[.746]
THIN	2.5997	1.4680	1.7709	[.077]**
THIN_P	-5.7565	3.4126	-1.6868	[.092]**
SEL	0.6090	1.1643	0.5231	[.601]
SEL_P	-0.3006	3.0078	-0.0999	[.920]
REM	-1.2100	3.3711	-0.3589	[.720]
REM_P	3.9361	8.9691	0.4388	[.661]
F_DIS	-0.0000	0.0000	-1.2209	[.223]
S_DIS	0.0000	0.0000	0.0151	[.988]
PERDIS	0.0000	0.0000	1.2134	[.225]
PERADJ	0.3510	0.2463	1.4247	[.155]
CONIFER	-0.1523	0.1173	-1.2990	[.194]
HARDWOOD	-0.0823	0.0964	-0.8544	[.393]

* significant at 95% level, ** significant at 90% level

The Final Full Developed model has an F-statistic of 18.00, and an adjusted R-squared of 0.49. The Lagrange-Multiplier heteroscedasticity test statistic, 0.7864 (P-value=0.376), finds no heteroscedasticity. The RESET test statistic, 2.6659 (P-value=0.103), finds that within the 95% confidence interval, all systematic curvature between the dependent and independent variables is explained. These summary statistics demonstrate a much improved model over the linear model in Table 15. The F, RESET, and LM heteroscedasticity statistics have all greatly improved. The R^2 values from the linear

model and the final model are not comparable since the dependent variable is not the same form.

Many coefficients exhibit the expected sign and are statistically significant. The coefficients for HOUSE, LOT, HWY, GARAGE, UTIL, HOME, H20, GSP, and PERPUB all have the expected positive signs and are statistically significant. The coefficients for D and MH both have the expected negative signs and are statistically significant. The uncertain *a priori* PRISON coefficient is negative and statistically significant.

Some statistically insignificant coefficients had expected signs. The variables ZONED, BR, B, PAVE, REGNLP, F_DIS, PERDIS, and PERADJ all have expected signs but are insignificant. ZONED, BR, B, PAVE, REGNLP, PERDIS, and PERADJ coefficients all have expected positive signs, while F_DIS has the expected negative sign.

Other statistically insignificant coefficients had unexpected signs. The coefficients for CITY, R_INT, and S_DIS are all positive while the expectation was negative. PLAT has an unexpected negative sign.

The variables of concern in this model are PERPUB, F_DIS, S_DIS, PERDIS, and PERADJ. Of these variables, PERPUB, S_DIS, F_DIS, and PERDIS provide mixed results on developed private property values. The coefficients of the quadratic and cubic terms of PERPUB are all significant within the 90% confidence interval, the linear and

squared coefficients are significant within the 95% confidence interval. To measure the impact of PERPUB on PRICE, take the partial derivative of the $\log(\text{PRICE})$ function with respect to price. The partial derivative, $\frac{\partial \log(\text{PRICE})}{\partial \text{PERPUB}}$, is equal to:

$$(-12.2285 + 64.0405 * \text{PERPUB} - 64.2516 * \text{PERPUB}^2)$$

The average value for PERPUB is 0.4061 and for PERPUB^2 is 0.1994. This equation has a positive relationship with $\log(\text{PRICE})$ at the average values. Using the mean values for PERPUB, the impact, on average, on $\log(\text{PRICE})$ is 0.9653. This represents the change in $\log(\text{PRICE})$ given a one unit change in PERPUB holding all other variables constant. The coefficients of PERPUB are decimal, representing a percentage. A one unit change in PERPUB would be 1.00, or equivalent to 100%. Therefore, we must divide the derivative, 0.9653, by 100 to represent the change in $\log(\text{PRICE})$ for a one percent change in PERPUB. The derivative divided by 100 is 0.009653. Kennedy (1981) states that the average percentage impact of a continuous independent variable on the dependent variable in a semi-log model is the partial derivative. Therefore, the average percentage increase in PRICE from a one-percent increase in PERPUB is 0.9653% or approximately one percent. One percent of the average sales price of developed property, \$31,044, is \$310. The mean value for PERPUB for the Full Developed Model data is 41%, and the values ranged from 8% to 76%.

The coefficients of the S_DIS, F_DIS, and PERDIS variables are not significant within the 90% confidence interval. Therefore, proximity to either State or Federal public land has no effect on developed property values, though increasing the percentage of public land in the surrounding area has a small positive impact. The distance proximity

variables can be transformed in a number of ways, to offer conclusive evidence. The aggregation of the separate S_DIS and F_DIS distance measures into one distance measure, PUBDIS, creates a statistically insignificant and negative coefficient. Therefore, aggregation of the owner specific distance variables into one public land distance variable does not change the result that distance has no impact. If the PERPUB related variables are dropped from the model, the coefficient for F_DIS becomes statistically significant within the 95% confidence interval. Under these circumstances, moving 1000 feet farther from federal public land will decrease a property value by 0.13%. Under these circumstances, however, the statistical significance occurs at the cost of a decreased amount of information in the model, and is therefore suspect. Another possible transformation of the proximity variables would be into a dummy variable indicating if a property is adjacent, ABUT. The ABUT coefficient is not statistically significant (P value = 0.398) and has a negative coefficient. Further, breaking the PERPUB variable into two separate variables, one for percent of surrounding federal public land and one for percent of surrounding state public land, produces two positive but statistically insignificant coefficients.

Because of the incomplete information of the remaining timber harvesting variables, no conclusions should be drawn from the Developed Models. Aggregation of all harvesting related variables into one, HARVEST, does not negligibly affect the variables of concern. Discussion of these variables will take place in the Adjacent Model sections.

Vacant Property Full Models

The Developed Vacant Full Model has 672 sales observations (Table 17). The model has an F-statistic, testing all coefficients jointly equal to zero, of 3.91. The R-squared and adjusted R-squared terms are 0.22 and 0.17 respectively. The Ramsey RESET test statistic is extremely high, at 93.67. The high RESET test statistic finds, within the 95% confidence interval, that unexplained systematic curvature exists in the model. The Lagrange-Multiplier test for heteroscedasticity finds the existence of heteroscedasticity within the 95% confidence interval.

TABLE 17. LINEAR VACANT FULL MODEL ESTIMATION RESULTS.				
Dependent Variable:	Price			
F-statistic:	3.9106	D-W:	1.7098	
R-squared:	0.2235	RESET:	93.6657	
Adj. R-squared:	0.1663	LM Het. Test:	41.2833	
N:	672			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-335076.9000	1320841.0000	-0.2537	[.800]
LOT	298.6792	57.0510	5.2353	[.000]*
LOT2	-0.4430	0.3675	-1.2053	[.229]
LOT3	0.0001	0.0005	0.2065	[.836]
CITY	399.4160	659.1241	0.6060	[.545]
CITY2	-0.4806	5.9501	-0.0808	[.936]
CITY3	-0.0047	0.0180	-0.2603	[.795]
HWY	1244.8560	1272.4690	0.9783	[.328]
HWY2	-246.3751	222.6943	-1.1063	[.269]
HWY3	9.8493	9.4909	1.0378	[.300]
UTIL	1148.7600	3475.1020	0.3306	[.741]
PRISON	-18611.6700	10321.6800	-1.8032	[.072]**
ZONED	-73.4926	4077.0020	-0.0180	[.986]
PAVE	-4891.0550	1836.5490	-2.6632	[.008]*
PLAT	1232.3470	2028.6630	0.6075	[.544]

* significant at 95% level, ** significant at 90% level

Table 17 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
H2O	2125.8670	2278.5640	0.9330	[.351]
R_INT	154181.4000	339320.4000	0.4544	[.650]
R_INT2	-18896.4500	38374.8400	-0.4924	[.623]
R_INT3	756.8030	1436.2980	0.5269	[.598]
GSP	-643.7474	7102.4800	-0.0906	[.928]
GSP2	2.4080	30.8015	0.0782	[.938]
GSP3	-0.0026	0.0442	-0.0588	[.953]
REGNLP	5589.3890	4582.8580	1.2196	[.223]
PERPUB	-389399.9000	405928.6000	-0.9593	[.338]
PERPUB2	1072890.0000	1214947.0000	0.8831	[.378]
PERPUB3	-766569.2000	981661.9000	-0.7809	[.435]
CC	12747.2800	11672.0800	1.0921	[.275]
CC_P	-31520.0900	23086.5400	-1.3653	[.173]
SEED	1226.1800	10389.6500	0.1180	[.906]
THIN	28687.7500	17283.6900	1.6598	[.097]
THIN_P	-53526.4900	33082.1000	-1.6180	[.106]
SEL	10529.9600	22090.2600	0.4767	[.634]
SEL_P	1064.7080	52126.1500	0.0204	[.984]
REM	3601.7230	19292.0600	0.1867	[.852]
REM_P	-12402.8300	33831.8500	-0.3666	[.714]
F_DIS	-1.5932	1.1768	-1.3538	[.176]
F_DIS2	0.0002	0.0001	1.2306	[.219]
F_DIS3	0.0000	0.0000	-1.2597	[.208]
S_DIS	-0.3365	1.0998	-0.3060	[.760]
S_DIS2	0.0001	0.0001	0.8545	[.393]
S_DIS3	0.0000	0.0000	-1.2427	[.214]
PERDIS	1.7914	0.9114	1.9656	[.050]*
PERADJ	-50206.6600	30341.7900	-1.6547	[.098]**
PERADJ2	173260.2000	87323.6500	1.9841	[.048]*
PERADJ3	-133361.0000	66473.2900	-2.0062	[.045]*
CONIFER	-962.7979	2852.4290	-0.3375	[.736]
HARDWOOD	3738.0790	3034.2070	1.2320	[.218]

* significant at 95% level, ** significant at 90% level

The Step A vacant model finds only six coefficients statistically significant. Of the six significant coefficients, only LOT and PERDIS have the expected sign. The significant coefficients for PAVE and PERADJ have unexpected negative impacts. PRISON, which

is significant, has a negative impact on vacant property values in this model, while it had a positive impact on developed property. The last significant coefficient, THIN, should not be interpreted from this model. It has a positive sign.

Regarding the statistically insignificant coefficients, ZONED, F_DIS, and S_DIS have the expected negative signs. The coefficients for LOT, HWY, UTIL, H2O, PLAT, and REGNLP carry the expected positive signs, though they too are insignificant.

Many variable coefficients are statistically insignificant and carry the unexpected *a priori* sign. Both CITY and R_INT coefficients are positive in this model but were expected to be negative. The coefficients for GSP, PERPUB, and PERADJ are all negative while the opposite was expected. This model, like the Step A Developed Property Full Model, has many problems and can be improved.

The Vacant Full Model, Step B estimation results are presented in Table A7 in Appendix A. Due to the transformation of the dependent variable to $\log(\text{PRICE})$, the RESET test statistic and the Lagrange-Multiplier test statistic dropped dramatically. The Lagrange-Multiplier test statistic, 4.10, finds the existence of heteroscedasticity within the 95% confidence interval. The Ramsey RESET test finds that not all curvature is explained by the model. Because of the large improvement in these test statistics, $\log(\text{PRICE})$ is the preferred dependent variable.

The Step C model, correcting for heteroscedasticity, is presented in Table A8. The White variance-covariance consistent matrix is used to correct for heteroscedasticity (Gujarati 1995).

In Step D, the squared and cubic coefficients of the continuous independent variables are tested for statistical significance. These tests are presented in Table A9. Independent tests, testing whether particular independent variables' squared and cubic coefficients are different from zero, are presented first. Only the squared and cubic terms for LOT are statistically different from zero within the 95% confidence interval. The same coefficients for the F_DIS are statistically significant within the 90% confidence interval. All others are not statistically different from zero. The joint tests, testing if all squared and cubic coefficients together are different from zero find that we must reject the hypothesis that all squared and cubic terms are zero. A second joint test was then conducted to see if all squared and cubic coefficients, other than those for LOT and F_DIS, are jointly different from zero. This hypothesis can not be rejected. The Chi-squared test statistic for the test is 4.3211 with a P-value of 0.7421. The F-test statistic is 0.6173 with a P-value of 0.7438. Both tests are acceptable, and the coefficients of the squared and cubic terms for all continuous independent variables, other than LOT and F_DIS, are all assumed equal to zero.

For the “best” cubic Full Vacant Model removal of the insignificant squared and cubed terms increased the F-statistic and lowered the RESET test statistic (Table A10). The F-statistic increased from 4.8575 to 6.7104 with the removal of the insignificant terms. The

RESET statistic dropped from 4.3054 (P-value = 0.038) to 2.5083 (P-value = 0.131) and was no longer statistically significant within the 95% confidence interval. The Lagrange-Multiplier heteroscedasticity test found the presence of heteroscedasticity. The model presented in Table A10 was been corrected for heteroscedasticity.

The Step-E artificial regression model results are presented in Table A11. The tests of the quadratic and cubed terms are presented in Table A12, while the tests of the logarithmic terms can be found in Table A13. The tests of the quadratic and cubed terms find that LOT, HWY, and, PERPUB coefficients are all independently significant within the 90% confidence interval. The joint tests reject the hypothesis that all quadratic and cubed terms are jointly equal to zero. The tests of the logarithmic terms find only $\log(\text{PERPUB})$ to be independently significant within the 95% confidence interval. The joint hypothesis can not be rejected within the 90% confidence interval, but can not be accepted in the 95% confidence interval. Because the joint test of the quadratic and cubed terms can not be rejected within the 95% confidence interval, and the same joint test of the logarithmic terms can be over the same interval, the cubic model is considered superior.

The Final Vacant Full Model results are presented in Table 18. This model is corrected for heteroscedasticity using White's variance-covariance matrix. The Final Model has an F-statistic of 6.54 which is significant within the 95% confidence interval. The model also has an adjusted R-squared of 0.21. The RESET test statistic, 2.28, is not significant

within the 90% confidence interval, therefore finding no unaccounted systematic curvature.

TABLE 18. FINAL VACANT FULL MODEL ESTIMATION RESULTS.				
Dependent Variable:	Log(Price)			
F-statistic:	6.5357	D-W:	1.6848	
R-squared:	0.2466	RESET:	2.2818	
Adj. R-squared:	0.2089	LM Het. Test:	7.7603	
N:	672			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	7.8812	0.8064	9.7728	[.000]*
LOT	0.0213	0.0026	8.1960	[.000]*
LOT2	-0.0001	0.0000	-4.4931	[.000]*
LOT3	0.0000	0.0000	3.0792	[.002]*
CITY	0.0054	0.0016	3.3724	[.001]*
HWY	-0.0268	0.0079	-3.3751	[.001]*
UTIL	0.1984	0.1789	1.1092	[.268]
PRISON	0.1073	0.1943	0.5523	[.581]
ZONED	-0.1560	0.0980	-1.5920	[.112]
PAVE	-0.1831	0.0905	-2.0233	[.043]*
PLAT	0.0063	0.1030	0.0611	[.951]
H20	0.2589	0.0977	2.6494	[.008]*
R_INT	-0.0240	0.0520	-0.4623	[.644]
GSP	0.0034	0.0016	2.0890	[.037]*
REGNLP	0.2633	0.1726	1.5256	[.128]
PERPUB	0.4345	0.4073	1.0670	[.286]
CC	0.6770	0.4690	1.4434	[.149]
CC_P	-1.3838	0.9944	-1.3916	[.165]
SEED	0.3718	0.3449	1.0781	[.281]
THIN	1.4748	1.0355	1.4241	[.155]
THIN_P	-2.6499	2.1445	-1.2357	[.217]
SEL	1.6468	0.6185	2.6623	[.008]**
SEL_P	-2.2343	1.1414	-1.9575	[.051]*
REM	-0.0408	0.7089	-0.0576	[.954]
REM_P	-0.2113	1.0811	-0.1954	[.845]

* significant at 95% level, ** significant at 90% level

Table 18 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
F_DIS	-0.0001	0.0001	-2.5967	[.010]*
F_DIS2	0.0000	0.0000	1.9147	[.056]**
F_DIS3	-0.0000	0.0000	-1.5300	[.127]
S_DIS	0.0000	0.0000	0.3920	[.695]
PERDIS	0.0000	0.0000	0.2772	[.782]
PERADJ	0.3872	0.2364	1.6375	[.102]
CONIFER	-0.1729	0.1196	-1.4460	[.149]
HARDWOOD	-0.0232	0.0994	-0.2333	[.816]

* significant at 95% level, ** significant at 90% level

The final vacant full model has several statistically significant coefficients. Of these, LOT, H20, and GSP have expected positive coefficient signs. The significant F_DIS coefficient has the expected negative sign. The significant coefficients for CITY, HWY, and PAVE all have the opposite sign than expected.

Many coefficients have the expected sign, though are not statistically significant. The coefficients for UTIL, PLAT, REGNLP, PERPUB, PERDIS, and PERADJ all find a positive relationship with log(PRICE). The insignificant coefficient of R_INT has the expected negative sign.

The insignificant coefficient for PRISON is positive in the vacant full model though it is negative in the developed full model. The insignificant coefficient for ZONED is negative here, though it is positive in the Developed Full Model. Though having the opposite sign compared to the developed model, the coefficients for PRISON and ZONED are plausible in the vacant model. Many areas are populated, such as Rudyard, just south of Sault Ste. Marie, because of the presence of prisons. Development around

such areas may drive up vacant land values, while having the opposite effect on pre-existing developed property. Vacant zoned property may incur a larger negative impact from zoning regulations than developed property. This is because developed property may be “grandfathered” and therefore receives, primarily, the benefits associated with zoning while not incurring the full costs. Vacant property, on the other hand, will not be “grandfathered” and therefore incur both costs and benefits. The costs of zoning, in this case, are greater than the perceived benefits, though not statistically. In either case, neither PRISON or ZONED are statistically significant in the Vacant Full Final Model.

Of the public land related variables of interest, the coefficients for SEL, SEL_P, and F_DIS are all statistically significant within the 90% confidence interval. PERADJ is significant at a slightly lower interval of 89.8%. Because SEL, SEL_P, and PERADJ contained observations for abutting properties only, the results should not be interpreted from this model, rather the results of these variables should be interpreted from the Adjacent Vacant Model.

The overall impact of F_DIS on log(PRICE) is negative. The partial derivative of the log(PRICE) with respect to F_DIS is:

$$\frac{\partial \log(PRICE)}{\partial F_DIS} = -0.0001 + (2.7540E - 08) * F_DIS - (1.0157E - 12) * F_DIS^2$$

At the mean values of F_DIS and F_DIS², the derivative is equal to -0.0001. The average percentage impact of moving 1 foot away from federal public land on vacant property values is -0.00011, or -0.011%. This can be interpreted to mean that moving 1000 farther from to federal public land will decrease the average vacant property value

by 11%. The average vacant land price is \$14,555 per parcel, and 11% of this is \$1,601. The average vacant land price per acre is \$720.90, and 11% of this is \$79. The average distance from federal public land for vacant property is 1,894 feet, with a range from 0 to 28,901 feet. The PERDIS interaction term is statistically insignificant. Dropping the insignificant PERDIS from the model has no effect on the coefficients of F_DIS, F_DIS², or F_DIS³.

To simplify the model, several aggregations and transformations of variables can be completed. Several aggregations and transformations were examined in this model, after the Final Vacant Full Model was estimated. One aggregation that may be of interest is the combination of F_DIS and S_DIS, creating a variable, PUBDIS, that is not owner specific. Another aggregation is the transformation of the distance proximity variables to simple dummy variable, ABUT, indicating whether the property abuts public land. Aggregation of all harvesting variables into one variable was also attempted. Lastly, the harvesting related variables time frame was reduced. Initially, the models included harvesting activities up to 10 years previous to sale. This reduction only models harvesting activities up to 3 years previous to sale.

The aggregation and transformation of variables provided little differences from the final model. Transformation of the public land distance proximity variables did not change the results significantly. One transformation, dropping the F_DIS and S_DIS related variables and adding the combined distance from public land variable PUBDIS, found a positive and statistically insignificant coefficient. Another transformation of the distance

proximity variables to the ABUT dummy variable, found a negative statistically insignificant coefficient. Dividing the ABUT variable into two dummy variables, one identifying properties that abut federal land and another that identifies properties that abut state land produced similar findings. The coefficient for the federal abutting dummy variable was positive but statistically insignificant. The coefficient for the state abutting dummy variable was negative and insignificant. Dropping the PERPUB related variables from the model did not change the results. Breaking the PERPUB variable in to two separate variables, one for percent of surrounding federal public land and one for percent of surrounding state public land, produced two positive but statistically insignificant coefficients. Aggregation of all harvesting related variables into the HARVEST dummy variable had no affect on the model results.

Adjacent Models

This section presents the results of the Adjacent Models. Similar to the Full Models section, Steps A-E are reviewed for all Adjacent Models. Only the Step A and Step F models are presented in this chapter. The Step B through Step E models and statistical tests are presented in Appendix B.

Developed Property Adjacent Models

The Step A linear-cubic model estimation results are presented Table 19. The dependent variable is PRICE, and the model has 134 observations. The model F-statistic, 2.7985,

has a P-value of 0.00. Therefore, jointly, the coefficients of all independent variables are significantly different from zero. The model's R-squared and adjusted R-squared values are 0.61 and 0.39, respectively. The Ramsey RESET test statistic, 27.3310, has a P-value of 0.00, therefore finding curvature unaccounted for by the model within the 95% confidence interval. The Langrange-Multiplier test for heteroscedasticity finds the presence of heteroscedasticity within the 95% confidence interval.

TABLE 19. LINEAR DEVELOPED ADJACENT MODEL ESTIMATION RESULTS.				
Dependent Var.:	Price			
F-statistic:	2.7985	D-W:	1.9991	
R-squared:	0.6125	RESET:	27.3310	
Adj. R-squared:	0.3936	LM Het. Test:	32.6862	
N:	134			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-389694.5000	3381584.0000	-0.1152	[.909]
HOUSE	35.7070	57.9597	0.6161	[.539]
HOUSE2	-0.0446	0.0776	-0.5756	[.566]
HOUSE3	0.0000	0.0000	0.8242	[.412]
LOT	-1.6024	404.8094	-0.0040	[.997]
LOT2	10.5014	8.0811	1.2995	[.197]
LOT3	-0.0567	0.0376	-1.5072	[.135]
CITY	-203.5976	2692.3540	-0.0756	[.940]
CITY2	9.3845	38.9383	0.2410	[.810]
CITY3	-0.0394	0.1435	-0.2746	[.784]
HWY	2504.0740	3692.2370	0.6782	[.499]
HWY2	-349.0210	527.2342	-0.6620	[.510]
HWY3	14.5612	20.2775	0.7181	[.475]
GARAGE	9889.2890	4778.6040	2.0695	[.042]*
UTIL	6420.1920	8395.6920	0.7647	[.447]
PRISON	-48698.2500	32178.4400	-1.5134	[.134]
ZONED	-3212.3720	15982.3200	-0.2010	[.841]
BR	-6516.5810	23814.2600	-0.2736	[.785]
DD	-7991.9150	5115.4670	-1.5623	[.122]
MH	-12933.6300	6322.8130	-2.0456	[.044]*
PAVE	11844.7500	7011.9180	1.6892	[.095]**

* significant at 95% level, ** significant at 90% level

Table 19 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
HOME	-4136.9970	5676.6260	-0.7288	[.468]
PLAT	8318.9990	9818.4820	0.8473	[.399]
H20	7572.1890	7748.1370	0.9773	[.331]
R_INT	379745.8000	866303.6000	0.4384	[.662]
R_INT2	-44745.4300	97918.4100	-0.4570	[.649]
R_INT3	1750.2340	3659.6550	0.4783	[.634]
GSP	-10198.4200	23267.5400	-0.4383	[.662]
GSP2	53.3132	100.9942	0.5279	[.599]
GSP3	-0.0888	0.1453	-0.6108	[.543]
REGNLP	-8572.1350	15042.3800	-0.5699	[.570]
PERPUB	-947728.1000	1077077.0000	-0.8799	[.381]
PERPUB2	2840523.0000	3203945.0000	0.8866	[.378]
PERPUB3	-2203608.0000	2577979.0000	-0.8548	[.395]
CC	-59387.0000	57690.0500	-1.0294	[.306]
CC_P	134449.5000	132025.5000	1.0184	[.311]
SEED	-46323.1500	26141.9500	-1.7720	[.080]**
THIN	99772.3800	59198.9600	1.6854	[.096]**
THIN_P	-223020.7000	138005.3000	-1.6160	[.110]
SEL	43987.4900	46103.5600	0.9541	[.343]
SEL_P	-78511.5000	119012.8000	-0.6597	[.511]
REM	33243.7300	120867.0000	0.2750	[.784]
REM_P	-62885.2400	321361.6000	-0.1957	[.845]
FED	93.4613	12743.8300	0.0073	[.994]
PERADJ	17445.2700	54395.8500	0.3207	[.749]
PERADJ2	-19063.3200	146215.1000	-0.1304	[.897]
PERADJ3	60.3124	107008.7000	0.0006	[1.00]
CONIFER	-624.3693	5225.9930	-0.1195	[.905]
HARDWOOD	1023.0600	5663.3200	0.1806	[.857]

* significant at 95% level, ** significant at 90% level

Only three variable's coefficients were statistically significant within the 90% confidence interval. GARAGE and PAVE both had positive significant coefficients, while MH had a negative significant coefficient. None of the public land or timber harvesting related variables were significant within the 95% confidence interval.

The Step B log-cubic model is estimated next. The estimation results are presented in Table B1. The transformation of the dependent variable from linear to logarithmic greatly reduces the RESET and Lagrange-Multiplier test statistics. The RESET statistic, 0.0007, has a P-value of 0.98, therefore finding statistically no unaccounted curvature. The Lagrange-Multiplier heteroscedasticity test statistic (P-value = 0.21) finds no heteroscedasticity within the 90% confidence interval. The F-statistic increased slightly with the dependent variable transformation. Due to these improvements in the model, the logarithmic form of dependent variable is hereafter used.

The Lagrange-Multiplier test, discussed above, found no heteroscedasticity, therefore Step C is not needed. The Step D tests of all continuous independent variables' squared and cubed coefficients are presented in Table B2. The tests found none of the squared and cubed coefficients significantly different from zero within the 90% confidence interval. Neither joint test can be rejected. All squared and cubed terms are dropped subsequently.

The "best" cubic model was then estimated with linear continuous independent variables. The results are presented in Table B3. Dropping the insignificant quadratic and cubic terms increased the F-statistic as well as the adjusted R-squared. The F-statistic increased from 2.1136 (P-value = 0.010) to 3.1662 (P-value = 0.000). The adjusted R-squared increased from 0.2867 to 0.3426. The RESET and Lagrange-Multiplier test statistics found no unaccounted curvature or heteroscedasticity within the 90% confidence interval.

The artificial regression, combining both logarithmic and “best” cubic independent variables, is estimated next. The results are presented in Table B4. The “best” cubic model continuous model independent variables are tested first for independent and joint significance. The test results are presented in Table B5. The independent tests for LOT and HWY are the only independent tests significant within the 95% confidence interval. The joint tests rejects the hypothesis that all “best” independent variables are equal to zero.

The tests of the logarithmic terms in the artificial regression are presented in Table B6. None of the independent tests are significant within the 90% confidence interval. Neither joint test can be rejected. Considering the joint significance of the “best” terms, and the joint insignificance of logarithmic terms, the “best” cubic model is considered superior. This is the Final Adjacent Model, and is presented in Table 20.

TABLE 20. FINAL DEVELOPED ADJACENT MODEL ESTIMATION RESULTS.				
Dependent Variable:	Log(Price)			
F-statistic:	3.1662	D-W:	2.2039	
R-squared:	0.5008	RESET:	0.1023	
Adj. R-squared:	0.3426	LM Het. Test:	1.4453	
N:	134			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	7.5194	1.5995	4.7010	[.000]*
HOUSE	0.0005	0.0003	2.0491	[.043]*
LOT	0.0120	0.0028	4.2860	[.000]*
CITY	0.0002	0.0036	0.0552	[.956]
HWY	0.0214	0.0141	1.5202	[.132]

* significant at 95% level, ** significant at 90% level

Table 20 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
GARAGE	0.3434	0.1613	2.1287	[.036]*
UTIL	0.0698	0.2586	0.2700	[.788]
PRISON	-0.8160	0.5897	-1.3838	[.169]
ZONED	0.0271	0.3272	0.0828	[.934]
BR	0.6397	0.7856	0.8142	[.417]
D	-0.2997	0.1756	-1.7060	[.091]**
MH	-0.4584	0.2193	-2.0906	[.039]*
PAVE	0.4227	0.2356	1.7939	[.076]**
HOME	0.0817	0.1675	0.4877	[.627]
PLAT	0.1109	0.3100	0.3578	[.721]
H2O	0.3672	0.2568	1.4299	[.156]
R_INT	-0.0033	0.1036	-0.0315	[.975]
GSP	0.0051	0.0037	1.3731	[.173]
REGNLP	-0.3270	0.4301	-0.7603	[.449]
PERPUB	1.8242	1.2883	1.4160	[.160]
CC	-1.6914	1.9325	-0.8752	[.384]
CC_P	4.1620	4.4518	0.9349	[.352]
SEED	-0.0927	0.7593	-0.1221	[.903]
THIN	3.0224	1.8653	1.6204	[.108]
THIN_P	-6.3259	4.3757	-1.4457	[.151]
SEL	1.8088	1.5672	1.1541	[.251]
SEL_P	-3.2753	4.0656	-0.8056	[.422]
REM	0.6291	4.2261	0.1489	[.882]
REM_P	-0.8067	11.2561	-0.0717	[.943]
FED	0.0658	0.3161	0.2082	[.836]
PERADJ	0.1890	0.3397	0.5564	[.579]
CONIFER	-0.1364	0.1747	-0.7805	[.437]
HARDWOOD	-0.1275	0.1907	-0.6690	[.505]

* significant at 95% level, ** significant at 90% level

The final developed adjacent model has a slightly higher F-statistic, 3.1662, compared to the Step A model, 2.7985. The final model also has improved Ramsey RESET and LM heteroscedasticity test statistics compared to the Step A model. All the test statistics provide evidence of an improved model relative to the initial Step A model.

Contributing to the improvements, several variable coefficients are statistically significant and have the expected sign. The model finds the coefficients of HOUSE, LOT, GARAGE, and PAVE statistically significant within the 90% confidence interval. These coefficients also have the expected positive sign. The coefficients of D and MH are significant and have the expected negative sign.

Many of the insignificant coefficients have the expected sign. The insignificant coefficients for HWY, ZONED, BR, HOME, PLAT, H2O, GSP and PERPUB are all positive as expected. R_INT has an insignificant coefficient with its expected negative sign.

Three statistically insignificant coefficients have signs opposite of those expected. The coefficient for CITY is positive, and the coefficients for PRISON and REGNLP are negative.

The PERPUB variable is positive, but insignificant. (Note: the PERPUB variable is positive and significant in the Full Developed Model). The insignificant finding in the Adjacent Developed Model seems plausible, since the all properties this models are actually abutting public land while a large majority of those in the Full Developed Model were not.

Only the timber harvesting variable coefficient for THIN was near statistical significance. It is significant within the 89.20% confidence interval. The coefficient is positive. If this

confidence interval is considered acceptable, the impact a thinning has on an adjacent developed property value appears to be positive. Aggregation of all timber harvesting variables into one variable, HARVEST, produced no differences. The coefficient for HARVEST was positive and statistically insignificant within the 80% confidence interval. Reduction in the time since harvest from 0-10 years to 0-3 years had no impact on the model. Models with time frames less than 3 years could not be estimated due to the small occurrences of harvesting and therefore small variation in the harvesting variables.

Vacant Property Adjacent Models

The Step A linear-cubic model estimation results of vacant adjacent properties are presented in Table 21. The model has 179 observations. The F-statistic has a value of 2.9344 and a P-value of 0.00. The R-squared and adjusted R-squared are 0.4596 and 0.3030, respectively. The RESET test statistic, 63.7829 (P-value = 0.000), finds unaccounted curvature within the 95% confidence interval. The Langrange-Multiplier test statistic, 40.7625 (P-value = 0.00) finds the existence of heteroscedasticity.

TABLE 21. LINEAR VACANT ADJACENT MODEL ESTIMATION RESULTS.				
Dependent Variable:	Price			
F-statistic:	2.9344	D-W:	1.7961	
R-squared:	0.4596	RESET:	63.7829	
Adj. R-squared:	0.3030	LM Het. Test:	40.7625	
N:	179			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	1123464.0000	2349964.0000	0.4781	[.633]
LOT	627.6558	105.2831	5.9616	[.000]*
LOT2	-2.6605	0.6535	-4.0714	[.000]*
LOT3	0.0027	0.0008	3.4309	[.001]*
CITY	-990.1887	1360.5970	-0.7278	[.468]
CITY2	12.8426	16.7023	0.7689	[.443]
CITY3	-0.0436	0.0570	-0.7647	[.446]
HWY	3724.2030	2254.8630	1.6516	[.101]
HWY2	-588.3237	393.1330	-1.4965	[.137]
HWY3	22.9664	16.5041	1.3916	[.166]
UTIL	-12390.0000	15839.7400	-0.7822	[.435]
PRISON	3427.3780	33313.3200	0.1029	[.918]
ZONED	20578.3700	8738.6800	2.3549	[.020]*
PAVE	9615.8910	4568.7000	2.1047	[.037]*
PLAT	4869.8170	5644.5920	0.8627	[.390]
H20	10586.5600	5195.2130	2.0378	[.043]*
R_INT	-397610.0000	620566.1000	-0.6407	[.523]
R_INT2	44648.9700	70504.9100	0.6333	[.528]
R_INT3	-1674.4410	2650.5740	-0.6317	[.529]
GSP	328.5331	11865.8400	0.0277	[.978]
GSP2	-2.7662	51.4267	-0.0538	[.957]
GSP3	0.0061	0.0738	0.0824	[.934]
REGNLP	14524.9900	9982.0500	1.4551	[.148]
PERPUB	297368.3000	3096615.0000	0.0960	[.924]
PERPUB2	-597918.2000	6511833.0000	-0.0918	[.927]
PERPUB3	431463.2000	4199703.0000	0.1027	[.918]

significant at 95% level, ** significant at 90% level

Table 21 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
CC	-2288.9750	12684.9400	-0.1804	[.857]
CC_P	-304.2508	24592.5800	-0.0124	[.990]
SEED	-3289.5290	9584.3740	-0.3432	[.732]
THIN	916.1868	16905.2200	0.0542	[.957]
THIN_P	1296.7870	32759.5600	0.0396	[.968]
SEL	-11815.4600	22148.8900	-0.5335	[.595]
SEL_P	50548.7100	52019.4700	0.9717	[.333]
REM	-16395.9900	18598.2000	-0.8816	[.380]
REM_P	24469.6300	32771.9200	0.7467	[.457]
FED	-13623.5800	11771.5900	-1.1573	[.249]
PERADJ	-10680.4300	34791.3600	-0.3070	[.759]
PERADJ2	63547.1000	93821.9900	0.6773	[.499]
PERADJ3	-58513.5600	68520.2000	-0.8540	[.395]
CONIFER	-2664.6650	2985.7490	-0.8925	[.374]
HARDWOOD	1109.8590	3886.4980	0.2856	[.776]

* significant at 95% level, ** significant at 90% level

The coefficients for LOT, ZONED, PAVE, and H2O are the only coefficients statistically significant within the 95% confidence interval. Of these, LOT, PAVE, and H2O have the expected positive impact on price. The ZONED coefficient is also positive.

Many statistically insignificant variables exhibit expected signs. The insignificant coefficient for the R_INT has the expected negative sign. The insignificant coefficients for PLAT, GSP, PERPUB, and PERADJ all have the expected positive signs.

While many statistically insignificant coefficients have the expected signs, many did not. The insignificant coefficients for CITY and UTIL are negative, when *a priori* expectations had them as positive. The insignificant positive coefficients for HWY and

PRISON were expected to be negative. None of the public land variables of concern are statistically significant in this model.

The log-cubic Adjacent Vacant Model is estimated next, in Step B. The estimation results are presented in Table B7. The logarithmic transformation increased the F-statistic. The F-statistic in the Step A model is 2.9344, and is 4.2675 in the Step B model. The RESET test statistic fell from 63.7829 (P-value = 0.00) to 1.3951 (P-value = 0.240) with the logarithmic transformation. The Lagrange-Multiplier test statistic fell from 40.7625 (P-value = 0.00) to 0.5338 (P-value = 0.465). The logarithmic transformation removed heteroscedasticity and accounted for all curvature, both within the 95% confidence interval. The logarithmic model is therefore used subsequently.

Since no heteroscedasticity is present, Step C is not needed. The tests of squared and cubed coefficients for all continuous independent variables are conducted next. The tests' results are presented in Table B8. The results of the independent tests find only the coefficients for the squared and cubed LOT terms significant within the 90% confidence interval. Both of the joint tests can be rejected. Another joint test is conducted to see if all the squared and cubed coefficients except for those related to the LOT term are jointly equal to zero. The joint test results find a chi-squared test statistic of 5.7950 (P-value = 0.4465) and an F-statistic of 0.9658 (P-value = 0.4470). This test clearly can not be rejected. The "best" cubic model will retain the LOT^2 and LOT^3 terms, but will drop all other squared and cubed terms.

Table B9 presents the estimation results of the “best” adjacent vacant cubic model. The removal of the insignificant quadratic and cubic terms increased the model F-statistic from 4.2675 to 5.7530. The adjusted R-squared increased by a very small amount, from 0.4234 to 0.4278. The RESET test statistic increase slightly but is still insignificant within the 90% confidence interval. The presence of heteroscedasticity is still rejected within the 90% confidence interval. Only the coefficients for LOT, LOT², LOT³, PAVE, H2O, and FED are statistically significant within the 95% confidence interval.

The artificial regression is estimated next. The results are presented in Table B10. The results of the tests of the “best” model independent variables are presented in Table B11. None of independent tests of the “best” model independent variables are rejected. Neither joint test is rejected. The results of the logarithmic independent variables are presented in Table B12. The independent test for the logarithm of LOT is not rejected, while all others are. Neither joint test for all logarithmic independent variables are rejected. The independent tests found that the log(LOT) is not statistically equal to zero, and that the cubic form is.

None of joint tests are rejected, therefore neither the “best” model forms nor the logarithmic forms are superior in explaining curvature. Therefore two final model options should be considered. First, the Final Adjacent Vacant Model contains the log(LOT) variable and the other independent variables are those from the “best” model. Second, the Final Adjacent Vacant Model contains all logs of continuous independent variables.

The F-statistic's, adjusted R-square's, RESET statistic's, and Lagrange-Multiplier heteroscedasticity test statistic's between the two models are nearly identical. None of the coefficient signs are different between the models. All coefficients that are statistically significant within the 90% confidence interval in one model are statistically significant within the 90% confidence interval in the other. Due to these similarities, neither model provides evidence of superiority over the other. Therefore, for simplicity, the first model option will be considered the Final Adjacent Vacant Model. The results of this model are presented in Table 22.

TABLE 22. FINAL VACANT ADJACENT MODEL ESTIMATION RESULTS.				
Dependent Variable:	Log(Price)			
F-statistic:	5.7726	D-W:	1.7379	
R-squared:	0.4968	RESET:	1.9499	
Adj. R-squared:	0.4108	LM Het. Test:	0.2148	
N:	179			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	6.6579	1.4669	4.5387	[.000]*
Log(LOT)	0.4002	0.0591	6.7669	[.000]*
CITY	0.0013	0.0034	0.3818	[.703]
HWY	-0.0074	0.0131	-0.5628	[.574]
UTIL	-0.7959	0.6817	-1.1675	[.245]
PRISON	0.2024	0.5528	0.3661	[.715]
ZONED	0.7057	0.2059	3.4266	[.001]*
PAVE	0.0799	0.1902	0.4202	[.675]
PLAT	-0.0541	0.2471	-0.2191	[.827]
H20	0.3334	0.2074	1.6074	[.110]
R_INT	-0.0809	0.0825	-0.9803	[.328]
GSP	0.0021	0.0026	0.7901	[.431]
REGNLP	0.4736	0.3817	1.2409	[.217]

* significant at 95% level, ** significant at 90% level

Table 22. (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
PERPUB	2.2767	1.5178	1.5000	[.136]
CC	-0.3051	0.5430	-0.5619	[.575]
CC_P	0.5571	1.0601	0.5255	[.600]
SEED	0.2708	0.4226	0.6408	[.523]
THIN	0.0529	0.7242	0.0731	[.942]
THIN_P	0.1490	1.4107	0.1057	[.916]
SEL	0.1916	0.8832	0.2169	[.829]
SEL_P	0.4871	1.9881	0.2450	[.807]
REM	-0.4673	0.8111	-0.5761	[.565]
REM_P	0.5480	1.4230	0.3851	[.701]
FED	-0.5592	0.1920	-2.9118	[.004]*
PERADJ	0.2912	0.2594	1.1227	[.263]
CONIFER	-0.0445	0.1255	-0.3544	[.724]
HARDWOOD	0.2683	0.1489	1.8018	[.074]**

* significant at 95% level, ** significant at 90% level

The model robustness statistics of the final adjacent vacant model are all improved over the Step A linear model. The final model has an F-statistic of 5.77, higher than the linear model's 2.9344. The final model has a RESET test statistic of 1.9499, which finds no unaccounted systematic curvature while the linear exhibits unaccounted curvature. The final model also finds no heteroscedasticity that plagued the linear model.

Four coefficients are statistically significant within the 95% confidence interval in the final model. The LOT, ZONED and HARDWOOD coefficients are positive and significant. The coefficient for FED is negative and significant. The sign of the LOT coefficient is as expected. The positive impact of ZONED is not as expected but is also not totally a surprise. Zoning has consistently demonstrated positive impacts on developed property values while having inconsistent impacts on vacant property values.

Analogous to the Final Vacant Full Model, the Final Adjacent Vacant Model finds that the only public land related variable coefficient that is statistically significant within the 95% confidence interval is related to federal land. The Final Full Vacant Model found a negative relationship between price and distance from federal public land (F_DIS). The Final Vacant Adjacent Model finds a negative relationship between adjacent vacant properties that abut federal land (FED), relative to state land, and the sales price. The base case of the Final Adjacent Vacant Model is vacant property that abuts state public land. Everything is in comparison to the base case. The negative F_DIS impact from the Full Model seems at odds with the negative FED impact in the Adjacent Model. These findings, though, may be stating the same result. The federal land abutting vacant properties sold, on average, for less than similar vacant properties abutting state land. The cheaper sales price may provide a large contrast between the sales prices of abutting and non-abutting vacant properties near federal land. This contrast may be much larger for properties near federal land than for those near state land. If so, then the contrast would likely have a negative impact on the distance from federal land, as found in F_DIS in the Final Full Adjacent Model.

From the Full Vacant Model, the impact of state land on private property values is not statistically significant. Abutting state land is a special case of the Final Full Vacant Model, where the distance from state land is equal to zero. We can then assume that abutting state property has no statistical impact on vacant land prices. Assuming this, the

coefficient of FED finds a negative relationship between vacant land prices of those abutting federal land relative to those not abutting federal land.

To interpret the dummy variable FED coefficient, as explained by Kennedy (1981), the average percentage impact on the sales price is:

$$\begin{aligned} &= \text{Exp}(c - .5 * v(c)) - 1, \text{ where } c \text{ is the coefficient and } v(c) \text{ is the variance of } c \\ &= e^{-0.5576} - 1 = 0.4388 \end{aligned}$$

Therefore, the impact of vacant land abutting federal public land is a decrease in value of 44%. The average value of vacant adjacent land is \$16,218, 44% of this is \$7,136. The average value per acre is \$570, and 44% of this is \$251.

Applying the same procedure to the HARDWOOD coefficient, we find that the average percentage increase in adjacent vacant property values due to the presence of adjacent hardwood forests is 29%. This is equivalent to \$4,703 per vacant property and \$165 per acre.

Aggregation of the timber harvesting related variables into the dummy variable, HARVEST, had an impact on the coefficient of FED. The coefficient is still negative and significant within the 95% confidence interval. The aggregation slightly changed the level of the coefficient, and the standard deviation. After the aggregation, the impact of federal land on adjacent properties is -62%. The impact prior to aggregation, -44%, should be considered more accurate due to the model containing more information.

Reduction of the time since harvest from 0-10 years prior to sale to 0-3 years had no effects on the model. Time frames of less than 3 years could not be estimated due to the small occurrences of the harvesting variables and therefore small variances.

Removal of Outliers

Tests for outliers were conducted on all four final models. The Studentized Residual (SR) approach was used to identify outliers. The SR approach estimates a SR for each observation by dividing each residual by its standard error. The ratio has a chi-squared distribution. Rather than examining and removing extreme dependent variable observations, the SR approach identifies observations that do not fit the final model well.

Removal of outliers in the Full Models had very little impact on the results. The SR approach identified 33 outliers in the Final Full Developed Model (Table A14). Of the 33 outliers, 24 had sales prices less than or equal to \$8,000 and 2 were greater than \$100,000. Removal of the outliers in this model had little effect. The impact of the PERPUB variable fell from 0.0097 to 0.0088. With rounding, the impact of increasing the amount of surrounding public land by 1% was still a 1% increase in developed property values. The impact of the F_DIS variable became statistically significant within the 90% confidence interval with the removal of outliers, though not within the 95% confidence interval. The impact amounts to an approximate -1.6%, or \$500, decrease in developed sales price for every 1000 feet away from federal public land if the level of significance is deemed acceptable.

The SR approach identified 37 outliers in the Final Vacant Full Model (Table A15). Of these, 15 were sales equal to or less than \$3,500 and 2 were over \$100,000. Removal of the outliers had little effect. The only change was a decrease from -11% to -11.5% in the sales price of vacant land for every 1000 feet farther from federal public land.

Removal of outliers in the Adjacent Models had very large impacts on the results. This is due in large part to the extremely small sample size of these models to begin with. The results of the Adjacent Models, relative to the full model, were questionable before any outliers in the Adjacent Models were dropped. The SR approach found 8 outliers in the Adjacent Developed Model (Table B13). Removal of outliers in this model required the removal of the BR, UTIL, and SEED_T variables also. These variables had few observations, removal of outliers developed a singular matrix with all the above mentioned variables collinear with the constant term. The results of the model with the outliers removed found a 700% increase in adjacent developed property sales prices if a thinning occurs.

The SR approach found 12 outliers in the Adjacent Vacant Model (Table B14). Removal of outliers also required the dropping of the UTIL variable in the Vacant Model due to near perfect collinearity with the constant term. Model results with outliers removed found a -37% impact on vacant properties abutting federal land relative to state land. The results also found a 396% increase in vacant property sales prices for a 1% increase in the percent of surrounding public land.

Removal of outliers in both of the Adjacent Models drastically changed the results of the models. Further the results of the models before and especially after are not believable and are inconsistent with the Full Models. The unrealistic behavior of the Adjacent Models was probably due to the extremely small sample sizes. Reliable results from the Adjacent Models would require much larger sample sizes.

CHAPTER 5: CONCLUSIONS

The history of United States public land policy, like most other policy, is marked by controversy. Continuously, public land policy controversy has involved three issues: (1) property rights, (2) public land ownership, and (3) the values associated with public land. The property rights issue includes nearby private ownership. How our public lands are managed may affect the property rights of nearby private property owners. The public property ownership issue, revived by the sagebrush rebellion, has proponents that believe that state or private ownership provides more net benefits than federal ownership. The values issue centers on what specific values are provided on public land. These values may impact nearby residents. All three of the historic and controversial issues are tied to private property near public land.

This research investigates some relationships between public ownership and nearby private property values. The specific relationships are related to the three common issues. The specific relationships are contained in the objectives of this research. The objectives are: (1) to estimate the impact of Michigan's public lands on sales prices of adjacent private lands, (2) to estimate the impact of proximity (distance) to public lands on private land sales, (3) to compare impacts of various types of public land use (ownership) on nearby private land values, and (4) to estimate the impact of public land timber harvesting on adjacent private property.

This final chapter concludes this research. Chapter five contains four sections. The first section summarizes the steps taken in this research, from the literature review through the methods. The second section reviews the results. The third section ties the results to various policy implications. The final section provides recommendations for future research.

Research Summary

The first step of this research involved a literature review. Primarily, the literature provided the theoretical foundation for hedonic price (or regression) analysis.

Additionally, the empirical literature presented commonly used data, modeling reference points, and solutions to existing problems for hedonic regression analysis.

The theory for hedonic price analysis provides the framework so that we can estimate the implicit prices embedded in market goods. Theoretically, market sales prices can be dissected into the various characteristics and attributes that make up the market good. In the end, the contributing proportion of the characteristic or attribute of the market sales price is estimated. Generally the characteristics and attributes do not have explicit markets in which they are traded. The theory applies to highly differentiable goods that are traded in a competitive market. Land property describes such a good. The supply and demand of land is fairly competitive. The supply and demand for housing is also fairly competitive. By assuming that indeed the markets for land and housing are

competitive then the theory provides a framework to break apart the sales price and measure the implicit prices.

The empirical literature provided various examples of commonly used data. Data such as acreage, square footage, distance from central business district, and distance from interstate highway have been commonly used in past studies. The use of these variables, in the existing literature, provided a list of suggested data. The use of these same variables provided a reference point for their statistical significance and directional impact (i.e., the sign of the coefficients). Further, the hedonic models in the empirical literature provide reference points for the robustness (i.e., adjusted R^2 and F-statistic) of many property value models. The models presented in this study have similar levels of robustness. Lastly, the empirical literature demonstrated that vacant and developed property values behave differently and should be modeled separately. The vacant and developed hedonic models in this study demonstrate different behavior. The models in this study reinforce past practice of separating vacant models from developed models.

The last important provision of the empirical literature was found in the many approaches to common estimation problems. Various approaches have been applied to estimating the correct functional form. In many cases, the functional form problem was ignored or assumed away. At the other extreme, the functional form problem is addressed with purely data-fitting techniques. Another problem associated with different functional forms is the interpretation of the results. The empirical literature provided interpretation of model coefficients under different functional forms.

The second step of this research was to determine the sampling frame and gather the required data needed to estimate hedonic models. The sampling frame was constructed with a few factors in mind, namely: data sources and limitations, data collection efficiency, size of sample areas, and controlling for influential factors. The sampling frame contained over three hundred townships. Nine randomly sampled townships were chosen and the data were collected from those townships. The data were collected from two primary sources for each township: the County Equalization Department and the township Assessors Office.

The third step involved the estimation of the hedonic models. Four models were required. Two models that contained all the adjacent and nonadjacent parcels were estimated, one for developed property and the other for vacant property. These two models are referred to as Full Models and addressed the first three objectives.

Additionally, two models were estimated for adjacent parcels only, one for developed property and the other for vacant property. These two models are referred to as Adjacent Models and they were needed to address the third and fourth objectives. From the empirical literature, a functional form determination and testing scheme (Steps A-F) was developed and each of the four models was put through it. After each model was put through the functional form scheme they became Final Models. Four Final Models were therefore estimated: Final Developed Full Model, Final Vacant Full Model, Final Developed Adjacent Model, and Final Vacant Adjacent Model.

Results

Four different models were required to address the objectives of this research. Two Full Models estimated the impact of proximity from public land on private property values and the impact of ownership of nearby public land on private property values. Two Adjacent Models estimated the impacts of public land timber harvesting on adjacent private property values and the ownership of adjacent public land on private property values. The two Full Models contained large sample sizes while the two Adjacent Models had much smaller sample sizes. The results of the Full Models were reasonable. The results of the Adjacent Models were questionable and at times conflicted with the Full Models. The reason for this is more than likely due to the small sample sizes of the Adjacent Models. More reliable results, with respect to the impacts of public land timber harvesting, would require larger sample sizes.

The two Full Models found, in general, that public land did impact both nearby developed and vacant property values, but in different ways. Four conclusions can be drawn from these models. First, the models found that Michigan's public lands had no impact on private adjacent developed property values but did affect vacant private land values. Vacant property values decreased in value, on average, by 11% for every 1000 feet farther away from federal public land, holding everything constant. Therefore, federal public land adjacent vacant property values are worth more than non-adjacent property values. Eleven percent, on average, amounts to \$79 per acre. Proximity and adjacency from state public land had no impact on property values.

Second, proximity to public land had no impact on developed private property sales but did affect vacant property values. As stated in the first result conclusion, vacant property values decreased in value the farther they were from federal public land. They decreased in value by 11% for every 1000 feet farther away. Proximity from state public land had no impact on property values.

Third, the impact of federal public land on developed property values did not differ from that of state ownership. The impact of federal ownership on vacant property values did differ from the impact of state ownership. As stated in the first and second result conclusions, proximity from federal public land had an impact on vacant property values, while proximity from state public land did not.

Fourth, the percentage of public land in the surrounding nine-township area did positively affect private developed property values. A one percent increase in the amount of surrounding public land caused a 0.9653% increase in the average developed property value. This is, on average, equivalent to \$310. While this was true for develop property values it was not for vacant property values. This last result was not public landowner specific.

Due to the small sample sizes of the Adjacent Models, and the resulting conflicting results, no conclusions can be drawn about the impact of public land timber harvesting on private property values. Neither Adjacent Model found a statistically significant

relationship between timber harvesting and the sales price of adjacent properties. The Vacant Adjacent Model did find a statistically significant difference between the sales prices of vacant parcels adjacent to federal and state land. The difference amounted to a 44%, on average, premium for state land adjacency. This was equivalent to \$251 per acre. This conclusion is in direct conflict with the Vacant Full Model. It is likely that this result was due to small sample problems.

One potential flaw in the models presented in this study is the lack of information regarding nearby private forestland. Private forestland may have similar impacts on nearby private property values as public land. Without this data, the models may have behaved in ways that differ from how they may have behaved with the data. This could be one reason why the adjacent models did not find any impact from timber harvesting. Another reason could be related to the distance of the timber harvesting from adjacent properties. This study recorded timber harvesting activities up to one-quarter mile away from adjacent properties. This distance may have been too large, causing too large of a variation in key variables to be found significant. Another possible reason for not finding any impact from timber harvesting could be the time that elapsed between harvest and sale of the property. The data collection methods used in this study did not allow the models with times between harvest and property sale of less than three years to be estimated. The data set simply did not have enough observations, and therefore variation for statistical estimation. If this study used different data collection methods targeting small differences between harvest and property sale the results may have been different.

In summary, the results in Michigan find: the percentage of public property in the surrounding nine townships positively impact developed property values and proximity to federal public land positively impacts vacant property values. The results found no statistically significant impacts on private property values from public land timber harvesting.

Policy Implications

Historically, federal ownership and management of land had been repeatedly challenged. Interest groups have demanded the sale of federal public land and/or the disposition to state ownership. There is no reason to believe that future challenges to federal ownership of land will not be challenged. Further, there is no reason to believe that state ownership will not be challenged. The results from this study may have considerable implications if the current structure of public land changes in Michigan. Changes in the public land structure could change a nearby property owners wealth, primarily for large land holders. Further, changes in the public land structure would change a regions property tax base. Changes in the property tax base could therefore change property tax revenues and property tax rates. The exact impact is specific to a geographic location, and is dependent upon many factors including the amount of surrounding public land, the amount of private vacant and developed property.

One policy-related implication to the results is the possible change in local property tax bases as a result of changing the amount of public land or the ownership of public land.

The results find that an increased percentage of public land increases the average developed property value. This can also be interpreted to mean that a decrease in the amount of public land would decrease nearby developed property values. A decrease in the amount of public land would increase the amount of private property, and therefore the amount of taxable land, and simultaneously lowering developed property values. If the property tax rate did not change, this would also be accompanied by lower developed property taxes (assuming updated tax records). The net effect here is indeterminable. The property tax base, property tax rate, amount of public land, and the number and value of developed parcels in the nine surrounding townships would be needed to determine the net effect. Either way, the increase or decrease in the amount of public land will affect nearby developed property values.

The results demonstrate that vacant property values increase the nearer they are to federal public lands. This would imply that increases in federal public land would cause associated increases in nearby vacant land values. Increases in the amount of federal land would decrease private land and simultaneously decrease the local property tax base. Like the case above, the net effect can not be determined here, but the change in the amount of federal public land may have an impact on local vacant property owners. Further, a decrease in the amount of federal public land would decrease vacant property values.

A related result found that federal public land has a negative impact on adjacent property relative to state public land. Here, replacing federal land with state land would increase

adjacent vacant property values. Federal public land has the opposite impact on non-adjacent vacant land. Therefore, replacing federal land with state land would decrease non-adjacent vacant property values. The net effect depends upon the amount of public land and the amounts of adjacent and non-adjacent vacant properties. Similar to the above conclusions, a change in the amount of federal land relative to state land will impact adjacent property owners.

Either changing the amount of public land, or changing public ownership of land will likely impact nearby local property values. The impact on property values is also likely to affect property taxes. The impact on property values is an impact on private wealth, especially to owners of large plots or more expensive property.

Recommendations for Future Research

One recommendation for future research would be to conduct a similar study that would include information about surrounding private forested land. This study may have been improved by controlling the possible effects that nearby private forested land may have had on private property values. Generally, detailed inventory and timber harvesting information for private forested land is difficult to obtain. Inventory and timber harvesting information for large areas of private forested land near both federal and state public land would be ideal for a future study. With this information the effects of surrounding private forested land could be incorporated and investigated in conjunction with the effects of public land.

A second recommendation for future research would be to include information about the existing trees and forests on the private property observations. Drombrow et al. demonstrated that “mature” trees on private property increased property values on average. It is possible that the trees and forests on private property could not only increase the value but also interact with the impact of public land. Using information about the existing trees and forests on the private parcels would allow the controlling of the possible interactions. Though this information would be useful, consistent and reliable data may be very difficult to obtain.

A third recommendation for future research would be to conduct a similar study at intervals over time. Smith et al. find that regression results applied to property values provide reliable but individual coefficients produced in the models may not produce accurate measurements over time. Therefore, future studies should be conducted to observe changes in the coefficients of concern.

Another recommendation for future research would be to determine property owner’s perceptions surrounding nearby public lands. This study measured actual impacts on property values assuming perceptions. Surveying land-owners to identify they’re knowledge and perceptions about the public land and timber harvesting activities would compliment this study. Modeling landowners segmented into different groups based on the level of their perceptions could be a further extension.

The last recommendation for future research would be to investigate the impact of different public land types, other than national and state forests, on private property values. The results of this study have no implications for other public land types.

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APPENDIX A

Full Developed Model

TABLE A1. LOG-LINEAR DEVELOPED FULL MODEL ESTIMATION RESULTS.				
Dependent Variable:	Log(Price)			
F-statistic:	12.4904	D-W:	2.1503	
R-squared:	0.5293	RESET:	3.7064	
Adj. R-squared:	0.4869	LM Het. Test:	0.8864	
N:	667			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	10.5990	46.1274	0.2298	[.818]
HOUSE	0.0003	0.0005	0.5613	[.575]
HOUSE2	0.0000	0.0000	0.5088	[.611]
HOUSE3	0.0000	0.0000	-1.0202	[.308]
LOT	0.0122	0.0059	2.0496	[.041]
LOT2	0.0000	0.0001	0.3719	[.710]
LOT3	0.0000	0.0000	-0.6879	[.492]
CITY	0.0192	0.0241	0.7955	[.427]
CITY2	-0.0001	0.0002	-0.5545	[.579]
CITY3	0.0000	0.0000	0.4215	[.674]
HWY	0.0037	0.0478	0.0785	[.937]
HWY2	0.0055	0.0077	0.7153	[.475]
HWY3	-0.0002	0.0003	-0.6722	[.502]
GARAGE	0.3128	0.0562	5.5620	[.000]
UTIL	0.3713	0.0865	4.2929	[.000]
PRISON	-0.8208	0.3665	-2.2397	[.025]
ZONED	0.0277	0.1679	0.1649	[.869]
BR	0.0612	0.1551	0.3950	[.693]
B	0.3774	0.4491	0.8402	[.401]
D	-0.5163	0.0594	-8.6949	[.000]
MH	-0.7608	0.0834	-9.1227	[.000]
PAVE	-0.0022	0.0639	-0.0337	[.973]
HOME	0.1289	0.0547	2.3553	[.019]
PLAT	0.0086	0.0711	0.1215	[.903]

Table A1 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
H2O	0.2813	0.0874	3.2190	[.001]
R_INT	-10.0376	11.5283	-0.8707	[.384]
R_INT2	1.1203	1.3038	0.8593	[.391]
R_INT3	-0.0411	0.0488	-0.8419	[.400]
GSP	0.3781	0.2903	1.3025	[.193]
GSP2	-0.0016	0.0013	-1.2989	[.194]
GSP3	0.0000	0.0000	1.3217	[.187]
REGNLP	0.0927	0.1868	0.4961	[.620]
PERPUB	-22.5354	14.3740	-1.5678	[.117]
PERPUB2	63.4994	42.9295	1.4792	[.140]
PERPUB3	-47.1712	34.7177	-1.3587	[.175]
CC	-0.3765	1.3682	-0.2752	[.783]
CC_P	1.4060	3.1893	0.4408	[.659]
SEED	-0.1680	0.6285	-0.2672	[.789]
THIN	2.9350	1.5230	1.9270	[.054]
THIN_P	-6.5963	3.5449	-1.8608	[.063]
SEL	0.6545	1.2137	0.5393	[.590]
SEL_P	-0.4702	3.1407	-0.1497	[.881]
REM	-1.0484	3.4238	-0.3062	[.760]
REM_P	3.6441	9.1161	0.3997	[.689]
F_DIS	0.0000	0.0000	-0.1601	[.873]
F_DIS2	0.0000	0.0000	-0.0826	[.934]
F_DIS3	0.0000	0.0000	-0.0266	[.979]
S_DIS	0.0000	0.0000	-0.3617	[.718]
S_DIS2	0.0000	0.0000	0.8792	[.380]
S_DIS3	0.0000	0.0000	-1.1146	[.265]
PERDIS	0.0000	0.0000	0.9715	[.332]
PERADJ	0.0870	1.1027	0.0789	[.937]
PERADJ2	1.4831	3.4005	0.4362	[.663]
PERADJ3	-1.5502	2.6673	-0.5812	[.561]
CONIFER	-0.1694	0.1223	-1.3846	[.167]
HARDWOOD	-0.1000	0.1076	-0.9294	[.353]

TABLE A2. TESTS OF SQUARED AND CUBED COEFFICIENTS OF FULL DEVELOPED MODEL.				
Independent Tests				
Parameter	Estimate	Standard Error	t-statistic	P-value
HOUSE	0.0000	0.0000	0.5087	[.611]
LOT	0.0000	0.0001	0.3704	[.711]
CITY	-0.0001	0.0002	-0.5549	[.579]
HWY	0.0053	0.0074	0.7164	[.474]
R_INT	1.0792	1.2550	0.8599	[.390]
GSP	-0.0016	0.0013	-1.2989	[.194]
PERPUB	16.3281	8.4285	1.9373	[.053]
F_DIS	0.0000	0.0000	-0.0826	[.934]
S_DIS	0.0000	0.0000	0.8792	[.379]
PERADJ	-0.0671	0.9808	-0.0684	[.945]
Joint Tests				
Chi-squared(10):	8.8867	P-value:	0.5429	
F(10, 1272):	0.8887	P-value:	0.5432	

TABLE A3. "BEST" DEVELOPED FULL MODEL ESTIMATION RESULTS.				
Dependent Variable:	Log(Price)			
F-statistic:	17.9966	D-W:	2.1181	
R-squared:	0.5142	RESET:	2.6659	
Adj. R-squared:	0.4857	LM Het. Test:	0.7864	
N:	667			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	8.7221	0.7374	11.8284	[.000]
HOUSE	0.0003	0.0001	3.6168	[.000]
LOT	0.0112	0.0014	8.2618	[.000]
CITY	0.0012	0.0015	0.7876	[.431]
HWY	0.0353	0.0076	4.6319	[.000]
GARAGE	0.3166	0.0555	5.7073	[.000]
UTIL	0.3788	0.0839	4.5172	[.000]
PRISON	-0.6406	0.2874	-2.2289	[.026]
ZONED	0.1589	0.1158	1.3722	[.170]
BR	0.1009	0.1533	0.6580	[.511]
B	0.3407	0.4371	0.7795	[.436]
D	-0.5375	0.0581	-9.2552	[.000]
MH	-0.7670	0.0816	-9.4054	[.000]
PAVE	0.0053	0.0612	0.0859	[.932]
HOME	0.1428	0.0532	2.6827	[.007]
PLAT	-0.0288	0.0618	-0.4666	[.641]
H20	0.2735	0.0852	3.2079	[.001]
R_INT	0.0034	0.0366	0.0923	[.926]
GSP	0.0069	0.0012	5.9469	[.000]
REGNLP	0.0157	0.1383	0.1136	[.910]
PERPUB	-12.2285	5.5863	-2.1890	[.029]
PERPUB2	32.0225	16.1273	1.9856	[.048]
PERPUB3	-21.4172	12.4046	-1.7266	[.085]

Table A3 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
CC	0.0004	1.3381	0.0003	[1.00]
CC_P	0.3983	3.1202	0.1277	[.898]
SEED	-0.2012	0.6207	-0.3240	[.746]
THIN	2.5997	1.4680	1.7709	[.077]
THIN_P	-5.7565	3.4126	-1.6868	[.092]
SEL	0.6090	1.1643	0.5231	[.601]
SEL_P	-0.3006	3.0078	-0.0999	[.920]
REM	-1.2100	3.3711	-0.3589	[.720]
REM_P	3.9361	8.9691	0.4388	[.661]
F_DIS	0.0000	0.0000	-1.2209	[.223]
S_DIS	0.0000	0.0000	0.0151	[.988]
PERDIS	0.0000	0.0000	1.2134	[.225]
PERADJ	0.3510	0.2463	1.4247	[.155]
CONIFER	-0.1523	0.1173	-1.2990	[.194]
HARDWOOD	-0.0823	0.0964	-0.8544	[.393]

TABLE A4. DEVELOPED FULL MODEL ARTIFICIAL REGRESSION ESTIMATION RESULTS.				
Dependent Variable:	Log(Price)			
F-statistic:	12.4904	D-W:	2.1503	
R-squared:	0.5293	RESET:	3.7064	
Adj. R-squared:	0.4869	LM Het. Test:	0.8864	
N:	667			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	17.6343	19.7937	0.8909	[.373]
HOUSE	0.0002	0.0002	0.9694	[.333]
LOG(HOUSE)	0.1321	0.1313	1.0066	[.315]
LOT	0.0080	0.0022	3.6842	[.000]
LOG(LOT)	0.0934	0.0470	1.9866	[.047]
CITY	0.0049	0.0039	1.2531	[.211]
LOG(CITY)	0.0981	0.3901	0.2515	[.801]
HWY	0.0450	0.0162	2.7767	[.006]
LOG(HWY)	-0.0844	0.0960	-0.8790	[.380]
GARAGE	0.3154	0.0561	5.6264	[.000]
UTIL	0.3733	0.0849	4.3977	[.000]
PRISON	-0.0904	0.5812	-0.1555	[.876]
ZONED	0.1946	0.1631	1.1930	[.233]
BR	0.1074	0.1538	0.6984	[.485]
B	0.3199	0.4469	0.7158	[.474]
D	-0.5120	0.0591	-8.6696	[.000]
MH	-0.7523	0.0834	-9.0223	[.000]
PAVE	0.0083	0.0631	0.1308	[.896]
HOME	0.1134	0.0547	2.0744	[.038]
PLAT	0.0657	0.0773	0.8507	[.395]
H20	0.2766	0.0864	3.2002	[.001]
R_INT	0.3276	0.5903	0.5551	[.579]
LOG(R_INT)	-2.9445	5.0714	-0.5806	[.562]
GSP	0.0117	0.0208	0.5615	[.575]
LOG(GSP)	-1.0725	4.7914	-0.2238	[.823]
REGNLP	0.2437	0.1891	1.2886	[.198]

Table A4 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
PERPUB	2349.2590	1956.4290	1.2008	[.230]
PERPUB2	-942.0409	825.2016	-1.1416	[.254]
PERPUB3	262.0888	252.1448	1.0394	[.299]
LOG(PERPUB)	-2404.8780	1985.6690	-1.2111	[.226]
CC	-0.0456	1.3658	-0.0334	[.973]
CC_P	0.5837	3.1807	0.1835	[.854]
SEED	-0.1597	0.6258	-0.2551	[.799]
THIN	2.3040	1.5387	1.4973	[.135]
THIN_P	-5.1462	3.5810	-1.4371	[.151]
SEL	0.2925	1.1847	0.2469	[.805]
SEL_P	0.3235	3.0626	0.1056	[.916]
REM	-1.7962	3.3990	-0.5284	[.597]
REM_P	5.5495	9.0349	0.6142	[.539]
F_DIS	0.0000	0.0000	0.2152	[.830]
LOG(F_DIS)	0.0195	0.0233	0.8355	[.404]
S_DIS	0.0000	0.0000	0.2885	[.773]
LOG(S_DIS)	0.0309	0.0210	1.4703	[.142]
PERDIS	0.0000	0.0000	-0.0187	[.985]
PERADJ	-1.8776	2.2033	-0.8522	[.394]
LOG(PERADJ)	3.0642	2.9072	1.0540	[.292]
CONIFER	-0.1345	0.1265	-1.0634	[.288]
HARDWOOD	-0.0165	0.1325	-0.1242	[.901]

TABLE A5. DEVELOPED FULL MODEL ARTIFICIAL REGRESSION TESTS – QUADRATIC TERMS.				
Independent Tests				
Parameter	Estimate	Standard Error	t-statistic	P-value
HOUSE	0.0002	0.0002	0.9694	[.332]
LOT	0.0080	0.0022	3.6842	[.000]
CITY	0.0049	0.0039	1.2531	[.210]
HWY	0.0450	0.0162	2.7767	[.005]
R_INT	0.3276	0.5903	0.5551	[.579]
GSP	0.0117	0.0208	0.5615	[.574]
PERPUB	1669.3070	1382.5890	1.2074	[.227]
F_DIS	0.0000	0.0000	0.2152	[.830]
S_DIS	0.0000	0.0000	0.2885	[.773]
PERADJ	-1.8776	2.2033	-0.8522	[.394]
Joint Tests				
Chi-squared(10):	24.5697	P-value:	0.0062	
F(10, 1272):	2.4569	P-value:	0.0066	

TABLE A6. DEVELOPED FULL MODEL ARTIFICIAL REGRESSION TESTS – LOGARITHMIC TERMS.				
Independent Tests				
Parameter	Estimate	Standard Error	t-statistic	P-value
HOUSE	0.1321	0.1313	1.0066	[.314]
LOT	0.0934	0.0470	1.9866	[.047]
CITY	0.0981	0.3901	0.2515	[.801]
HWY	-0.0844	0.0960	-0.8790	[.379]
R_INT	-2.9445	5.0714	-0.5806	[.561]
GSP	-1.0725	4.7914	-0.2238	[.823]
PERPUB	-2404.8780	1985.6690	-1.2111	[.226]
F_DIS	0.0195	0.0233	0.8355	[.403]
S_DIS	0.0309	0.0210	1.4703	[.141]
PERADJ	3.0642	2.9072	1.0540	[.292]
Joint Tests				
Chi-squared(10):	10.8802	P-value:	0.3669	
F(10, 1280):	1.0880	P-value:	0.3679	

Full Vacant Model

TABLE A7. LOG-QUADRATIC VACANT FULL MODEL ESTIMATION RESULTS.				
Dependent Variable:	Log(Price)			
F-statistic:	4.8575	D-W:	1.6749	
R-squared:	0.2634	RESET:	4.3054	
Adj. R-squared:	0.2091	LM Het. Test:	4.0981	
N:	672			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	28.2631	66.1024	0.4276	[.669]
LOT	0.0225	0.0029	7.8666	[.000]
LOT2	-0.0001	0.0000	-3.9568	[.000]
LOT3	0.0000	0.0000	2.7963	[.005]
CITY	-0.0002	0.0330	-0.0064	[.995]
CITY2	0.0000	0.0003	0.1433	[.886]
CITY3	0.0000	0.0000	-0.1958	[.845]
HWY	0.0756	0.0637	1.1876	[.235]
HWY2	-0.0134	0.0111	-1.2023	[.230]
HWY3	0.0005	0.0005	1.0244	[.306]
UTIL	0.1992	0.1739	1.1455	[.252]
PRISON	-0.3376	0.5166	-0.6536	[.514]
ZONED	-0.0025	0.2040	-0.0121	[.990]
PAVE	-0.1994	0.0919	-2.1697	[.030]
PLAT	-0.0415	0.1015	-0.4083	[.683]
H20	0.2856	0.1140	2.5041	[.013]
R_INT	-0.8245	16.9815	-0.0486	[.961]
R_INT2	0.0626	1.9205	0.0326	[.974]
R_INT3	-0.0014	0.0719	-0.0199	[.984]
GSP	-0.2082	0.3554	-0.5857	[.558]
GSP2	0.0009	0.0015	0.5651	[.572]
GSP3	0.0000	0.0000	-0.5325	[.595]
REGNLP	0.0903	0.2294	0.3939	[.694]
PERPUB	-0.4283	20.3150	-0.0211	[.983]
PERPUB2	-2.3728	60.8029	-0.0390	[.969]
PERPUB3	5.6643	49.1280	0.1153	[.908]

Table A7 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
CC	0.7002	0.5841	1.1986	[.231]
CC_P	-1.4000	1.1554	-1.2117	[.226]
SEED	0.4590	0.5200	0.8827	[.378]
THIN	1.4981	0.8650	1.7320	[.084]
THIN_P	-2.7460	1.6556	-1.6586	[.098]
SEL	1.3040	1.1055	1.1796	[.239]
SEL_P	-1.3837	2.6087	-0.5304	[.596]
REM	-0.0289	0.9655	-0.0299	[.976]
REM_P	-0.1849	1.6931	-0.1092	[.913]
F_DIS	-0.0001	0.0001	-2.3461	[.019]
F_DIS2	0.0000	0.0000	2.1325	[.033]
F_DIS3	0.0000	0.0000	-2.0126	[.045]
S_DIS	0.0000	0.0001	-0.6281	[.530]
S_DIS2	0.0000	0.0000	0.9422	[.346]
S_DIS3	0.0000	0.0000	-1.1782	[.239]
PERDIS	0.0000	0.0000	0.9879	[.324]
PERADJ	-1.5513	1.5185	-1.0216	[.307]
PERADJ2	6.0106	4.3702	1.3754	[.170]
PERADJ3	-4.6565	3.3267	-1.3997	[.162]
CONIFER	-0.1441	0.1428	-1.0094	[.313]
HARDWOOD	0.0741	0.1518	0.4878	[.626]

TABLE A8. LOG-QUADRATIC VACANT FULL MODEL ESTIMATION
RESULTS CORRECTING HETEROSCEDASTICITY.

Dependent Variable:	Log(Price)			
F-statistic:	4.8575	D-W:	1.6749	
R-squared:	0.2634	RESET:	4.3054	
Adj. R-squared:	0.2091	LM Het. Test:	4.0981	
N:	672			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	28.2631	64.1124	0.4408	[.659]
LOT	0.0225	0.0028	7.9954	[.000]
LOT2	-0.0001	0.0000	-4.4975	[.000]
LOT3	0.0000	0.0000	3.1952	[.001]
CITY	-0.0002	0.0341	-0.0062	[.995]
CITY2	0.0000	0.0003	0.1221	[.903]
CITY3	0.0000	0.0000	-0.1530	[.878]
HWY	0.0756	0.0595	1.2701	[.205]
HWY2	-0.0134	0.0112	-1.1971	[.232]
HWY3	0.0005	0.0005	0.9756	[.330]
UTIL	0.1992	0.1807	1.1027	[.271]
PRISON	-0.3376	0.5457	-0.6187	[.536]
ZONED	-0.0025	0.2127	-0.0116	[.991]
PAVE	-0.1994	0.0961	-2.0743	[.038]
PLAT	-0.0415	0.1103	-0.3757	[.707]
H20	0.2856	0.1043	2.7377	[.006]
R_INT	-0.8245	16.8428	-0.0490	[.961]
R_INT2	0.0626	1.9091	0.0328	[.974]
R_INT3	-0.0014	0.0716	-0.0200	[.984]
GSP	-0.2082	0.3169	-0.6569	[.511]
GSP2	0.0009	0.0014	0.6330	[.527]
GSP3	0.0000	0.0000	-0.5958	[.552]
REGNLP	0.0903	0.2316	0.3901	[.697]
PERPUB	-0.4283	20.7392	-0.0207	[.984]
PERPUB2	-2.3728	62.3217	-0.0381	[.970]
PERPUB3	5.6643	50.5161	0.1121	[.911]

Table A8 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
CC	0.7002	0.4592	1.5246	[.128]
CC_P	-1.4000	0.9762	-1.4340	[.152]
SEED	0.4590	0.2953	1.5543	[.121]
THIN	1.4981	1.0455	1.4329	[.152]
THIN_P	-2.7460	2.1888	-1.2546	[.210]
SEL	1.3040	0.7195	1.8124	[.070]
SEL_P	-1.3837	1.5206	-0.9100	[.363]
REM	-0.0289	0.6761	-0.0427	[.966]
REM_P	-0.1849	1.0960	-0.1687	[.866]
F_DIS	-0.0001	0.0001	-2.0195	[.044]
F_DIS2	0.0000	0.0000	1.6675	[.096]
F_DIS3	0.0000	0.0000	-1.3862	[.166]
S_DIS	0.0000	0.0001	-0.6038	[.546]
S_DIS2	0.0000	0.0000	1.0689	[.286]
S_DIS3	0.0000	0.0000	-1.4542	[.146]
PERDIS	0.0000	0.0000	0.9122	[.362]
PERADJ	-1.5513	1.3830	-1.1217	[.262]
PERADJ2	6.0106	4.0020	1.5019	[.134]
PERADJ3	-4.6565	2.9449	-1.5812	[.114]
CONIFER	-0.1441	0.1176	-1.2256	[.221]
HARDWOOD	0.0741	0.1288	0.5751	[.565]

TABLE A9. TESTS OF SQUARED AND CUBED TERMS OF FULL VACANT LOG-QUADRATIC MODEL.				
Independent Tests				
Parameter	Estimate	Standard Error	t-statistic	P-value
LOT	-0.0001	0.0000	-4.4990	[.000]
CITY	0.0000	0.0003	0.1220	[.903]
HWY	-0.0129	0.0107	-1.2065	[.228]
R_INT	0.0612	1.8375	0.0333	[.973]
GSP	0.0009	0.0014	0.6330	[.527]
PERPUB	3.2915	12.0860	0.2723	[.785]
F_DIS	0.0000	0.0000	1.6675	[.095]
S_DIS	0.0000	0.0000	1.0689	[.285]
PERADJ	1.3541	1.2485	1.0846	[.278]
Joint Tests				
Chi-squared(9):	25.7845	P-value:	0.0022	
F(9, 1292):	2.8649	P-value:	0.0025	

TABLE A10. "BEST" VACANT FULL MODEL ESTIMATION RESULTS.				
Dependent Variable:	Log(Price)			
F-statistic:	6.5357	D-W:	1.6848	
R-squared:	0.2466	RESET:	2.2818	
Adj. R-squared:	0.2089	LM Het. Test:	7.7603	
N:	672			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	7.8812	0.8064	9.7728	[.000]
LOT	0.0213	0.0026	8.1960	[.000]
LOT2	-0.0001	0.0000	-4.4931	[.000]
LOT3	0.0000	0.0000	3.0792	[.002]
CITY	0.0054	0.0016	3.3724	[.001]
HWY	-0.0268	0.0079	-3.3751	[.001]
UTIL	0.1984	0.1789	1.1092	[.268]
PRISON	0.1073	0.1943	0.5523	[.581]
ZONED	-0.1560	0.0980	-1.5920	[.112]
PAVE	-0.1831	0.0905	-2.0233	[.043]
PLAT	0.0063	0.1030	0.0611	[.951]
H20	0.2589	0.0977	2.6494	[.008]
R_INT	-0.0240	0.0520	-0.4623	[.644]
GSP	0.0034	0.0016	2.0890	[.037]
REGNLP	0.2633	0.1726	1.5256	[.128]
PERPUB	0.4345	0.4073	1.0670	[.286]
CC	0.6770	0.4690	1.4434	[.149]
CC_P	-1.3838	0.9944	-1.3916	[.165]
SEED	0.3718	0.3449	1.0781	[.281]
THIN	1.4748	1.0355	1.4241	[.155]
THIN_P	-2.6499	2.1445	-1.2357	[.217]
SEL	1.6468	0.6185	2.6623	[.008]
SEL_P	-2.2343	1.1414	-1.9575	[.051]
REM	-0.0408	0.7089	-0.0576	[.954]
REM_P	-0.2113	1.0811	-0.1954	[.845]
F_DIS	-0.0001	0.0001	-2.5967	[.010]
F_DIS2	0.0000	0.0000	1.9147	[.056]
F_DIS3	0.0000	0.0000	-1.5300	[.127]
S_DIS	0.0000	0.0000	0.3920	[.695]
PERDIS	0.0000	0.0000	0.2772	[.782]
PERADJ	0.3872	0.2364	1.6375	[.102]
CONIFER	-0.1729	0.1196	-1.4460	[.149]
HARDWOOD	-0.0232	0.0994	-0.2333	[.816]

TABLE A11. VACANT FULL MODEL ARTIFICIAL REGRESSION ESTIMATION RESULTS.				
Dependent Variable:	Log(Price)			
F-statistic:	5.5089	D-W:	1.6953	
R-squared:	0.2639	RESET:	5.8737	
Adj. R-squared:	0.2160	LM Het. Test:	5.2077	
N:	672			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	35.9034	22.6439	1.5856	[.113]
LOT	0.0198	0.0050	3.9188	[.000]
LOT2	-0.0001	0.0000	-2.9614	[.003]
LOT3	0.0000	0.0000	2.2432	[.025]
LOG(LOT)	0.0377	0.0927	0.4061	[.685]
CITY	0.0024	0.0039	0.6211	[.535]
LOG(CITY)	0.0830	0.2336	0.3554	[.722]
HWY	-0.0333	0.0198	-1.6800	[.093]
LOG(HWY)	0.1095	0.1173	0.9336	[.351]
UTIL	0.2162	0.1789	1.2080	[.227]
PRISON	-0.3707	0.3249	-1.1411	[.254]
ZONED	0.0741	0.1228	0.6036	[.546]
PAVE	-0.1821	0.0979	-1.8594	[.063]
PLAT	-0.0352	0.1421	-0.2477	[.804]
H20	0.2612	0.1035	2.5247	[.012]
R_INT	0.5257	0.9277	0.5667	[.571]
LOG(R_INT)	-4.8872	7.9425	-0.6153	[.539]
GSP	0.0262	0.0255	1.0301	[.303]
LOG(GSP)	-5.0667	5.8998	-0.8588	[.391]
REGNLP	0.2166	0.2149	1.0075	[.314]
PERPUB	15.1798	6.8218	2.2252	[.026]
LOG(PERPUB)	-19.2865	8.9459	-2.1559	[.031]
CC	0.7126	0.4797	1.4856	[.138]
CC_P	-1.3772	1.0275	-1.3403	[.181]
SEED	0.4072	0.3153	1.2917	[.197]
THIN	1.2803	1.0231	1.2514	[.211]
THIN_P	-2.4069	2.1388	-1.1254	[.261]
SEL	1.6656	0.7717	2.1585	[.031]
SEL_P	-2.4329	1.6463	-1.4778	[.140]
REM	0.0803	0.6096	0.1317	[.895]
REM_P	-0.4906	0.9235	-0.5312	[.595]

Table A11 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
F_DIS	0.0000	0.0001	0.0196	[.984]
F_DIS2	0.0000	0.0000	0.3041	[.761]
F_DIS3	0.0000	0.0000	-0.4442	[.657]
LOG(F_DIS)	-0.0326	0.0368	-0.8868	[.376]
S_DIS	0.0000	0.0000	-0.7084	[.479]
LOG(S_DIS)	0.0288	0.0256	1.1279	[.260]
PERDIS	0.0000	0.0000	0.3617	[.718]
PERADJ	0.6776	2.3636	0.2867	[.774]
LOG(PERADJ)	-0.4958	3.1663	-0.1566	[.876]
CONIFER	-0.1143	0.1143	-0.9999	[.318]
HARDWOOD	0.1095	0.1438	0.7612	[.447]

TABLE A12. ARTIFICIAL REGRESSION TESTS – QUADRATIC TERMS.				
Independent Tests				
Parameter	Estimate	Standard Error	t-statistic	P-value
LOT	0.0197	0.0050	3.9216	[.000]
CITY	0.0024	0.0039	0.6211	[.535]
HWY	-0.0333	0.0198	-1.6800	[.093]
R_INT	0.5257	0.9277	0.5667	[.571]
GSP	0.0262	0.0255	1.0301	[.303]
PERPUB	15.1798	6.8218	2.2252	[.026]
F_DIS	0.0000	0.0001	0.0196	[.984]
S_DIS	0.0000	0.0000	-0.7084	[.479]
PERADJ	0.6776	2.3636	0.2867	[.774]
Joint Tests				
Chi-squared(9):	29.4289	P-value:	0.0006	
F(10, 1272):	3.2699	P-value:	0.0007	

TABLE A13. ARTIFICIAL REGRESSION TESTS – LOGARITHMIC TERMS.				
Independent Tests				
Parameter	Estimate	Standard Error	t-statistic	P-value
LOT	0.0377	0.0927	0.4061	[.685]
CITY	0.0830	0.2336	0.3554	[.722]
HWY	0.1095	0.1173	0.9336	[.351]
R_INT	-4.8872	7.9425	-0.6153	[.538]
GSP	-5.0667	5.8998	-0.8588	[.390]
PERPUB	-19.2865	8.9459	-2.1559	[.031]
F_DIS	-0.0326	0.0368	-0.8868	[.375]
S_DIS	0.0288	0.0256	1.1279	[.259]
PERADJ	-0.4958	3.1663	-0.1566	[.876]
Joint Tests				
Chi-squared(10):	14.7519	P-value:	0.0980	
F(10, 1280):	1.6391	P-value:	0.0986	

**TABLE A14. FINAL DEVELOPED FULL MODEL ESTIMATION
RESULTS WITHOUT OUTLIERS.**

Dependent Variable:	Log(Price)			
F-statistic:	29.12	D-W:	1.9768	
R-squared:	0.6443	RESET:	4.7596	
Adj. R-squared:	0.6221	LM Het. Test:	1.4735	
N:	667			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	9.75899	0.5923	16.48	.0001
HOUSE	0.0003	0.0001	5.08	.0001
LOT	0.0096	0.0010	9.18	.0001
CITY	0.0004	0.0012	0.30	.7642
HWY	0.0352	0.0060	5.83	.0001
GARAGE	0.3102	0.0447	6.94	.0001
UTIL	0.3027	0.0672	4.50	.0001
PRISON	-0.6641	0.2278	-2.92	.0037
ZONED	0.1574	0.0934	1.69	.0925
BR	0.2080	0.1231	1.69	.0915
B	0.2559	0.3414	0.75	.4537
D	-0.5750	0.0466	-12.34	.0001
MH	-0.7777	0.0655	-11.87	.0001
PAVE	-0.0173	0.0492	-0.35	.7250
HOME	0.17023	0.0428	3.98	.0001
PLAT	-0.0003	0.0003	-1.00	.3179
H20	0.1750	0.0669	2.62	.0091
R_INT	-0.0360	0.0295	-1.22	.2230
GSP	0.0059	0.0009	6.31	.0001
REGNLP	-0.0305	0.1099	-0.28	.7815
PERPUB	-14.9154	4.4226	-3.37	.0008
PERPUB2	38.5905	12.7313	3.03	.0025
PERPUB3	-25.9767	9.7820	-2.66	.0081

Table A14 (continued).

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
CC	0.2603	1.0468	0.25	.8037
CC_P	-0.2468	2.4398	-0.10	.9195
SEED	-0.3777	0.4864	-0.78	.4377
THIN	2.9313	1.1516	2.55	.0112
THIN_P	-6.8561	2.6814	-2.56	.0108
SEL	0.5295	0.9091	0.58	.5605
SEL_P	-0.1796	2.3490	-0.08	.9391
REM	0.0209	2.6415	0.01	.9937
REM_P	0.5308	7.0278	0.08	.9398
F_DIS	-0.0000	0.0001	-1.84	.0656
S_DIS	-0.0000	0.0000	-0.37	.7098
PERDIS	0.0000	0.0000	1.37	.1697
PERADJ	0.2089	0.2000	1.04	.2967
CONIFER	-0.0013	0.0962	-0.01	.9895
HARDWOOD	-0.0060	0.0788	-0.08	.9397

TABLE A15. FINAL VACANT FULL MODEL ESTIMATION RESULTS
WITHOUT OUTLIERS.

Dependent Variable:	Log(Price)			
F-statistic:	8.84	D-W:	1.6488	
R-squared:	0.3196	RESET:	6.9327	
Adj. R-squared:	0.2834	LM Het. Test:	1.2878	
N:	672			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	7.6614	0.7128	10.75	.0001
LOT	0.0220	0.0022	9.93	.0001
LOT2	-0.0001	0.0000	-4.94	.0001
LOT3	0.0000	0.0000	3.45	.0006
CITY	0.0033	0.0013	2.50	.0125
HWY	-0.0182	0.0079	-2.29	.0226
UTIL	0.3059	0.1480	2.07	.0391
PRISON	0.0215	0.1668	0.13	.8976
ZONED	-0.2059	0.0839	-2.46	.0144
PAVE	-0.0991	0.0767	-1.29	.1966
PLAT	0.0013	0.0007	1.93	.0540
H20	0.2603	0.0927	2.81	.0052
R_INT	-0.0118	0.0447	-0.26	.7920
GSP	0.0045	0.0014	3.24	.0013
REGNLP	0.1052	0.1503	0.70	.4840
PERPUB	0.4860	0.3482	1.40	.1633
CC	0.4923	0.4906	1.00	.3160
CC_P	-1.1131	0.9781	-1.14	.2556
SEED	0.3606	0.4359	0.83	.4085
THIN	1.5521	0.7144	2.17	.0302
THIN_P	-2.7451	1.3731	-2.00	.0460
SEL	1.8249	0.8447	2.16	.0311
SEL_P	-2.4637	1.9564	-1.26	.2084
REM	0.0723	0.7959	0.09	.9276
REM_P	-0.3863	1.3934	-0.28	.7817
F_DIS	-0.0002	0.0000	-3.57	.0004
F_DIS2	0.0000	0.0000	2.96	.0032
F_DIS3	-0.0000	0.0000	-2.59	.0097
S_DIS	0.0000	0.0000	0.26	.7980
PERDIS	-0.0000	0.0000	-0.08	.9346
PERADJ	0.4527	0.2537	1.78	.0749
CONIFER	-0.1614	0.1171	-1.38	.1688

Table A15 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
PERDIS	-0.0000	0.0000	-0.08	.9346
PERADJ	0.4527	0.2537	1.78	.0749
CONIFER	-0.1614	0.1171	-1.38	.1688
HARDWOOD	-0.0646	0.1044	-0.62	.5366

APPENDIX B

Adjacent Developed Model

TABLE B1. LOG-QUADRATIC DEVELOPED ADJACENT MODEL ESTIMATION RESULTS.				
Dependent Variable:	Log(Price)			
F-statistic:	2.1136	D-W:	2.3004	
R-squared:	0.5441	RESET:	0.0007	
Adj. R-squared:	0.2867	LM Het. Test:	1.5183	
N:	134			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-31.6059	129.6809	-0.2437	[.808]
HOUSE	-0.0003	0.0022	-0.1471	[.883]
HOUSE2	0.0000	0.0000	0.3208	[.749]
HOUSE3	0.0000	0.0000	-0.2143	[.831]
LOT	-0.0015	0.0155	-0.0998	[.921]
LOT2	0.0003	0.0003	1.0401	[.301]
LOT3	0.0000	0.0000	-1.1062	[.272]
CITY	0.0494	0.1032	0.4786	[.633]
CITY2	-0.0005	0.0015	-0.3313	[.741]
CITY3	0.0000	0.0000	0.2882	[.774]
HWY	-0.1788	0.1416	-1.2629	[.210]
HWY2	0.0234	0.0202	1.1569	[.251]
HWY3	-0.0007	0.0008	-0.8944	[.374]
GARAGE	0.4382	0.1833	2.3912	[.019]
UTIL	-0.0572	0.3220	-0.1776	[.859]
PRISON	-1.0289	1.2340	-0.8338	[.407]
ZONED	0.1908	0.6129	0.3113	[.756]
BR	0.4766	0.9133	0.5218	[.603]
D	-0.3011	0.1962	-1.5347	[.129]
MH	-0.5226	0.2425	-2.1552	[.034]
PAVE	0.3832	0.2689	1.4251	[.158]
HOME	-0.1183	0.2177	-0.5436	[.588]
PLAT	0.0758	0.3765	0.2012	[.841]

Table B1 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
H2O	0.3504	0.2971	1.1792	[.242]
R_INT	13.7464	33.2220	0.4138	[.680]
R_INT2	-1.5844	3.7551	-0.4219	[.674]
R_INT3	0.0604	0.1403	0.4305	[.668]
GSP	-0.0078	0.8923	-0.0088	[.993]
GSP2	0.0002	0.0039	0.0444	[.965]
GSP3	0.0000	0.0000	-0.0760	[.940]
REGNLP	0.0852	0.5769	0.1477	[.883]
PERPUB	-23.7614	41.3050	-0.5753	[.567]
PERPUB2	72.7663	122.8686	0.5922	[.555]
PERPUB3	-56.3423	98.8633	-0.5699	[.570]
CC	-2.9969	2.2124	-1.3546	[.179]
CC_P	7.2462	5.0631	1.4312	[.156]
SEED	-0.4224	1.0025	-0.4213	[.675]
THIN	3.9028	2.2702	1.7191	[.089]
THIN_P	-8.3556	5.2924	-1.5788	[.118]
SEL	2.2045	1.7680	1.2469	[.216]
SEL_P	-4.5304	4.5640	-0.9926	[.324]
REM	0.3531	4.6351	0.0762	[.939]
REM_P	0.4048	12.3239	0.0328	[.974]
FED	-0.1992	0.4887	-0.4077	[.685]
PERADJ	0.5229	2.0860	0.2507	[.803]
PERADJ2	0.0711	5.6072	0.0127	[.990]
PERADJ3	-0.6496	4.1037	-0.1583	[.875]
CONIFER	-0.0863	0.2004	-0.4308	[.668]
HARDWOOD	-0.0346	0.2172	-0.1591	[.874]

TABLE B2. TESTS OF SQUARED AND CUBED TERMS OF ADJACENT DEVELOPED LOG-QUADRATIC MODEL.				
Independent Tests				
Parameter	Estimate	Standard Error	t-statistic	P-value
HOUSE	0.0000	0.0000	0.3208	[.748]
LOT	0.0003	0.0003	1.0397	[.298]
CITY	-0.0005	0.0015	-0.3314	[.740]
HWY	0.0227	0.0195	1.1663	[.244]
R_INT	-1.5240	3.6148	-0.4216	[.673]
GSP	0.0002	0.0039	0.0443	[.965]
PERPUB	16.4241	25.9339	0.6333	[.527]
PERADJ	-0.5785	1.8396	-0.3145	[.753]
Joint Tests				
Chi-squared(8):	3.3069	P-value:	0.9137	
F(8, 1269):	0.4134	P-value:	0.9134	

TABLE B3. "BEST" DEVELOPED ADJACENT MODEL ESTIMATION RESULTS.				
Dependent Variable:	Log(Price)			
F-statistic:	3.1662	D-W:	2.2039	
R-squared:	.5008	RESET:	0.1023	
Adj. R-squared:	.3426	LM Het. Test:	1.4453	
N:	134			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	7.5194	1.5995	4.7010	[.000]
HOUSE	0.0005	0.0003	2.0491	[.043]
LOT	0.0120	0.0028	4.2860	[.000]
CITY	0.0002	0.0036	0.0552	[.956]
HWY	0.0214	0.0141	1.5202	[.132]
GARAGE	0.3434	0.1613	2.1287	[.036]
UTIL	0.0698	0.2586	0.2700	[.788]
PRISON	-0.8160	0.5897	-1.3838	[.169]
ZONED	0.0271	0.3272	0.0828	[.934]
BR	0.6397	0.7856	0.8142	[.417]
D	-0.2997	0.1756	-1.7060	[.091]
MH	-0.4584	0.2193	-2.0906	[.039]
PAVE	0.4227	0.2356	1.7939	[.076]
HOME	0.0817	0.1675	0.4877	[.627]
PLAT	0.1109	0.3100	0.3578	[.721]
H2O	0.3672	0.2568	1.4299	[.156]
R_INT	-0.0033	0.1036	-0.0315	[.975]
GSP	0.0051	0.0037	1.3731	[.173]
REGNLP	-0.3270	0.4301	-0.7603	[.449]
PERPUB	1.8242	1.2883	1.4160	[.160]
CC	-1.6914	1.9325	-0.8752	[.384]
CC_P	4.1620	4.4518	0.9349	[.352]
SEED	-0.0927	0.7593	-0.1221	[.903]
THIN	3.0224	1.8653	1.6204	[.108]
THIN_P	-6.3259	4.3757	-1.4457	[.151]

Table B3 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
SEL	1.8088	1.5672	1.1541	[.251]
SEL_P	-3.2753	4.0656	-0.8056	[.422]
REM	0.6291	4.2261	0.1489	[.882]
REM_P	-0.8067	11.2561	-0.0717	[.943]
FED	0.0658	0.3161	0.2082	[.836]
PERADJ	0.1890	0.3397	0.5564	[.579]
CONIFER	-0.1364	0.1747	-0.7805	[.437]
HARDWOOD	-0.1275	0.1907	-0.6690	[.505]

TABLE B4. DEVELOPED ADJACENT ARTIFICIAL REGRESSION MODEL ESTIMATION RESULTS.				
Dependent Variable:	Log(Price)			
F-statistic:	2.6260	D-W:	2.2321	
R-squared:	0.5304	RESET:	0.0860	
Adj. R-squared:	0.3284	LM Het. Test:	1.3434	
N:	134			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	-35.6355	62.4360	-0.5708	[.570]
HOUSE	0.0012	0.0006	2.1672	[.033]
LOG(HOUSE)	-0.3860	0.3338	-1.1563	[.251]
LOT	0.0104	0.0048	2.1792	[.032]
LOG(LOT)	0.0394	0.1286	0.3065	[.760]
CITY	0.0060	0.0086	0.6977	[.487]
LOG(CITY)	-0.1972	0.6405	-0.3078	[.759]
HWY	0.0836	0.0388	2.1558	[.034]
LOG(HWY)	-0.4142	0.2727	-1.5190	[.132]
GARAGE	0.4059	0.1728	2.3489	[.021]
UTIL	-0.0269	0.3005	-0.0894	[.929]
PRISON	-0.5500	0.7824	-0.7029	[.484]
ZONED	0.2847	0.4659	0.6110	[.543]
BR	0.7712	0.8420	0.9159	[.362]
D	-0.2611	0.1862	-1.4025	[.164]
MH	-0.4412	0.2286	-1.9304	[.057]
PAVE	0.3697	0.2529	1.4620	[.147]
HOME	-0.0787	0.1919	-0.4102	[.683]
PLAT	0.1567	0.3566	0.4393	[.661]
H2O	0.3351	0.2841	1.1795	[.241]
R_INT	0.7970	1.5688	0.5080	[.613]
LOG(R_INT)	-6.4462	13.4948	-0.4777	[.634]
GSP	-0.0470	0.0629	-0.7467	[.457]
LOG(GSP)	11.9344	14.5290	0.8214	[.414]
REGNLP	-0.1006	0.5078	-0.1981	[.843]
PERPUB	7.2700	18.1955	0.3996	[.690]
LOG(PERPUB)	-7.8104	24.3361	-0.3209	[.749]

Table B4 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
CC	-2.3825	2.0206	-1.1791	[.241]
CC_P	5.8771	4.6644	1.2600	[.211]
SEED	-0.4627	0.7956	-0.5815	[.562]
THIN	3.7487	2.1220	1.7666	[.081]
THIN_P	-8.0556	4.9481	-1.6280	[.107]
SEL	2.1591	1.6296	1.3250	[.188]
SEL_P	-4.1754	4.2258	-0.9881	[.326]
REM	0.2247	4.4004	0.0511	[.959]
REM_P	0.6942	11.6745	0.0595	[.953]
FED	-0.0870	0.4368	-0.1992	[.843]
PERADJ	-1.9234	3.3028	-0.5824	[.562]
LOG(PERADJ)	2.9221	4.5350	0.6443	[.521]
CONIFER	-0.0999	0.1867	-0.5353	[.594]
HARDWOOD	-0.1010	0.2047	-0.4937	[.623]

TABLE B5. DEVELOPED ADJACENT MODEL ARTIFICIAL REGRESSION TESTS – QUADRATIC TERMS.				
Independent Tests				
Parameter	Estimate	Standard Error	t-statistic	P-value
HOUSE	0.0012	0.0006	2.1672	[.030]
LOT	0.0104	0.0048	2.1792	[.029]
CITY	0.0060	0.0086	0.6977	[.485]
HWY	0.0836	0.0388	2.1558	[.031]
R_INT	0.7970	1.5688	0.5080	[.611]
GSP	-0.0470	0.0629	-0.7467	[.455]
PERPUB	7.2700	18.1955	0.3996	[.689]
PERADJ	-1.9234	3.3028	-0.5824	[.560]
Joint Tests				
Chi-squared(8):	16.5301	P-value:	0.0354	
F(8, 1277):	2.0663	P-value:	0.0352	

TABLE B6. DEVELOPED ADJACENT MODEL ARTIFICIAL REGRESSION TESTS – LOGARITHMIC TERMS.				
Independent Tests				
Parameter	Estimate	Standard Error	t-statistic	P-value
HOUSE	-0.3860	0.3338	-1.1563	[.248]
LOT	0.0394	0.1286	0.3065	[.759]
CITY	-0.1972	0.6405	-0.3078	[.758]
HWY	-0.4142	0.2727	-1.5190	[.129]
R_INT	-6.4462	13.4948	-0.4777	[.633]
GSP	11.9344	14.5290	0.8214	[.411]
PERPUB	-7.8104	24.3361	-0.3209	[.748]
PERADJ	2.9221	4.5350	0.6443	[.519]
Joint Tests				
Chi-squared(8):	5.8650	P-value:	0.6624	
F(8, 1277):	0.7331	P-value:	0.6623	

Adjacent Vacant Model

TABLE B7. LOG-QUADRATIC VACANT ADJACENT MODEL ESTIMATION RESULTS.				
Dependent Variable:	Log(Price)			
F-statistic:	4.2675	D-W:	1.8115	
R-squared:	0.5530	RESET:	1.3951	
Adj. R-squared:	0.4234	LM Het. Test:	0.5338	
N:	179			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	119.2046	105.4498	1.1304	[.260]
LOT	0.0281	0.0047	5.9375	[.000]
LOT2	-0.0001	0.0000	-4.0673	[.000]
LOT3	0.0000	0.0000	3.4600	[.001]
CITY	-0.0322	0.0611	-0.5272	[.599]
CITY2	0.0008	0.0007	1.1032	[.272]
CITY3	0.0000	0.0000	-1.3200	[.189]
HWY	0.0700	0.1012	0.6921	[.490]
HWY2	-0.0219	0.0176	-1.2438	[.216]
HWY3	0.0011	0.0007	1.4209	[.158]
UTIL	-0.5375	0.7108	-0.7563	[.451]
PRISON	1.0348	1.4949	0.6923	[.490]
ZONED	0.7988	0.3921	2.0372	[.044]
PAVE	0.2220	0.2050	1.0829	[.281]
PLAT	-0.1351	0.2533	-0.5335	[.595]
H20	0.5236	0.2331	2.2460	[.026]
R_INT	-41.7587	27.8466	-1.4996	[.136]
R_INT2	4.8053	3.1638	1.5189	[.131]
R_INT3	-0.1833	0.1189	-1.5412	[.126]
GSP	0.0510	0.5325	0.0957	[.924]
GSP2	-0.0004	0.0023	-0.1640	[.870]
GSP3	0.0000	0.0000	0.2394	[.811]
REGNLP	0.9029	0.4479	2.0157	[.046]
PERPUB	34.0567	138.9542	0.2451	[.807]
PERPUB2	-43.5348	292.2051	-0.1490	[.882]
PERPUB3	11.9426	188.4530	0.0634	[.950]

Table B7 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
CC	0.1059	0.5692	0.1861	[.853]
CC_P	-0.0994	1.1035	-0.0901	[.928]
SEED	0.4110	0.4301	0.9557	[.341]
THIN	-0.1802	0.7586	-0.2375	[.813]
THIN_P	0.8300	1.4700	0.5646	[.573]
SEL	0.0125	0.9939	0.0125	[.990]
SEL_P	1.4314	2.3343	0.6132	[.541]
REM	-0.7816	0.8346	-0.9365	[.351]
REM_P	0.9690	1.4706	0.6589	[.511]
FED	-0.7523	0.5282	-1.4241	[.157]
PERADJ	0.7364	1.5612	0.4717	[.638]
PERADJ2	-1.0652	4.2101	-0.2530	[.801]
PERADJ3	0.5161	3.0747	0.1679	[.867]
CONIFER	-0.1247	0.1340	-0.9304	[.354]
HARDWOOD	0.2461	0.1744	1.4110	[.160]

TABLE B8. TESTS OF SQUARED AND CUBED COEFFICIENTS OF ADJACENT VACANT LOG-QUADRATIC MODEL.				
Independent Tests				
Parameter	Estimate	Standard Error	t-statistic	P-value
LOT	-0.0001	0.0000	-4.0680	[.000]
CITY	0.0008	0.0007	1.1024	[.270]
HWY	-0.0209	0.0169	-1.2351	[.217]
R_INT	4.6220	3.0449	1.5180	[.129]
GSP	-0.0004	0.0023	-0.1639	[.870]
PERPUB	-31.5922	106.0576	-0.2979	[.766]
PERADJ	-0.5491	1.3688	-0.4011	[.688]
Joint Tests				
Chi-squared(7):	26.0561	P-value:	0.0005	
F(7, 1294):	3.7223	P-value:	0.0006	

TABLE B9. "BEST" LOG-LINEAR VACANT ADJACENT MODEL ESTIMATION RESULTS.				
Dependent Variable:	Log(Price)			
F-statistic:	5.7530	D-W:	1.7918	
R-squared:	0.5178	RESET:	2.2086	
Adj. R-squared:	0.4278	LM Het. Test:	0.4532	
N:	179			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	8.0181	1.4321	5.5989	[.000]
LOT	0.0291	0.0041	7.0804	[.000]
LOT2	-0.0001	0.0000	-5.5176	[.000]
LOT3	0.0000	0.0000	4.7283	[.000]
CITY	-0.0026	0.0035	-0.7456	[.457]
HWY	-0.0043	0.0130	-0.3311	[.741]
UTIL	-0.7475	0.6726	-1.1114	[.268]
PRISON	0.1345	0.5493	0.2449	[.807]
ZONED	0.8706	0.2119	4.1076	[.000]
PAVE	0.1124	0.1873	0.6000	[.549]
PLAT	-0.2441	0.2344	-1.0415	[.299]
H2O	0.4121	0.2050	2.0101	[.046]
R_INT	-0.1198	0.0829	-1.4449	[.151]
GSP	0.0018	0.0026	0.6993	[.485]
REGNLP	0.3359	0.3780	0.8886	[.376]
PERPUB	2.1840	1.4845	1.4712	[.143]
CC	-0.3600	0.5358	-0.6720	[.503]
CC_P	0.6625	1.0452	0.6339	[.527]
SEED	0.2538	0.4164	0.6095	[.543]
THIN	-0.0342	0.7142	-0.0478	[.962]
THIN_P	0.4880	1.3918	0.3506	[.726]
SEL	0.1026	0.8777	0.1169	[.907]
SEL_P	0.8400	1.9748	0.4254	[.671]
REM	-0.8946	0.8045	-1.1120	[.268]
REM_P	1.1395	1.4112	0.8075	[.421]
FED	-0.8328	0.2058	-4.0459	[.000]
PERADJ	0.2608	0.2565	1.0167	[.311]
CONIFER	-0.1280	0.1258	-1.0174	[.311]
HARDWOOD	0.1580	0.1538	1.0272	[.306]

TABLE B10. VACANT ADJACENT ARTIFICIAL REGRESSION MODEL ESTIMATION RESULTS.

Dependent Variable:	Log(Price)			
F-statistic:	4.7501	D-W:	1.7237	
R-squared:	0.5376	RESET:	0.5404	
Adj. R-squared:	0.4244	LM Het. Test:	0.1300	
N:	179			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	43.7754	45.4683	0.9628	[.337]
LOT	0.0140	0.0090	1.5482	[.124]
LOT2	-0.0001	0.0000	-2.0030	[.047]
LOT3	0.0000	0.0000	1.9763	[.050]
LOG(LOT)	0.3050	0.1498	2.0360	[.044]
CITY	-0.0040	0.0089	-0.4555	[.649]
LOG(CITY)	-0.0821	0.7042	-0.1166	[.907]
HWY	0.0054	0.0317	0.1713	[.864]
LOG(HWY)	-0.0517	0.2018	-0.2561	[.798]
UTIL	-0.7352	0.6967	-1.0553	[.293]
PRISON	0.1677	0.5907	0.2840	[.777]
ZONED	0.9378	0.3356	2.7943	[.006]
PAVE	0.0735	0.2002	0.3673	[.714]
PLAT	-0.0395	0.2635	-0.1500	[.881]
H20	0.3756	0.2106	1.7835	[.077]
R_INT	-1.4363	1.3983	-1.0271	[.306]
LOG(R_INT)	11.0358	12.0029	0.9194	[.359]
GSP	0.0464	0.0464	1.0015	[.318]
LOG(GSP)	-10.5568	10.7825	-0.9791	[.329]
REGNLP	0.3296	0.3826	0.8613	[.390]
PERPUB	17.8651	54.1568	0.3299	[.742]
LOG(PERPUB)	-22.7048	80.9337	-0.2805	[.779]
CC	-0.3488	0.5446	-0.6405	[.523]
CC_P	0.6668	1.0572	0.6307	[.529]
SEED	0.1160	0.4266	0.2720	[.786]

Table B10 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
THIN	-0.0304	0.7379	-0.0412	[.967]
THIN_P	0.3805	1.4242	0.2671	[.790]
SEL	-0.0008	0.9268	-0.0008	[.999]
SEL_P	1.0671	2.1115	0.5054	[.614]
REM	-0.6612	0.8243	-0.8021	[.424]
REM_P	0.9791	1.4457	0.6773	[.499]
FED	-0.8651	0.2925	-2.9580	[.004]
PERADJ	-1.1143	2.5304	-0.4404	[.660]
LOG(PERADJ)	1.7937	3.3955	0.5283	[.598]
CONIFER	-0.0969	0.1299	-0.7459	[.457]
HARDWOOD	0.1323	0.1672	0.7912	[.430]

TABLE B11. VACANT ADJACENT MODEL ARTIFICIAL REGRESSION TESTS – QUADRATIC TERMS.				
Independent Tests				
Parameter	Estimate	Standard Error	t-statistic	P-value
LOT	0.0139	0.0090	1.5458	[.122]
CITY	-0.0040	0.0089	-0.4555	[.649]
HWY	0.0054	0.0317	0.1713	[.864]
R_INT	-1.4363	1.3983	-1.0271	[.304]
GSP	0.0464	0.0464	1.0015	[.317]
PERPUB	17.8651	54.1568	0.3299	[.741]
PERADJ	-1.1143	2.5304	-0.4404	[.660]
Joint Tests				
Chi-squared(7):	3.8632	P-value:	0.7954	
F(7, 1299):	0.5519	P-value:	0.7967	

TABLE B12. VACANT ADJACENT MODEL ARTIFICIAL REGRESSION TESTS – LOGARITHMIC TERMS.				
Independent Tests				
Parameter	Estimate	Standard Error	t-statistic	P-value
LOT	0.3050	0.1498	2.0360	[.042]
CITY	-0.0821	0.7042	-0.1166	[.907]
HWY	-0.0517	0.2018	-0.2561	[.798]
R_INT	11.0358	12.0029	0.9194	[.358]
GSP	-10.5568	10.7825	-0.9791	[.328]
PERPUB	-22.7048	80.9337	-0.2805	[.779]
PERADJ	1.7937	3.3955	0.5283	[.597]
Joint Tests				
Chi-squared(7):	6.1186	P-value:	0.5260	
F(7, 1299):	0.8741	P-value:	0.5274	

TABLE B13. FINAL DEVELOPED ADJACENT MODEL ESTIMATION RESULTS WITHOUT OUTLIERS.				
Dependent Variable:	Log(Price)			
F-statistic:	4.90	D-W:	2.1609	
R-squared:	0.5969	RESET:	0.0038	
Adj. R-squared:	0.4752	LM Het. Test:	0.0826	
N:	134			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	7.4079	1.5820	4.68	.0001
HOUSE	0.0006	0.0002	2.76	.0068
LOT	0.0112	0.0023	4.89	.0001
CITY	-0.0005	0.0029	-0.17	.8687
HWY	0.0277	0.0122	2.26	.0260
GARAGE	0.3930	0.1373	2.86	.0051
PRISON	-0.6925	0.6354	-1.09	.2786
ZONED	0.0109	0.2548	0.04	.9660
D	-0.3545	0.1501	-2.36	.0202
MH	-0.4296	0.1816	-2.37	.0200
PAVE	0.3680	0.1817	2.03	.0456
HOME	0.0208	0.1424	0.15	.8843
PLAT	-0.0026	0.0046	-0.56	.5739
H20	0.2408	0.2105	1.14	.2555
R_INT	0.0120	0.0848	0.14	.8873
GSP	0.0056	0.0031	1.82	.0714
REGNLP	-0.4316	0.4088	-1.06	.2937
PERPUB	1.8569	1.7344	1.07	.2870
CC	-1.3270	1.6702	-0.79	.4289
CC_P	3.4349	3.8346	0.90	.3726
THIN	3.6728	1.5573	2.36	.0204
THIN_P	-8.0453	3.6573	-2.20	.0302

Table B13 (continued).				
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
SEL	1.7800	1.3140	1.35	.1787
SEL_P	-3.2191	3.4248	-0.94	.3496
REM	2.1433	3.5398	0.61	.5463
REM_P	-4.9792	9.4368	-0.53	.5990
FED	0.1336	0.2696	0.50	.6213
PERADJ	-0.0235	0.2897	-0.08	.9354
CONIFER	0.0103	0.1480	0.07	.9447
HARDWOOD	-0.1061	0.1547	-0.69	.4944

TABLE B14. FINAL VACANT ADJACENT MODEL ESTIMATION RESULTS WITHOUT OUTLIERS.

Dependent Variable:	Log(Price)			
F-statistic:	11.24	D-W:	2.0520	
R-squared:	0.6691	RESET:	0.0253	
Adj. R-squared:	0.6096	LM Het. Test:	0.0352	
N:	179			
Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	4.0736	1.2336	3.30	.0012
Log(LOT)	0.4623	0.0430	10.76	.0001
CITY	0.0067	0.0035	1.95	.0535
HWY	-0.0040	0.0105	-0.38	.7056
PRISON	-0.2616	0.6427	-0.41	.6846
ZONED	0.4173	0.1997	2.09	.0385
PAVE	0.1145	0.1641	0.70	.4866
PLAT	0.0035	0.0050	0.69	.4930
H20	0.2200	0.1851	1.19	.2369
R_INT	0.0223	0.0664	0.34	.7372
GSP	0.0053	0.0021	2.55	.0120
REGNLP	0.5958	0.4846	1.23	.2210
PERPUB	3.9618	1.4757	2.68	.0081
CC	-0.6655	0.4477	-1.49	.1394
CC_P	1.3616	0.8862	1.54	.1267
SEED	0.0730	0.3278	0.22	.8241
THIN	0.7073	0.7789	0.91	.3654
THIN_P	-0.9945	1.6255	-0.61	.5417
SEL	0.5503	0.7037	0.78	.4355
SEL_P	0.1200	1.5822	0.08	.9397
REM	-0.6264	0.6765	-0.93	.3560
REM_P	1.4843	1.2734	1.17	.2458
FED	-0.4400	0.2257	-1.95	.0533
PERADJ	0.4579	0.2011	2.28	.0243
CONIFER	-0.0541	0.0985	-0.55	.5836
HARDWOOD	0.0955	0.1209	0.79	.4309