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HAZARDS AND AMENITIES:
EXAMINING THE BENEFITS OF HAZARDOUS WASTE CLEAN-UP
AND SUPPORT FOR FARMLAND PRESERVATION

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HAZARDS AND AMENITIES: EXAMINING THE BENEFITS OF HAZARDOUS WASTE CLEAN-UP AND SUPPORT FOR FARMLAND PRESERVATION

By

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ABSTRACT

HAZARDS AND AMENITIES: EXAMINING THE BENEFITS OF HAZARDOUS WASTE CLEAN-UP AND SUPPORT FOR FARMLAND PRESERVATION

By

Brady J. Deaton, Jr.

Allocating resources to achieve land use objectives can be informed by examining the opportunity costs associated with those objectives. However, applying the concept of opportunity cost is particularly difficult because land is not homogenous. Rather, each land parcel is differentiated from others by its own set of distinct attributes which includes the character of surrounding land and its uses. Therefore, even after the end objectives of a land use policy are agreed on, the means of achieving those objectives are likely to be complicated by the heterogeneity in any particular parcel of land and in the character of its surroundings. The research and analytical methods described in this dissertation are designed to address these complications as they present themselves in two land use issues of contemporary importance in Michigan and throughout the United States: hazardous waste clean-up and farmland preservation.

The first essay examines the effect of hazardous waste sites on residential property values in Lansing, Michigan. A hedonic price function is estimated and interpreted to suggest that increased exposure to hazards is negatively capitalized into housing prices. Thus, the benefit of clean-up is estimated to be positive. However, increased proximity to areas of high industrial activity is also found to be negatively capitalized into housing prices. Failure to account for areas of high industrial activity is shown to overstate the

effect of hazardous waste sites on property values, which, in turn inflates benefit estimates associated with hazardous waste clean-up.

The second essay examines factors that motivate public support for farmland preservation. The influence that farmland attributes have on public support for farmland preservation is examined with data collected from a door-to-door survey conducted in Kent County, Michigan. Residents were provided with a hypothetical referendum scenario designed to elicit a vote for or against a proposal to support a County initiative to preserve farmland. The household cost of the program and the farmland attributes were varied by the survey design. The survey results are interpreted to suggest that respondents are more likely to support a farmland preservation initiative if it is designed to preserve farmland located in an area of the County referred to as the Fruit Ridge. Variations in described levels of agricultural productivity or environmental quality, did not significantly influence the likelihood that respondents would support farmland preservation.

DEDICATION

To my parents Anne and Brady Deaton,
and my wife and son, Justine Richardson and William Brady Deaton.

ACKNOWLEDGMENTS

I want to express my deepest gratitude to each member of my committee, the faculty and staff of the department of Agricultural Economics, and my fellow graduate students. Together they formed a community of support and made this challenging voyage a somewhat smoother passing. The consistent theme of this group has been one of good will and I will endeavor to pass this theme on.

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Finally, I am particularly grateful to my family. They have contributed greatly to my research effort but more importantly they have brought meaning, joy, laughter, and love, to the continual series of events that I refer to as *my life*.

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INTRODUCTION

Public action to influence the allocation of resources to shape urban and rural environments is an evolving and important component of contemporary public policy. Significant levels of public funds are spent cleaning up hazardous waste sites, re-using former industrial areas, and preserving farmland, wetlands and forests, to mention a few examples. Economists are often involved in these policies and their influence manifests itself in a number of analytical approaches, generally involving analyses that clarify the opportunity costs of one policy design versus another. Understanding these tradeoffs, in some instances, can lead to policy design that is welfare enhancing from the normative standpoint of efficiency.

Applying the concept of opportunity costs to land use policy is made particularly difficult because land is not homogenous. Rather, each land parcel is differentiated from others by its own set of distinct attributes which includes the character of surrounding land and its uses. Therefore, even after the end objectives of a land use policy are agreed on, the means of achieving those objectives are likely to be complicated by the heterogeneity in any particular parcel of land and in the character of its surroundings. The research and analytical methods described in this dissertation are designed to address these complications as they present themselves in two land use issues of contemporary importance throughout the United States and in Michigan: hazardous waste clean-up and farmland preservation.

The first analysis '*Estimating the Benefits of Hazardous Waste Clean-Up in areas of High Industrial Activity: A Hedonic Approach*', estimates a hedonic price function

using 4,502 housing observations in Lansing, Michigan from 1992 to 2000. The estimated coefficients on the hedonic price function are interpreted to suggest that increased exposure to Superfund sites, sites identified by the Environmental Protection Agency as posing significant health threats, is negatively capitalized into housing prices; and, therefore, the benefits of clean-up is estimated to be positive. However, increased proximity to areas of high industrial activity is also found to be negatively capitalized into housing prices. Moreover. Superfund sites and areas of high industrial activities are spatial correlates in the Lansing area.

In this case study, failure to take into account areas of high industrial activity, as much of the previous literature has done, is shown to inflate benefit estimates of hazardous waste clean-up. Accordingly, if hazardous waste sites and areas of high industrial activity are spatial correlates in other urban areas, as is likely the case, more efficient allocations of public funds can be achieved by considering the residential and industrial character of surrounding land uses.

The second analysis '*Support for Farmland Preservation: The Influence of Farmland Attributes and Respondent Characteristics*' examines the public objectives associated with farmland preservation. A stratified random sample of residents of Kent County, Michigan was drawn and a door-to-door survey was conducted in August 2001. The survey was designed to simulate a hypothetical voting scenario in which respondents were asked to vote on farmland preservation proposals that varied by cost of the program to the household, agricultural productivity, environmental quality, and location.

The results of the survey are consistent with standard economic expectations, increases in the level of costs presented to the respondent decrease the probability that a

respondent will support the farmland preservation program. Higher levels of household income increase the likelihood that a respondent will support the proposed farmland preservation program. However, the influence of farmland attributes on respondent choice was less clear.

The empirical results suggest that respondents are less willing to support a farmland preservation initiative if the farmland to be preserved is characterized as having relatively lower levels of agricultural productivity. Alternatively, if the farmland to be preserved was targeted towards a unique area of Kent County referred to as the 'Fruit Ridge', respondents appear to more likely to support the preservation initiative. Surprisingly, variation in the environmental quality of the farmland to be preserved, as described in the survey, did not appear to influence the likelihood that one would support a farmland preservation initiative. Similarly, the probability of support for the farmland preservation initiative did not appear to be influenced by farmland characterized as having relatively higher levels of agricultural productivity or farmland characterized as being located next to highways.

Currently the Kent County government is considering a farmland preservation initiative to preserve 50 percent of the farmland in Kent County. The research findings suggest that respondents are very sensitive to the costs of the program. Moreover, public support for these programs may vary depending on which land is targeted for preservation. The empirical results in this analysis suggest that land in the 'Fruit Ridge' is likely to be associated with increased public benefits. Clearly the benefits of targeting one parcel of land versus another may also need to consider the relative costs of those parcels.

The Road Ahead

Philosophies of land use have been presented by such authorities as the Old Testament (see Leviticus), Plato, Locke, and countless other revered philosophers and philosophies. Indeed, much of contemporary geopolitics attests to the continuing disagreements about land use policies. Neither philosophers nor political leaders have solved the issues of how and for whom the land should be used. One role of economic analysis and education is to clarify concepts and use analytical methods that enlighten public understanding of land use issues. Simply put, land use policy is likely to be continually complicated and debated, in part because land is differentiated and its use, particularly in urbanizing areas, almost always influences the well being of another in a non-trivial way.

Economists enter the debate with a set of concepts and analytical tools that are useful to decision makers as they ask questions and as they weigh the tradeoffs of their decisions. The challenge, I believe, for improving land use policy will be for economist to extend the concept of opportunity costs to each level of decision making in the political processes that give rise to policy. In this way economic analyses can improve public understanding and development of the initial land use objective as well as detailing policies that achieve these objectives efficiently.

ESSAY 1:
ESTIMATING BENEFITS TO HAZARDOUS WASTE CLEAN-UP IN AREAS OF HIGH INDUSTRIAL ACTIVITY: A HEDONIC APPROACH

1.1. Introduction

An extensive literature assesses the perceptual benefits that result from reduced exposure to environmental hazards (see Farber, 1998). Many of these studies use a distance-to-hazard measure to account for variation in levels of perceived exposure. Perceived exposure to environmental hazards is assumed to decline as distance between a hazard and a person(s) increases. The distance-to-hazard measure is consistent with health risk models, many of which incorporate a measure of distance between the hazard and population exposed (Gayer and Viscusi, 2000; Viscusi and Hamilton, 1999). Moreover, the distance-to-hazard measure seems consistent with public perceptions; studies suggest an inverse relationship between public opposition to undesirable land uses and one's proximity to the undesirable land use site (Farber, 1998). However, in some cases hazardous waste sites may be spatially correlated with areas of high industrial activity. Failure to account for this relationship may bias empirical examinations which seek to evaluate the deleterious effects of hazardous waste sites on property values and/or the benefits of hazardous waste clean-up.

Smith and Desvousges (1986) employed a contingent valuation method (CVM) to estimate the benefits associated with increased distance from hazardous waste sites. Their survey of homeowners, in the suburbs of Boston, found that people were willing to pay a premium for housing farther away from hazardous waste sites, all else constant (Smith and Desvousges, 1986). While their survey design does not assert a featureless

plain to the respondent, it asks the respondent to hold other spatial features constant as distance between a residence and an undesirable land use increases. Such is the case in several studies that examine the property value effect that results from perceived exposure to hazards.

Kohlhase (1991) employed a hedonic property model to examine the effect on property values of exposure to hazardous waste sites in the Houston area. Kohlhase's findings suggest a premium for reduced exposure to hazardous waste sites after the sites were identified as significant hazards warranting attention by the Environmental Protection Agency (EPA). In the empirical analysis, perceptions of exposure were assumed to be a function of distance and, hence, omitted spatial features are implicitly assumed to be randomly distributed throughout the spatial area. Kiel and Zabel (2001) employed the hedonic method in a similar manner and used the coefficient estimate from the distance-to-hazard variable to estimate benefits of cleaning up hazardous waste sites (Superfund sites).

A more robust spatial approach to examining the benefits of reduced exposure to hazards appears in Gayer and Viscusi's analysis of marginal willingness to pay for reduced risk (2000). Included in their hedonic price function are a number of other spatial features that are expected to also influence housing prices.[1] Increased proximity to these variables had a statistically significant effect on housing values. Hite et al., (2001) also incorporated other spatial features in their hedonic analysis examining the property-value impacts of landfills. The authors used the standard-distance to hazard measure to

[1] See Gayer and Viscusi (2000), pg. 445, for a detailed description.

estimate the property-value impacts of landfills and a series of dummy variables to measure the property value effects associated with relative proximity to other environmental disamenities (i.e. railroads, freeways, airports) and amenities (i.e. parks and golf courses). The importance of the additional spatial variables appears to depend on the market segment (urban or suburban) under consideration (Hite, et al., 2001). Both Hite et al., and Gayer and Viscusi, provide empirical results that suggest housing prices are influenced by the presence of other spatial features.

Morris and Perle (1999) argue that a logical spatial relationship exists between areas of high industrial activity and hazardous waste. Their argument centers around two key observations: (1) hazardous waste is a by-product of industrial processes and (2) transportation costs are positive. Given these observations the authors were not surprised to find that the majority of hazardous waste sites in Wayne County, MI were located in industrial corridors , which, in turn, are associated with railroad networks and river fronts (Morris and Perle, 1999).

This paper's analysis extends previous research in two ways. First it incorporates a measure of industrial activity into analysis designed to examine the effect of hazards on property. Second, it explicitly examines the empirical and practical significance of omitting the industrial measure. The approach taken is to estimate a hedonic price function for approximately 4,502 housing sales in Lansing, Michigan between 1992-2000. The relative proximity of each house to one of two prominent hazardous waste sites (Superfund sites) provides a proxy measure of perceived levels of exposure to the health risks and nuisances associated with the presence of hazardous waste sites. In addition, a similar measure is used to provide a proxy measure of perceived exposure to the

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disamenities of high industrial activity. The results examine the extent to which the housing prices are altered by perceived exposure to hazardous waste sites and industrial areas. Moreover, the results examine the primary research hypothesis that the omission from the analysis of measures of high industrial areas tends to inflate benefit estimates of reduced exposure to hazardous waste sites. Given the magnitude of expenditures on hazardous waste cleanups, examining this bias is of relevance to policy makers.[2]

The next section provides the theoretical background for the hedonic approach. The third section develops the empirical model and identifies the method used to explore the primary research hypothesis. The fourth section describes the area of study. The fifth section reviews the method of data collection. The sixth section provides empirical estimates. The seventh section uses the estimated hedonic price function to measure the benefits of hazardous waste clean-up. The sensitivity of these benefit estimates to omission of variables that account for industrial activity is examined. The final sections provide a summary of the key findings and research implications.

1.2. Hedonic Model

The hedonic hypothesis is that goods are valued for their utility-bearing attributes (Rosen, 1974). In a competitive housing market, buyers are assumed to evaluate attributes of housing and decide which 'bundle' of attributes the buyer is willing to purchase. The implicit price of each attribute will be determined by demand for and supply of these attributes. Freeman (1993) suggests the following thought experiment: Imagine a group of buyers going to a grocery store and finding a supply of grocery carts

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[2] For example between 1991 and 1996 the EPA spend approximately 25% of its budget on hazardous waste clean-up (Hamilton and Viscusi, (1999).

with varying bundles of varying types of groceries. The challenge to the buyers in the grocery store is to sort themselves between the grocery carts. The process of sorting occurs via a bidding process that will reflect preferences and the relative supplies of various groceries in the grocery carts. Equilibrium is said to occur when no buyer in the grocery store is willing to trade his or her grocery cart.

In the housing market buyers are assumed to sort themselves in a manner similar to that described by Freeman's thought experiment. Thus, the final price paid for housing is expected to reflect variation in housing attributes as well as income constraints. "Under competitive conditions, an hedonic equilibrium requires that the change in price of a house in response to a change in any attribute (at given levels of other attributes) exactly equals the marginal bid and marginal offer of the buyers and sellers for that characteristic (Smith and Huang, 1995)." Thus, hedonic price functions, which specify final housing prices as a function of housing attributes are often used to estimate marginal willingness to pay for specific attributes.

If levels of a non-market attribute (i.e. disamenities associated with hazardous waste sites) can be correctly measured, a hedonic price function can be specified to examine the extent to which variation in the non-market attribute is incorporated in the price of the final product. The general form of the hedonic (h) price function is:

$$P_{h_i} = P_h(z_i) \tag{1}$$

so that the price (P) of the *ith* housing unit is a function of the vector of attributes associated with the *ith* house. These attributes are often categorized as 'structural',

'neighborhood', and 'environmental'. Structural attributes include features like the square footage of floor area, the number of bathrooms, and the acreage on which the house sits. 'Neighborhood' attributes are often used to characterize the socio-demographic character of the area. Numerous studies have detailed a relationship between housing prices and the socio-demographic features of the neighborhood surrounding the home (Cutler, et al., 1999; Massey and Denton, 1988). 'Environmental' attributes often refer to amenities or disamenities that result from some use of the land, air, or water. Prominent examples include air quality, noise, exposure to hazardous waste sites, proximity to parks and other open spaces.

This research is particularly concerned with the influence that perceptions of exposure to hazards may have on housing prices. Examining this effect using a hedonic price function requires some way of measuring variation in this attribute. As discussed earlier, a distance-to-hazard measure is often used as a proxy measure for these perceptions. Increases in the distance between a home and an environmental hazard is expected to be associated with higher housing values, all else constant (see Farber, 1998).

Figure 1.1 illustrates the relationship between changes in the level of exposure to a hazard and housing prices. At a high level of exposure housing prices would be expected to be quite low. For example, a home located adjacent to a toxic waste site that emits life threatening toxins would be expected to sell for very little. However, as figure 1.1 illustrates, the price of the house is expected to increase as the level of perceived exposure to the hazard is reduced. The perceived level of exposure is expected to fall as

distance between the home and the hazardous waste site increases. Freeman (1993) notes that there are a priori reasons to expect the hedonic price function to be concave from below. As households approach a zero level of perceived exposure their implicit willingness-to-pay for a reduction in exposure to the hazard is expected to diminish.

Each point on the hedonic price function, under a competitive market assumption, represents the tangency of a supplier's offer curve and a buyer's bid curve. A large body

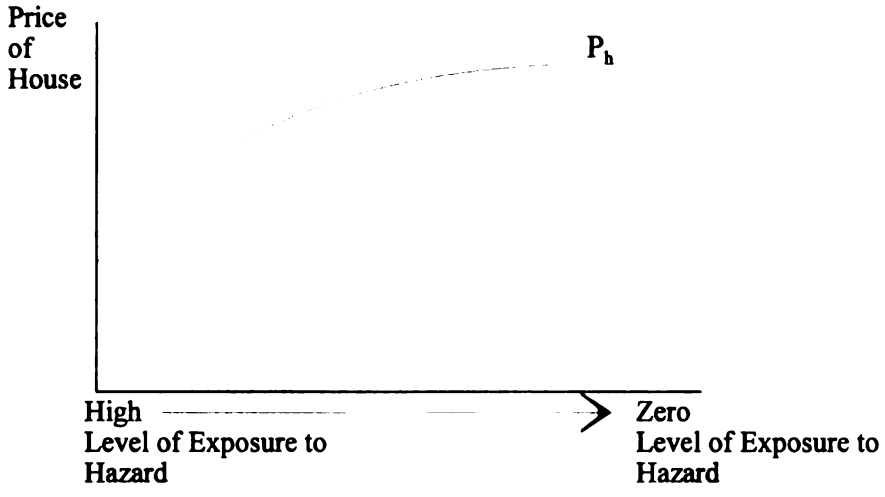

Figure 1.1. Hedonic Price Function (P_h)

of literature discusses the difficulty of using coefficients from the hedonic price function to derive welfare measures. Freeman (1993) provides a review of this literature. The difficulty in deriving welfare estimates from the hedonic price function stems from the relationship that the hedonic price function measures. The hedonic price function is measuring the locus of demand and supply; an envelope of equilibrium points where individuals' bid schedules are just tangent to sellers offer schedules. This equilibrium

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relationship poses potential problems of identification (Rosen, 1974) and endogeneity (Bartik, 1987).

However, for marginal changes, the derivative of the hedonic price function with respect to the pollution variable (i.e., distance) has been shown to be equivalent to marginal value or marginal willingness to pay (Small, 1975). Aggregating marginal willingness to pay for households in a given area is one method of obtaining a benefit estimate from the hedonic price function.

Freeman (1993) describes a special case in which the hedonic price function itself can be used to measure economic benefits that result from non-marginal changes in the levels of an environmental disamenity. This case is relevant when the number of the properties affected by the disamenity is small and 'localized' relative to the size of the housing market. In this scenario the hedonic price function is not expected to shift due to changes in the level of the disamenity. Cleaning up a localized disamenity will increase the property value and thereby increase the actual or implicit rent associated with living in that house. If moving is costless residents can move back to their original equilibrium point on the hedonic price function. In this scenario the change in property value associated with cleaning-up the localized disamenity is a net-welfare measure. Freeman (1993) provides a detailed discussion of this special case (see pg. 397).

1.3. Empirical Model and Testable Hypotheses

A hedonic price function is specified such that the price of a residential home is assumed to be a function of the bundle of attributes that characterize the home and the year that the home was sold. The empirical specification of the hedonic price function is:

$$(2) \qquad \ln(P_i) = \beta_0 + \beta_1 \ln(D_i^H) + \beta_2 \ln(D_i^I) + \Theta Z_i + \Phi Y_i + u_i$$

where, the price of house, i, is determined by: (1) proximity to hazardous waste sites, D^H; (2) proximity to areas of high industrial activity, D^I; (3) a vector of attributes that describe the house and the character of the neighborhood in which the house resides, Z_i; (4) and, a set of dummy variables to account for the year in which the house was sold, Y_i. The error term, u_i, is assumed to have a conditional mean of zero and a constant variance. The functional form assumes a log-log relationship between price of the house and proximity to the hazardous waste site and proximity to areas of high industrial activity. The remaining relationships between housing price and housing attributes are specified as a log-level function, with the exception of floor area and age of the house which also appear in logarithmic form. The full set of variables used to estimate the hedonic price function are provided in table 1.

Table 1.1. Variables Collected for Regression Analysis and Description

Variable	Description of Variable
Dependent Variable	
Price	Final housing sale price for years between 1992-2000.
Hazard and Industrial Variables	
Hazard	Distance from each home to the nearest superfund site in meters.
Industrial	Distance from each home to the nearest perimeter of an area zoned as 'highly industrial', in meters.
Housing Structure Variables	
Bath	# of bathrooms in each house sold..
Floor	Residential floor area in square feet.
Age	Effective age of the house when sold.
Acre	Total acreage sold with the house.
sty 11/4*	= 1, if 1.25 story home; 0 otherwise.
sty 11/2	= 1, if 1.5 story home; 0 otherwise.
sty 13/4	= 1, if 1.75 story home; 0 otherwise.
Sty2	= 1, if 2 story home; 0 otherwise.
dumstyle	= 1, if raised ranch, tri-level, or 21/2 story home; 0 otherwise.
Neighborhood Variables	
Crime	# of Malicious Destruction of Property Violations by block group for 1996.
Income	Median household income, by block group.
Edu	Percentage of persons with a college degree, by block group.
Black	Percentage of the population that is black, non-hispanic, by block group.
Hisp	Percentage of population that is hispanic, by block group.
Rent	Percentage of the households that rent, by block group.
Commute	Percentage of those whose commute to work is less than 20 minutes; by block group.
Year Variables	
dum93**	=1 if year = 1993; 0 otherwise.
dum94	=1 if year = 1994; 0 otherwise.
dum95	=1 if year = 1995; 0 otherwise.
dum96	=1 if year = 1996; 0 otherwise.
dum97	=1 if year = 1997; 0 otherwise.
dum98	=1 if year = 1998; 0 otherwise.
dum99	=1 if year = 1999; 0 otherwise.
dum2000	=1 if year = 2000; 0 otherwise.

* 1 story house is the omitted variable.

**1992 is the omitted variable.

Of particular interest is the price effect that results from perceptions of exposure to the heath risks and/or disamenities that emanate from proximity to hazardous waste sites and areas of high industrial activity. The 'hazard' variable, D^H, measures distance from each house i to the nearest hazardous waste site listed on the EPA's National Priorities List in Lansing. This measure is used as a proxy measure for the relative exposure to the hazards. Reduced proximity to the hazardous waste site is expected to proxy reduced exposure to the hazardous waste site. Increases in D^H is hypothesized to be positively associated with a higher housing price. Thus β_1, is hypothesized to be positive.

Residents are also expected to value reduced exposure to areas of high industrial activity. Decreased exposure to areas of high industrial activity is, therefore, expected to be associated with higher housing values. Thus, increases in the 'industrial' variable D^I, which measure each home's straight line distance to the perimeter of the nearest area zoned as highly industrial, is expected to be associated with higher housing values. Therefore β_2, is hypothesized to be positive.

The price effect associated with exposure to hazard is hypothesized to be overestimated by failure to account for the price effect that results from exposure to the disamenities of industrial areas. Equation three illustrates the biased relationship in the coefficient estimate for β_1 if the industrial variable is omitted from estimation of the hedonic price function.

$$E(\tilde{\beta}_1) = \beta_1 + \beta_2 \frac{\sum_{i=1}^{n} (\ln D_i^H - \ln \bar{D}_i^H) \ln D_i^I}{Var(\ln D_i^H)} \quad (3)$$

The beta coefficients are consistent with those defined in equation 2. Equation 3 implicitly assumes that the correlation between the other explanatory variables and the industrial or hazard variables is zero (see Wooldridge, pg. 92 for detailed discussion). As equation 3 illustrates, an inflated estimate of the hazard coefficient is expected if the industrial coefficient β_2 is positive and statistically significant and the correlation between the hazard and industrial variables is positive (Wooldridge, 1999).

Table 1.1 describes the full set of variables used to estimate the hedonic price function. Increases in the number of bathrooms, square footage, floor area, and acreage of the home are expected to be associated with increases in housing price, all else constant. Increases in the age of the home are expected to be associated with a decline in housing values, all else constant. The price effect associated with the style of the home (1 story versus 2 story) is uncertain given the fact that the model controls for floor area. However, it may be that construction costs or preferences differ by housing style. Thus, categorical variables are included to account for different housing styles.

Housing values are expected to be adversely affected by the occurrences of crime in the neighborhood. One crime measure, the number of reported cases of malicious destruction of property, was included as a quality of neighborhood measure in the hedonic price function. Higher levels of the crime are expected to be associated with lower

housing prices. The additional set of neighborhood variables expected to influence observed housing values include, income, education, percentage of renters, race and ethnicity, commuting time to employment. Higher levels of neighborhood income and education are expected to be valued neighborhood attributes. Therefore, higher levels of income and education in a neighborhood are expected to be associated with higher housing prices. The percentage of renters in a neighborhood may also affect the price of housing in a neighborhood. Renters may have less of an incentive to invest in property or neighborhood maintenance then residential homeowners. Thus, higher percentages of renters in a neighborhood is hypothesized to be associated with reduced housing prices, all else constant.

The race and ethnicity of the neighborhood have been shown to be associated with lower housing prices, thus these variables are also included in the analysis (Cutler, et al., 1999; Massey and Denton, 1988). Greater proximity of households to areas of employment is expected to reduce the costs of commuting. This savings is expected to be capitalized into property values and result in higher housing prices. The commute variable measures the percentage of those whose commute to work is less than 20 minutes in a specified neighborhood. Higher levels of the commute variable is expected to be associated with higher housing prices, all else constant.

1.4. Area of Study

The city of Lansing, Michigan encompasses an area of approximately 33.8 square miles with a total population of 119,128 persons (U.S. Census Bureau, DP-1, Michigan, 2000). Lansing is also the State's capital. The property value and household income levels in Lansing are lower when compared to the rest of the State. For example, the

1990 median value of housing in Lansing was $48,400 as compared to the median value of housing in the State which was $60,600 (Ibid., DP-1, Lansing City, 1990; Ibid., DP-1, Michigan 1990). Moreover, the 1990 median household income for the city of Lansing was $26,398 while the median household income for the state of Michigan was $31,020 (Ibid, DP-4, Lansing City, 1990; Ibid, DP-4, Michigan 1990).

The industrial history of Lansing has shaped the present issue of hazardous waste. The two sites examined in this paper are linked, both spatially and causally, to previous industrial activity. Ironically, one of the hazardous waste sites being examined is referred to as the 'Motor Wheel' site because it served as a waste area for the Motor Wheel corporation from 1938 to 1978 (U.S. EPA, Motor Wheel, 2001). The other hazardous waste site under examination is known as 'Barrels Inc.'. Barrels Inc., recycled industrial metal barrels from 1964 to1981 (U.S. EPA, Barrels Inc., 2001). Both of these sites are located in the northern section of the city in close proximity to areas that were, and presently are, areas of high industrial activity. Figure 2, provides a map identifying Motor Wheel and Barrels Inc., as well as areas zoned for high industrial activity.

Today, both the Motor Wheel site and Barrels Inc. are hazardous waste sites whose degree of hazard, as judged by the EPA, is significant enough to warrant listing on the EPA's National Priority List (NPL). Sites listed on the NPL undergo a series of Federal oversight processes which are designed to achieve long term cleanup. These sites are often referred to as 'Superfund' sites. For a detailed description of the Superfund processes and history see Hamilton and Viscusi's book, *Calculating Risks?*, published in 1999.

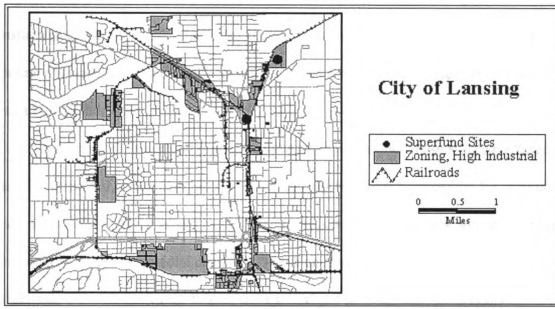

Figure 1.2. Location of Sites and High Industrial Areas

Detailed information concerning the Motor Wheel and Barrels Inc., sites are available on a number of EPA's web sites (see EPA, November 2001 and EPA, March 2001). Much of the information available on these sites is summarized in the forthcoming discussion. Motor Wheel is a 24 acre site that was used primarily for industrial waste from 1938 to 1978. The site was 'discovered' by the EPA in 1981 and investigation of this site resulted in a Hazardous Ranking Score that placed it on the National Priorities List in 1986. Being placed on this list initiates Federal oversight of a number of steps designed to achieve long-term cleanup. Areas within Motor Wheel pose a direct health risk to humans. Moreover, there is an indirect threat to citizens within a broad area if the hazard were to contaminate the underlying water aquifer.

During Barrels Inc.'s active years (1964-1981), the company recycled metal barrels. As the initial step in recycling these barrels the contents of the barrels were often dumped in the 1.8 acre area in which Barrels Inc. operated. Since the metal barrels came

from a variety of industries, the residuals in the barrels contained a variety of industrial wastes that constitute present hazards. Barrels disposed of this waste, as well as its own operation's waste, on site. In 1982 the EPA became aware of the site, and in 1989 the site was added to the NPL.

A number of Superfund processes have taken place since these sites were listed on the NPL. A record of decision (ROD) which outlines the general procedure for cleanup was submitted for Motor Wheel in 1991 and Barrels in 1996. However, actual clean up does not begin until a remedial design (RD), which provides the engineering details, is submitted. The RD for Motor Wheel, though initiated in 1992, was not actually completed until 1997. The RD for Barrels is still being developed. Currently Motor Wheel is still in the remedial action phase of cleanup while Barrels is still developing its RD.

1.5. Data Collection

In order to examine the effect of Barrels Inc. and Motor Wheel sites on surrounding residential property values, data was collected to specify a hedonic price function. Residential housing sales data and associated structural characteristics of residential homes were obtained from the Lansing Assessor's office for the years 1992 to 2000. The universe of sales available to the Assessor's office include all housing sales that were registered by the counties in which the city of Lansing lies. Sales categorized as foreclosures, sheriffs sales, quick claim deeds, and other non-conventional forms of sale were not considered 'arms length' sales and were omitted from the data set.

The perceptions of the hazards are expected to be localized to a relatively small area. This allows the hedonic equation to be estimated in a smaller, relatively

homogenous area (see Palmquist, 1992). The area used to estimate the hedonic price function includes housing located north of a major east-west highway (I-496) that effectively divides the city into two segments. Both sites under investigation are located in the northern portion of Lansing (see Figure 1.2). In addition, housing sales that were closer to a Superfund site located outside the incorporated area of Lansing were omitted from the data set.

Table 1.1 provides a definition of the variables that were gathered for analysis. Geographic Information Systems (GIS) was used to determine the straight line distance between housing observations and the perimeter boundary of the nearest Superfund site (either Barrels Inc. or Motor-Wheel). The perimeter of the Superfund sites was mapped using a global positioning system. The coordinates were applied to the base map files using 1990 Tiger Base File maps and Michigan Framework data. GIS was also used to measure the straight line distance from each housing sale to the area zoned as 'highly industrial'. A boundary map of industrial zoning was provided by the city of Lansing Assessor's Office.

A crime variable was specified and data were provided by the Lansing Police Department. The variable was measured by the number of malicious destruction of property violations that occurred in each block group for 1996. Violations were tallied for each block group and subsequently linked to the housing sales data at the block group level. The neighborhood characteristics income, education, race, ethnicity, rent, and commute (defined in Table 1.1) come from the U.S. 1990 Census, summary tape files # 3, and are measured at the block group level for the city of Lansing, Michigan. GIS was used to link the location of each housing sale with its block group.

1.6. Empirical Estimates and Regression Results

The mean and standard deviation of the dependent and explanatory variables are provided in Table 1.2. The mean housing price and income variable were consistent with estimates of housing values and median income described in the 'area of study' section. Ordinary Least Squares (OLS) is used to estimate the hedonic price function. Table 1.3 presents the coefficient estimates of the hedonic price function. Model 1 estimates the hedonic price function without an industrial variable. Model 2 estimates the hedonic price function with an industrial variable. Bruesch-Pagan test of the residuals rejected the null hypothesis of homoskedasticity and therefore, a valid estimator of the standard errors is obtained using a method usually referred to as White, Huber, Eicker, 'sandwich', or 'robust', standard errors (see Wooldridge, 1999).

The estimated coefficients of the hedonic price function were, for the most part, consistent with a priori expectations. The floor area of the home and the age of the house were found to be important factors explaining variation in housing values. For example, both Model 1 and Model 2 coefficient estimates of floor area suggest that a 10% increase in floor space is expected to raise the housing price by approximately 6%. Moreover the floor area variable is statistically significant different from zero (Ho: $\beta_i = 0$) at the .05% significance level. Both models also suggest that increases in the age of the house was associated with a decline in the house's value. A 10% increase in the age of the house is associated with approximately a 2% decrease in the price of the home. Neither acreage or the number of bathrooms are found to be statistically significant determinants of housing prices in the model (at the .05 significance level).

Table 1.2. Summary of Variables (4502 Observations)

Continuous Variables		
Variables	**Mean**	**Std. Deviation**
price	49055	28906
hazard	1670	723
industrial	894	646
bath	1.313	.534
sqft	1165	465
age	71.867	23.556
acres	.148	.102
income	24458	9728
educ	16.7	12.2
black	12.357	10.246
hisp	10.795	8.637
rent	43.983	19.771
crime	22.317	12.932
Categorical Variables		
Variables	**Mean**	**Std. Deviation**
sty1	.380	.485
sty 11/4	.091	.288
sty 11/2	.071	.258
sty13/4	.110	.313
sty2	.330	.470
dumstyle	.010	.100
92	.088	.284
93	.084	.278
94	.096	.294
95	.096	.295
96	.110	.313
97	.110	.313
98	.121	.326
99	.127	.333
00	.114	.318

Table 1.3 OLS Coefficient Estimates with Huber-White Standard Errors ( )

Dependent Variable = ln(price)	Model 1	Model 2
ln(hazard)	.038 (.012)**	.015 (.013)
ln(industrial)	----------	.034 (.009)**
bath	-.005 (.016)	-.005 (.016)
ln(floor)	.681 (.037)**	.675 (.038)**
ln(age)	-.172 (.036)**	-.174 (.036)**
acres	.146 (.263)	.167 (.274)
sty11/4	.018 (.018)	.015 (.018)
sty11/2	-.046 (.023)	-.043 (.023)
sty13/4	-.071 (.021)**	-.067 (.022)**
sty2	-.081 (.021)**	-.078 (.021)**
dumstyle	.104 (.055)	.112 (.056)*
crime	.0002 (.0005)	.004 (.005)
income	.000007 (.0000017)**	.000008 (.0000017)**
educ	.006 (.0009)**	.004 (.0009)**
black	-.005 (.0006)**	-.005 (.0006)**
hisp	-.008 (.001)**	-.0007 (.001)**
rent	-.003 (.0005)**	-.002 (.0005)**
commute	.001 (.0008)	.002 (.0008)**

Table 1.3 Continued

Dependent Variable = ln(price)	Model 1	Model 2
93	-.003 (.027)	-.007 (.027)
94	.103 (.023)**	.101 (.023)**
95	.135 (.023)**	.133 (.023)**
96	.174 (.023)**	.174 (.023)**
97	.244 (.023)**	.242 (.022)**
98	.315 (.022)**	.312 (.022)**
99	.362 (.022)**	.360 (.022)**
00	.461 (.023)**	.458 (.023)**
Constant	6.024 (.295)**	5.926 (.288)**
	Number of obs = 4502 F(25,4476) = 369.98 R-squared = 0.613	Number of obs = 4502 F(26, 4475) = 355.58 R-squared = 0.615

** Statistically different from zero at the .025 significance level.
* Statistically different from zero at the .05 significance level.

The estimated coefficients for income, education, and commute variables suggest that homes located in neighborhoods characterized by higher incomes, higher levels of education, and in greater proximity to areas of work are associated with relatively higher housing prices, all else constant. These coefficient estimates are statistically different from zero at the .05 significance level.

Increases in the percentages of minorities (black and hispanic) and renters in a neighborhood are associated with relatively lower housing prices all else constant. Higher levels of crime, as measured by malicious destruction of property, was also hypothesized to be associated with lower property values, all else constant. However, the

coefficient estimate of the crime variable is not statistically significant at the .05 significance level.

The empirical findings in Model 1 support the hypothesized relationship between proximity to the Superfund sites and housing values. Increased distance from hazardous waste sites is associated with higher housing prices, all else constant. In Model 1 a 10% increase in distance from a superfund site is associated with a .3% increase in housing value. Moreover, this value is statistically significant at the .05 significance level. However, Model 2, which includes a measure for a house's proximity to an area zoned as highly industrial, provides a decidedly different coefficient estimate for the hazard effect. In Model 2 the coefficient for hazard is approximately cut in half and the variable is no longer statistically significant at the .05 level. On the other hand, the industrial variable is positive and statistically significant at the .05 significance level. Model 2 suggests that people are willing to pay a premium for reduced proximity to areas of high industrial activity however, once the industrial effect is accounted for, the hazard effect is no longer statistically significant at the .05 significance level.

Estimates of the hazard variable appear highly sensitive to the inclusion of a variable that measures relative proximity to industrial areas. The inflated value of the hazard coefficient estimate in Model one is consistent with the expected relationships defined by equation 3 examining omitted variable bias. That relationship suggested that the coefficient of "hazard" would be inflated if the industrial coefficient was statistically significant and the correlation between hazard and industrial was positive. The empirical results confirmed these relationships. The industrial coefficient estimate is positive and

statistically significant and the correlation between " hazard "and "industrial" variables is positive (Pearson correlation coefficient for hazard and industrial is .5).

1.7. Benefit Estimates

Benefit estimates for cleaning-up the Superfund sites are derived using the estimated hedonic price functions presented in Table 1.3. Nonetheless, as discussed earlier, the hedonic price function itself can be used as a benefit measure if the area affected by the disamenity is small relative to the housing market under examination (i.e. localized disamenity). Kiel and Zabel (2001) argue that the concept of localized "...is applicable to the cleanup of a hazardous waste site since the impact on house values will only be felt in the vicinity of the site (pg. 170)".

The steps taken to estimate the benefit of cleaning-up both superfund sites are outlined in the following paragraphs. The estimated coefficients of the hedonic price function are used to predict the logarithm of housing price for each housing observation. These values are transformed into expected prices using anti-logs (exponential).[3] In a similar manner the hedonic price function is used to predict the expected price of a house if complete clean-up of both sites were to occur. The post clean-up price of a home is derived from the hedonic price function by predicting the price of each house at a distance from the sites where exposure to hazard is not expected to influence housing values.

Because the log-log function generates a hazard effect whose marginal change approaches zero asymptotically, defining the exact point where the hazards have no

[3] The estimates are adjusted for biases that result from taking the anti-log of the predicted logged dependent variable (see Stynes, D. et al, 1986 for a complete discussion). The adjustment method used is outlined by Wooldridge, 1999, pg.. 202.

housing effect is unclear and therefore the exact point is a judgement call. In this study benefit estimates are derived for houses within one-half mile from either hazardous waste site. The difference between the predicted price of each housing observation, estimated at one-half mile from either Superfund site, and the predicted value of each housing observation as described by its current set of attributes, define a benefit estimate for each house that results from clean-up of the sites. The benefits of cleaning-up the Superfund sites are measured under an assumption that the clean-up is expected to influence housing values within one-half mile of either site. Expanding the area used to estimate benefits will alter the magnitude of benifts associated with Model 1 and Model 2, but the percentage difference in the benefit estimates (between Model 1 and Model 2) will remain consistent.

Each housing observation and associated benefit estimate are sorted into associated Assessor's neighborhood as defined by the City of Lansing. The number of residential units in each assessor's neighborhood serves as an approximate density measure for housing surrounding within one-half mile of the Superfund sites. The mean values of the predicted benefits for each Assessor neighborhood are multiplied by the number of residential units and these values are aggregated to derive an estimate of the benefit of clean-up.

The benefit estimates using Model 1 coefficient estimates is approximately $1,1431,285. The benefit estimate using Model 2 coefficient estimates is approximately $563,995. Both estimates are in nominal dollars. Thus, failure to account for areas of high industrial activity may lead to benefit estimates that greatly over exaggerate the benefits of hazardous waste clean-up. Moreover, the finding that the hazard effect in

Model 2 was not statistically different from zero suggests that the 'benefit' differences between Model 1 and Model 2 may be even greater than those estimated. Clearly these benefits estimates do not take into account the non-use values associated with site clean-up and are not designed to take into account benefits from actual reductions in risk. Still, contrasting benefit estimates using Model 1 and 2, illustrates the potential bias in benefits that emerges if one fails to account for the industrial character.

1.8. Summary of Key Findings

In the case study area, residential property located in close proximity to a Superfund site is also likely to be located in close proximity to an area zoned as highly industrial. Like hazardous waste sites, areas of high industrial activities are expected to be associated with an array of hazards and disamenities that reduce surrounding property values. Failure to account for this spatial correlation, in estimating the hedonic price function, is shown to over emphasize the negative impact that Superfund sites have on surrounding property values. Moreover, the benefit estimates of Superfund clean-up, as derived from the hedonic price function, are shown to be sensitive to the omission of the industrial variable. In this analysis, failure to account for proximity to areas of industrial activity, resulted in benefit estimates that were approximately twice as high as benefit estimates that included a measure of industrial activity.

1.9 Implications of the Research

The benefits of cleaning up a hazardous waste sites, in many cases, accrue to surrounding residents in a manner that is non-rival and non-exclusive. This characterization of benifts helps explain why the burden of hazardous waste clean-up falls heavily on public institutions. However, like private decision makers, public institutions

face the difficult task of deciding how to allocate scarce resources across different activities over time. Ideally, an understanding of the economic costs and benefits of different activities can lead to an improved set of policy decisions and resource allocations. Unfortunately, in the case of hazardous waste clean-up, information about the opportunity costs of one expenditure versus another is difficult to obtain. One approach to estimating the benefits of clean-up is to use a hedonic property value method and estimate the property value effect on property depending on its relative proximity to hazardous waste sites. In some cases the estimated hedonic price function can then be used to derive benefit estimates for hazardous waste clean-up. However, as this analysis suggests, the magnitude of these benefits are likely to be sensitive to spatial correlates (i.e. the presence of high industrial activity).

Because industrial activity and hazardous waste may be spatially correlated in areas through-out the United States this study may be relevant to policy makers and researchers. The study emphasizes the notion that the benefits of hazardous waste clean-up will depend on the character of the land-use surrounding hazardous waste sites. Clean-up of hazardous waste sites located in high industrial areas may not generate the same level of benefits to residential property owners as clean-up of hazardous waste sites that are not located in high industrial activities. Future research can address this issue directly. Moreover, it will be important to identify the extent to which the distribution of benefits and costs accrue to land holders versus renters. Such information will help policy makers with the difficult task of prioritizing which hazardous waste sites should be cleaned up and provide insight into how the benefits and costs of these policies will be distributed.

In some cases it may be that the industrial character of neighborhoods pose an even greater hazard or nuisance to surrounding residents than the hazardous waste site. Clearly this will depend on the character of the hazardous waste site and the character of the industrial area. Nonetheless, in some cases, addressing the influence of industrial activity on residential housing may be an alternative approach to improving the well being of residents who live in close proximity to both hazardous waste sites and areas of high industrial activity. In these cases the opportunity costs associated with hazardous waste clean-up may be appropriately expanded to consider expenditures designed to mitigate the hazards and nuisances associated with present industrial activity. Thus, in some cases it may be appropriate to expand the decision making opportunity set to include activities that address industrial disamenities.

Finally, it is important to note that the combination of public-private institutions that are currently addressing hazardous waste clean-up represent a distinctly different set of institutions than those that were in place when the hazardous waste was generated. For example, Barrels Inc.'s, use of land as a dumping site for its industrial activities in the 1960's is presently viewed as having compromised the well being of surrounding residents. In hindsight, one can imagine that a different set of public-private institutions, other than those that were in place in Barrel's Inc.'s active years, might have led Barrels Inc. to dispose of its waste in a manner that would have been less damaging.

If past industrial activities generated present day hazards, in a unforseen manner, then it may be the case that present day industrial activities are shaping what the future will regard as a 'hazard', in some unforeseeable manner. However, as is the case now, the costliness of the future hazard will very likely depend, in part, on the density of

surrounding populations. In some cases, policy makers may be able to avoid high future costs by presently re-examining the underlying set of rules and incentives (zoning, affordable housing, etc.) that will govern future spatial relationships between residential housing location and industrial activity.

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ESSAY 2:
SUPPORT FOR FARMLAND PRESERVATION: THE INFLUENCE OF FARMLAND ATTRIBUTES AND RESPONDENT CHARACTERISTICS: A CASE STUDY OF KENT COUNTY, MICHIGAN, 2001

2.1. Introduction

Public involvement in the 'preservation' of specific land uses is a widely observed phenomena in the United States. Evidence of this public activity was made apparent in the 240 local and state ballot initiatives during the 1998 elections, designed to protect or improve parks, farmlands, historic resources, watersheds, green-ways, and biological habitats. Over seventy percent of these initiatives were approved by voters, approvals that will result in more than $7.5 billion in state and local conservation spending (Myers, 1999). The 1998 initiatives which were designed to preserve land use in its current status represent a 50% increase from the number of initiatives in 1996 (Ibid.). This increase was sustained by the November 2000 state and local elections where 257 ballot measures were designed to preserve open spaces. Of the 257 ballot measures, 201 (78%) were passed by voters (Myers, 2001).

Farmland is a common component of these preservation efforts. Land in farms occupies forty to fifty percent of total land area in the U.S., much of which is in close proximity to rapidly growing areas (OTA, 1995). Between January 1974 and February 2000, State and local farmland preservation organizations used public funds to purchase permanent conservation easements on approximately 819,000 acres of U.S. farmland (Kuminoff and Sumner, 2001).

Since the 1970's economists have examined the impetus behind farmland preservation and the distribution of costs and benefits associated with farmland

preservation programs. The literature has emphasized that the benefits/costs associated with farmland preservation are expected to vary depending on which farmland is preserved (i.e. location and attributes of the farmland to be preserved) (Bromley, 2000, Gardner, 1977, Kline and Wichelns, 1998, Kline and Wichelns, 1996). The heterogeneity in farmland attributes and the resulting heterogeneity in motivations for farmland preservation pose difficulty in the design of farmland preservation programs, a primary concern to some economists (see Libby, 1996).

Surprisingly, empirical studies that examine the influence of farmland attributes on an income constrained choice to support farmland preservation programs are rare . For example, the majority of willingness-to-pay studies assume a high degree of homogeneity in the attributes of the farmland to be preserved (see Beasley, et al., 1986; Bergstrom, et al., 1985; Drake, 1992; Halstead, 1984; Krieger, 1999). These studies asked respondents to make tradeoffs between income and 'farmland'. In these studies, farmland is described as 'prime farmland', or 'agricultural land', or 'agricultural development rights'. Thus, the extent to which individual support, and thereby broader public support, for farmland preservation varies by attributes of the land to be preserved (i.e. environmental quality, wildlife habitat, location) has not often been addressed.

However some weighting of these attributes is implicit in all programs that allocate public monies to preserve farmland. State-wide programs, like Michigan's 1974 Farmland and Open Space Preservation Program (P.A. 116), were designed in part to preserve farmland by providing tax breaks to farmland owners in exchange for temporary transfer of development rights. In this program the attributes of farmland are not used as a criteria for deciding which farmlands receive public support. Thus, farmland is

implicitly treated as a homogenous good. Other programs are more targeted in their approach. For example, Michigan's Purchase of Development Rights (PDR) program prioritizes land based on agricultural productivity, location next to urban areas, environmental quality, and other attributes of the farmland.

The research described in this paper examines the extent to which individual support for farmland preservation hinge on the attributes of farmland to be preserved. The attributes of concern include the location of the farmland, relative productivity of the farmland, and relative environmental quality of the farmland being preserved. An important feature of the research is that it examines the influence of these attributes on the decision to support a farmland preservation initiative in a hypothetical scenario designed to examine choice in the context of costs to the respondent and his or her income.

In addition, the theoretical model developed in this paper examines the possibility that farmland preservation is motivated by expected changes in the land market that result in private gain to current resident land holders? Recent hedonic analysis suggests positive spillovers to private property from publicly protected forms of open space (Irwin and Bockstael, 2001). These pecuniary externalities may influence residents differently depending on their own endowments, particularly land ownership. The conceptual basis for endowment income effects is firmly rooted in theoretical discussions (Varian, 1996). Deaton and Norris (2001) commented on the need to incorporate land ownership patterns as a factor motivating individual support for public land use policies.

Approach to the Study

A door-to-door survey was conducted in Kent County, Michigan in August of 2001. The survey included a referendum scenario that was presented to a random sample of residents in Kent County. The residents were asked to vote for or against a County-wide initiative to preserve farmland. Respondents were provided with varied descriptions of the farmland preservation initiative. Specifically, the initiatives varied by the costs to the respondent, location of the farmland within the County, descriptions of agricultural productivity, and descriptions of environmental quality. The results from the empirical analysis examine the extent to which descriptions of farmland attributes influence respondents decisions to vote for or against the preservation initiative. In addition, the survey was designed to gather socio-economic characteristics of the respondents, including the land ownership characteristics.

The next section provides a theoretical framework that specifies a set of relationships between increases in publicly preserved farmland and a resident's utility. The theoretical model is developed for a resident landowner— a resident with an initial endowment of services associated with land. The model develops the general research hypotheses. The third section describes the survey method. The fourth section explains the general implementation model and introduces the probit model as a means to analyze the data generated from the survey. The fifth section examines the testable hypotheses using the empirical model. The final section describes potential implications of the research findings.

2.2. Theoretical Framework

The utility maximization problem facing a resident landholder is described below:

$$\text{Max } U = U(X_a, L; l_e)$$

(4)

$$\text{subject to: (1) } P_a X_a + P_L L \leq Y; \; w + P_L \bar{L} = Y.$$

where:

$U(*)$	=	the conventional utility function.
X_a	=	all other private goods.
L	=	land services.
l_e	=	A vector of attributes (quantity, water quality, wildlife habitat, agricultural productivity, etc.) which comprise publicly preserved farmland.
$\bar{L}$	=	Initial endowment of residential land services.
P_a	=	the price of all other goods.
P_L	=	market price for land services.
w	=	total wage income.
Y	=	total income.

The resident landowner is assumed to maximize utility from consuming private goods (X_a), land services (L), and publicly preserved land in agriculture use (hereafter referred to as farmland preserved), l_e. Each resident is assumed to have an initial endowment that yields land services, $\bar{L}$. The market price of land services is the rental value for land, P_L. This price, P_L, represents the opportunity cost associated with consuming land services derived from one's own land. Moreover, P_L, represents the price that must be paid to acquire a level of land services beyond one's initial endowment. The final level of consumption is limited by one's total income (Y) which is comprised of a wage income (w) and rental income ($P_L \bar{L}$). Rental income includes

both an implicit rental income, an amount paid to oneself for own consumption of land services, and an explicit rental income derived from renting one's services to others.

Faced with prices, wage, endowments, and exogenous amenities the resident owner is assumed to identify an optimal consumption bundle. Setting $P^a=1$, and solving equation 4, in terms of prices, total income, and farmland results in the following general form of indirect utility:

$$V(P_L,\ Y(w,\ P_L);\ l_e) \tag{5}$$

How will an increase in the level of farmland preserved (l_e) influence the level of indirect utility? The model derived suggests that the total effect will be comprised of three effects:(1) The change in utility associated with the increased levels in the vector of attributes that describe publicly preserved farmland; (2) The direction of the spillover effect, if any, that public preservation of farmland has on the value of land services; and, (3) Whether the resident landowner consumes his full endowment of land services or is assumed to be a net-buyer or net- supplier of land services.

Equations 6 and 7 identify the steps necessary to take the total differentiation of indirect utility with respect to farmland preservation. Equation 6 identifies the total differential while equation 7 identifies the total derivative.

$$dV = \frac{\partial V}{\partial l_e} dl_e + \frac{\partial V}{\partial P_L} dP_L + \frac{\partial V}{\partial Y}\frac{\partial Y}{\partial w} dw + \frac{\partial V}{\partial Y}\frac{\partial Y}{\partial P_L} dP_L \tag{6}$$

Equation 7 (above) examines the total effect on indirect utility for an increase in farmland preserved. Equation 8 simplifies equation 7 by assuming that farmland preservation does

$$(7) \qquad \frac{dV}{dl_e} = \frac{\partial V}{\partial l_e} + \frac{\partial V}{\partial P_L}\frac{dP_L}{dl_e} + \frac{\partial V}{\partial Y}\frac{\partial Y}{\partial w}\frac{dw}{dl_e} + \frac{\partial V}{\partial Y}\frac{\partial Y}{\partial P_L}\frac{dP_L}{dl_e}$$

not influence wage income. In addition, equation 8 is divided through by the partial of indirect utility with respect to wealth.

$$(8) \qquad \frac{\frac{dV}{dl_e}}{\frac{\partial V}{\partial Y}} = \left(\frac{\frac{\partial V}{\partial l_e}}{\frac{\partial V}{\partial Y}}\right) + \left(\frac{\frac{\partial V}{\partial P_L}\frac{dP_L}{dl_e}}{\frac{\partial V}{\partial Y}} + \frac{\partial Y}{\partial P_L}\frac{dP_l}{dl_e}\right)$$

Equation 8 identifies a number of conceptual relationships. The first parenthetical term can be interpreted in terms of marginal willingness to pay for increased levels of farmland preserved (wtp_e). This is the theoretical basis for much of the literature that examines willingness to pay for farmland preservation. However, the second and third brackets extend this analysis to allow for pecuniary gains and losses that may result if public preservation of farmland alters the price of private land. Roy's identity is applied to the first term in the second bracket to identify demand for private land (L*). Also, the endowment of land ($\bar{L}$) is substituted for the second term in the second bracket. Making the aforementioned substitutions and rearranging the order of terms results in the relationships defined by equation 9.

$$(9) \qquad \frac{\frac{dV}{dl_e}}{\frac{\partial v}{\partial Y}} = (wtp_e) + \left(\frac{dP_L}{dl_e}\right)(\bar{L} - L^*)$$

The left hand side of equation 9 defines the marginal willingness to pay for the total increased level of indirect utility that results from farmland preserved (l_e). The first bracketed term identifies marginal willingness to pay for marginal increases in farmland preserved. The second and third terms identify an argument similar to that developed by Cooley and LaCivita (1982) with regards to their work on growth controls. These terms suggest that benefits to the resident landowner depend on both changes in the price of privately held land and differences (if any) between the level of land services consumed (L^*) and the initial endowment of land services ($\bar{L}$).

The hypothesized sign of the first bracketed term is positive and this is the fulcrum on which examination of the testable hypotheses turns. The testable hypotheses are that increases in the levels of farmland attributes increase the probability that one will support a farmland preservation program. These hypotheses are tested in a hypothetical referendum setting in which a voter decides whether to incur increased taxes in return for increases in l_e. The voter's decision to support farmland preservation is assumed to reflect a comparison between a pre-preservation level of utility, i=0, and a post preservation level of utility, i = 1.

To isolate these testable hypotheses in the theoretical model, it is initially assumed that the respondent consumes the full level of his or her initial endowment of land

services. Thus utility is not influenced by the cost of consuming land services or rental income because the opportunity cost of consuming one's own endowment is exactly off-set by the implicit rent paid to oneself for that level of consumption. In addition P_a is defined as a numeraire price and set equal to 1. Thus in the absence of publicly preserved farmland, $l_e = 0$, the pre-preservation level of indirect utility, V^0, is represented by $V^0(Y^0(w))$. This level of utility is contrasted with the post-preservation level. Holding wage income constant, the comparison between the pre and post levels of utility reflect the tradeoff between the private cost of preserving the farmland, $C > 0$, and the benefits of publicly preserved farmland and is represented by, $V^1(Y^0(w)-C^1;l_e)$.

Faced with a decision to vote for or against a public ballot initiative to preserve farmland an individual is assumed to support farmland preservation if the status quo level of utility is greater than (or equal to) the post preservation level of utility; $V^0 \leq V^1$. Changes that increase the disparity between post preservation and status quo levels of indirect utility, $V^1 - V^0$, are therefore assumed to increase the likelihood of support for farmland preservation. If bracket one in equation 6 is positive, as hypothesized, the representative individual is expected to be willing to forego other goods in order to obtain increases in one or all of the attributes that characterize the farmland preservation initiative. Therefore, increases in the level of attributes are hypothesized to increase the probability that one will vote for a farmland preservation initiative, all else constant.

The theoretical model allows for the possibility that a farmland preservation policy may generate amenity benefits that are capitalized into the prices of private land values. For resident land owners the benefits of this increase will depend on whether one

consumes his or her endowment of land services, purchases more than their initial endowment, or supplies some of their initial endowment to others . For those who consume their endowment the increase in land prices will be off-setting–increases in implicit rent will equal increases in implicit rental income. For net-buyers of land services the increase in private land values may have a negative income endowment effect and reduce the probability that one will support a farmland preservation program. Alternatively, net-suppliers of land services may enjoy a positive income-endowment effect and therefore be more likely to support the policy initiative.

As discussed earlier, a representative individual faced with the decision to vote for or against a public effort to preserve farmland is expected to compare the current, status quo, level of utility with that which is expected to occur in the post preservation scenario. However, in the extended model the expected change in the price of privately owned land services may, in some cases, influence the likelihood that one will vote in support of a farmland preservation initiative. The following scenario is developed for the resident landowner who is a net-seller of land services.

Unlike the resident who consumes the full level of his or her land endowment, the net-seller's pre-farmland preservation level of indirect utility is dependent on the price of land services and wage income, $V^0(P_L^0, Y^0(w, P_L^0))$. Because the resident is a net-seller, any increase in cost of consuming land services is expected to be more than offset by gains in rental income; $V^1(P_L^1, Y^1(w, P_L^1)) > V^0(P_L^0, Y^0(w, P_L^0))$. This difference reflects the endowment income effect which, in this case, is expected to be positive. In addition, the resident is expected to weigh the costs of the preservation initiative, C, against the benefits associated with publicly preserved farmland preserved. The post

preservation level of utility is symbolized as $V^1(P_L^1, Y^1(w, P_L^1) - C, l_e)$. Thus a resident land owner who is a net-seller and remains a net-seller in the post-preservation scenario is hypothesized to be more likely to vote for a farmland preservation initiative if the farmland preservation initiative is expected to increase the price of land services[4].

2.3. Study Context and Survey Method

Kent County, Michigan was chosen as the area to examine support for farmland preservation. Kent County contains the Grand Rapids metropolitan area and has traditionally been one of the more important agricultural counties (in terms of gross revenue) in the state of Michigan. Population in Kent County between the years 1990-2000 has grown by 14% compared to 7% for the state of Michigan (U.S. Census).[5] In addition, Kent County contains the 'Fruit Ridge' an agricultural area located in the north-western portion of Kent County. The Fruit Ridge's location relative to Lake Michigan and its relatively high altitude have contributed to its capacity to grow fruit (mainly apples). These spatial features have contributed to the use of the term 'Fruit Ridge' as an identifier for a particular farming area in Kent County. Moreover, the study area was chosen as an important because the Kent County government is presently considering a substantial plan to preserve 50% of the farmland in Kent County through a Purchase of Development Rights Program (PDR).

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[4] Note, there are at least two plausible reasons for assuming that land values (P_L) are an increasing function of publicly preserved farmland. First increases in the quality and quantity of farmland preserved by the public may generate a stream of amenities that are capitalized into private property values (e.g. see Irwin 2001). Second, under a supply restriction assumption, increases in the acreage of farmland preserved reduce the level of land available for residential and other services bidding up the rental value for privately owned land.

[5] The total population (households) in Kent County is 574,335 (212,890). The total population (households) in Grand Rapids is 197,800 (73,217). (Census 2000 Summary File 1 (SF 1) 100 Percent Data).

A door-to-door survey was applied to a stratified random sample of Kent County households in order to examine the factors that contributed to resident support for a program to purchase agricultural conservation easements (PACE) in Kent County. The sample was stratified as 'urban' and 'rural'. Rural areas were defined as census tracts in which 100% of the population was defined as rural by the 1990 Census. The area defined as rural contained approximately 10% of the households in Kent County. The remaining 90% of households were therefore defined as urban. A random sample of urban and rural addresses was provided by Survey Sampling, Inc. from a data base of all listed phone numbers.

The total survey population was 205 households, although 12 of the listed households were either not in the County or the addresses provided did not exist. Hence the effective sample was 193 households. The survey response rate was 73% (141 surveys returned). Six surveys were not usable, resulting in 135 surveys available for empirical analysis.

The survey design was developed with the assistance of two focus groups of Kent County residents (one rural and the other urban residents). In addition the survey was reviewed with county extension agents. Pre-testing of the survey involved over twenty door-to-door visits of residents in Kent County. The focus group and door-to-door visits strongly influenced the method by which the final survey was administered. In particular, information derived from pre-testing indicated the need for a survey method that allowed the respondent freedom to take the survey at his or her convenience. The actual form used is provided in Appendix 2.

The final survey was administered as follows: First, the survey was brought to the door by an enumerator. If someone was home (a male or female who regarded themselves as a 'head' of the household), the enumerator introduced the survey. An introduction to the survey took an average of 10-15 minutes and involved describing each section of the survey to the respondent. The respondent was then asked to fill out the survey at his or her convenience and arrangements were made to pick up the survey sometime that day, during the week, or, in rare cases the respondent would request to mail back the survey. In four cases the survey was read to the respondent and the enumerator filled out the survey as directed by the resident respondent.

If the respondent was not home, the survey was left at their door with a note attached requesting that the survey be filled out and left at a specified place for pick-up the next day. A subsequent visit to all homes in which a survey was 'dropped' occurred. Subsequent visits can be broken into three broad categories: (1) 'Pickups', surveys which had been completed left at a specified place and were subsequently retrieved , (2) 'Introductions', in which the survey was introduced to the respondent and arrangements were made in a similar manner to the initial visit as described in the paragraph above, and (3) 'Mail-Drops', in which a survey was left with a self addressed, stamped envelope. Eighty-eight percent of the completed surveys involved an introduction to the survey. The remaining 20 percent of the surveys were split evenly between what is referred to above as pickups and mail-drops.

The survey itself consisted of six major sections. The first section of the survey introduced the respondent to the survey and defined a number of key words that would be used throughout the survey. The respondent was encouraged to refer back to these words

as they filled out the survey. The second and third sections of the survey asked the respondent to indicate, on a Likert scale, their opinions about farmland services and attributes of farmland.

The fourth section of the survey described a potential program to preserve farmland in Kent County. The program was described as a Purchase of Conservation Easement (PACE) program and the major of components of how a program like this would be applied in the County was described and then summarized. The fifth section provided three hypothetical voting scenarios in which the respondent was asked to vote on three different proposals for a PACE program in Kent County. Surveys that use a referenda scenario may lead to more reliable results then surveys that simply ask open ended questions for support (Arrow, et al., 1993).

The referendum descriptions varied by four factors: (1) a cost to the household; (2) the location of the farmland to be preserved; (3) agricultural productivity; and (4) environmental quality of the farmland to be preserved. Quantity of farmland to be preserved was 10% of the County and this was described but held constant in the survey design. Each factor varied by three levels. The four factors were explicitly defined in each contingent voting scenario which replicated a referenda situation. The four factors and three levels were varied in an orthogonal manner using the Taguchi design available on Minitab. Nine distinct combinations of factors resulted. Each of the three surveys had three contingent choice scenarios which generated 405 possible choice observations from the 135 usable surveys. Two survey sets were applied to the sample. The survey sets differed by the combination of factors and level of prices shown to respondents. Figure

2.1, provides an example of the referenda scenario. Finally, the last section of the survey asked the respondent to provide basic demographic information.

Ballot Proposal

If a majority of Kent County residents vote yes, your household will pay the special County tax and the County Government will purchase agricultural conservation easements on farmland with the characteristics described in the box below.

If a majority of Kent County residents vote no, your household will not pay the special tax and the County Government will not purchase agricultural conservation easements on farmland in the County.

Proposal A summarizes the proposal on which *you* are asked to vote:

Proposal A

Purchase of Agricultural Conservation Easements (PACE)

Cost:	$10 **per household each year for the next five years.**
Quantity:	**10% of the farmland** in Kent County (18,000 acres)
Location:	**Anywhere** in the County
Productivity:	**Below average** farmland productivity
Environmental Quality	

Please Indicate Your Vote in one box below:

Vote for Proposal A	Vote against Proposal A
☐	☐

Figure 2.1. Ballot Proposal

2.4. Implementation Model

A number of studies have integrated stated choice methods with Random Utility Models (RUM) in order to examine the relative preference for attributes identified in a survey design (Adamowicz, et al., 1998, Milon, et al., 1999, Opaluch, et al., 1993, Rolfe, et al., 2000, Rubey and Lupi, 1997, Swallow, et al., 1994). This section develops the utility-theoretic approach to the discrete choice model that is familiar in the literature ((Hanemann, 1984, McFadden, 1973). The model is adapted to the context of farmland preservation and serves as a theoretical basis for the empirical model used to examine a set of testable hypotheses

The following description of the RUM model is similar to other descriptions in previously cited literature. The model assumes that the relevant attributes of the farmland to be preserved are known by the respondent, i. However, randomness is assumed to enter the model because some relevant attributes are not included in the research/survey design. Utility (U) for the *j*th preservation scheme is separated into two components as described by equation 10:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{10}$$

The first component V_{ij} represents the systematic component which is varied in the survey and measured. The second component ε_{ij} is a random component for which a distributional assumption is required in order to make probabilistic statements about choice. The probability that an individual will choose one preservation scheme over

another will involve a comparison between the systematic and random components as depicted in equation 11:

$$(11) \qquad \Pr(U_{1j} > U_{1o}) = \Pr[V_{1j} + \varepsilon_{1j}) > (V_{1o} + \varepsilon_{1o})].$$

Equation 11 suggests that the probability that one will choose farmland preservation scheme, i =1, over scheme, i =0, is determined by the probability that the systematic and error components of utility associated with choice 1 are greater than the level of the systematic components associated with choice, 0.

The systematic component can be further described by a vector of utility coefficients, β's that measure the partial effects on the choice probability that result from marginal changes in the associated set of attributes x_{ij}:

$$(12) \qquad V_{ij} = \beta x_{ij}.$$

The survey design implemented in Kent County used a referendum format to present respondents with the discrete choice of voting for, or against, a proposal to preserve farmland. The description of the location and quality attributes of the farmland to be preserved varied. A vote for the proposal in this survey design suggests that the systematic and error components associated with a preservation scheme are greater than that associated with the systematic and error components that describe the pre-preservation level of utility. Since there is no farmland preserved in the pre-preservation scenario the systematic components associated with that state are set to zero and the

probability of voting yes involves a comparison between the systematic and error components that describe the preservation proposal and the error component associated with the respondents status quo situation:

$$\Pr(\text{Yes} \mid x_{i1}) = \Pr[(\beta x_{i1} + \varepsilon_{i1}) > (\varepsilon_{i0})]. \quad (13)$$

Equation 13 recognizes one of the primary objectives of the empirical analysis – to estimate the β coefficients for the explanatory variables. A probit model is estimated using the maximum-likelihood technique and is defined in its general form as:
where $y = 1$, and is defined as support for farmland preservation and x is a vector of explanatory variables theorized to explain variation in support of farmland preservation. The probability that one will support farmland preservation, $y \neq 0$, is assumed to follow a

$$\Pr(y = 1 \mid x) = \Phi(x\beta) \quad (14)$$

cumulative normal distribution, Φ, as described by equation 14.

2.5. Variables and Testable Hypotheses

Table 2.1 presents the set of explanatory variables hypothesized to influence the probability that one will vote for the PACE proposal as presented by the survey. The β coefficients are estimated using a probit model. The estimated coefficients provide

Table 2.1. Description and Hypothesized Sign of Explanatory Variables

Variable	Description of Variable	Hypothesized Sign
Dependent		
Vote	= 1, if respondent votes for PACE proposal; 0 otherwise	NA
β's; *Explanatory Variables*		
β_1; Cost	Cost ($10,$20,$50,$100,300) yearly cost to the respondent for five years if PACE proposal is approved by voters of Kent County.	Negative
Quantity	Held constant at 10% of farmland in County.	NA
β_2; HighProd*	= 1, if farmland is described as above average productivity; 0 otherwise.	Positive
β_3; LowProd	= 1, if farmland is described as below average productivity; 0 otherwise.	Negative
β_4; HighEQI**	=1, if farmland is described as having an above average environmental quality index (EQI); 0 otherwise.	Positive
β_5; LowEQI	=1, if farmland is described as having a below average EQI; 0 otherwise.	Negative
β_6; Highway***	=1, if farmland is located next to highway; 0 otherwise.	Positive
β_7;FruitRidge	=1, if farmland is located in the fruit ridge of Kent County; 0 otherwise.	Positive
β_8;Income	Total family income before taxes.	Positive
β_9; Acres	Total Acreage of Land Owned in Kent County	Positive
β_{10}; FLand	=1, if respondent owns farmland; 0 otherwise.	Negative
β_{11}; Age	Age of respondent	?
β_{12}; Gender	=1, if respondent is female; 0 otherwise	?
β_{13}; Children	number of own children under 25	?
β_{14}; Education	=1, if college education or greater; 0 otherwise	?
β_{15}; Rent	=1, if rent home; 0 otherwise	Negative
β_{16}; Constant	1	NA

* Average productivity is the omitted categorical variable.

** Average environmental quality is the omitted categorical variable.

*** Farmland located anywhere in the county is the omitted categorical variable.

information on the partial effect of each variable on the probability that one will vote yes to the hypothetical PACE referendum.

The first set of testable hypotheses is designed to address the research question: To what extent does individual support for farmland preservation, and thereby broader public support, hinge on the attributes of farmland to be preserved? The survey was structured so that this question could be examined in an income constrained scenario. Thus, the influence on support for preservation could be examined holding constant the cost of these programs as well as the income of the respondent. Increases in the cost of the program were hypothesized to be inversely associated with the probability that one would vote for the program. Additionally, a respondent's income was expected to increase the probability that one would support a preservation initiative.

Higher (lower) levels of farmland attributes, environmental quality and agricultural productivity, are hypothesized to positively (negatively) influence the probability that a respondent will support farmland preservation. For example, all else constant, it is hypothesized that an initiative described as preserving farmland characterized by higher than average levels of productivity will have a relatively higher probability of receiving support then a farmland preservation initiative designed to preserve farmland of average agricultural productivity. These hypotheses are tested by examining the sign and the statistical significance of the Beta coefficients.

Additionally, focus group discussions suggested that farmland preserved next to the highway and farmland located in the fruit ridge were also attributes that might positively influence respondent support for a farmland preservation initiative. For these reasons it is hypothesized that the probability of supporting the hypothetical PACE

referendum is increased if the farmland to be preserved is characterized as being located in the Fruit Ridge or next to the highway relative to a description which indicates the farmland will be located anywhere in the county.

The second major research question was concerned with the extent to which support for farmland preservation might be motivated by expected changes in the land market that result in private gain to current resident land holders. The theoretical model derived stylized situations in which the choice to support farmland preservation is in part motivated by an endowment-income effect. Specifically, if publicly preserved farmland influenced private land prices and a resident could be categorized as a net-buyer or net-seller of land services, then the theoretical model demonstrates the potential influence of an endowment income effect. The survey did not elicit the data needed to perform testable hypotheses with regards to the endowment income effect.

However, the survey did collect information on land ownership characteristics. These variables are included in the empirical analysis as exploratory variables. The survey elicited information on the quantity of land owned and whether the respondent was a homeowner or a renter. Respondents who own greater quantities of land may be, relatively, more likely to be net-sellers of land services. If it is assumed, in addition, that the proposal will lead to higher property values, then relatively higher levels of land owned may be associated with an increased probability of voting for the referendum to preserve farmland. However, increases in the quantity of land owned may also be a measure of one's wealth. Increases in the wealth of a respondent, all else constant, would also be expected to increase the probability of support. If resident renters expect farmland preservation initiatives to result in increased rental costs, then renters may be

hypothesized to be relatively less likely to vote for the proposal. However, because expectations with regards to changes in land values were not examined, the aforementioned relationships are exploratory as opposed to testable.

2.6. Results

Table 2.2 describes the frequencies, means, and median, for the dependent and explanatory variables used in the empirical analysis. Table 2.4. in the appendix, provides the frequencies of the cost and attribute variables that were constructed to be orthogonally related. Where possible, the summary statistics are compared with general population information concerning Kent County. The median income of respondents was $50,000 which is close to the $44,512 figure from the 1990 U.S. census. Approximately 60% of the respondents were male; the U.S. census data suggests that approximately 50% of the population are male. The average age of our respondents was approximately 48, slightly higher then the average age, 44, reported by the 1990 census.

Table 2.2. Description of Variables

Variable	Description	Survey Results	Kent County[1]
Vote	For	34.1%	
	Against	65.9%	
Income	Mean	62,845	
	Std. Dev.	45,334	
	Median	50,000	44,512[2]
Acres	Mean	7	
	Std. Dev.	25	
Acres (Urban Only)	Mean	.82	
	Std Dev.	2	
FLand	% who own	17.2%	
Age	Mean	48.83	44[3]
	Std. Dev	15.29	
Gender	Male	61.5 %	49.2%
	Female	38.5%	50.8%
Children	Mean	1.32	
	Std. Dev.	1.48	
Education	Less than College	66%	80%[4]
	College or higher	44%	20%
Renter	Rent	15.5%	29.7
Stratified Sample	% Urban	53.4 %	
	% Rural	46.6%	

[1] Unless otherwise noted data come from 2000 census Summary File 1.

[2] U.S. Census 1997 model based estimates.

[3] Mean age for population age 20 and above (U.S. Census 2000).

[4] From the 1990 Census Summary Tape File 3 (Educational Attainment of population above 25 years of age).

Table 2.3, provides regression results using a probit model. The probability that a respondent will vote for the initiative is estimated to be a function of the cost of the program, attributes of the farmland to be preserved, and socio-economic characteristics. The estimated Beta coefficients relate to changes in the probability of voting yes given incremental changes in the explanatory variables. The data is weighted using probability weights. Probability weights represent the inverse probability that an observation was selected from a rural or urban area (as constructed in the survey design)[6].

The standard errors are referred to as 'Robust' because they are estimated using a Hubert-White estimation procedure clustering individual responses. Clustering by the individual recognizes the individual as the primary sampling unit and suggests, for purposes of estimating the standard errors, that the error terms are only independent between different individuals (STATA, 1997) . While the use of weighted data and robust variance estimates are reported, regression results without the use of weights or robust variance estimates provide similar results with respect to statistical significance and directional signs of the estimated coefficients.

The predictive capacity of the empirical model is summarized at the bottom of the Table 2.3. The model predicts seventy-one percent of the votes correctly. However, it should be noted that in actuality respondents voted no to 64% of the proposed PACE

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[6]The probability that an observation is an urban household was approximately 1 in 2675 (divide total urban households (189,938) by urban sample (71)). The probability that a rural household was selected was approximately one in 370 (divide total rural households (22,952) divided by rural sample (62)). Rural households are over represented in the sample and thus the survey weights adjust for this bias. To maintain the relative proportion between rural and urban but allow each of the referendum choices to be weighted as a separate survey observation, each of the probabilities above is divided by 3 (the number of respondent choices). Thus the final probability weights are 891 for the urban strata and 123 for the rural strata.

Table 2.3. Probit Model Regression Results

Dependent Variable: Vote		
Explanatory Variables; DV = Discrete Variable;	Probit; ( )=Robust Std. Errors	Marginal Effects at Mean Values
β_1; Cost	-.0104*** (.002)	-.0037
β_2; DV = 1, if High Productivity Farmland	-.2616 (.234)	-.0913
β_3; DV= 1, if Low Productivity Farmland	-.3668* (.224)	-.1273
β_4;DV= 1, if High Env.Quality Index	.2338 (.187)	.0853
β_5;DV = 1, if Low Env.Quality Index	-.1454 (.2497)	-.0516
β_6; DV = 1, if Farmland Next to Highway	.0612 (.2231)	-.0220
β_7; DV = 1, if Farmland in the Fruit Ridge	.8046*** (.262)	.2964
β_8; Log of Family Income	.3511* (.2162)	.1257
β_9; Acres of Land Owned	.0267*** (.010)	.0095
β_{10}; DV = 1, if Own Farmland	-1.468*** (.466)	-.3321
β_{11}; Age	.0007 (.008)	-.0002
β_{12}; DV = 1, if Female	.3598 (.249)	.1299
β_{13}; Children	-.2434*** (.092)	-.0871
β_{14};DV = 1, if College Education or Higher	-.0794 (.284)	-.0283
β_{15} ; DV = 1, if Renter	.2465 (.3328)	.0908
β_{16}; Constant	-3.504 (2.421)	NA
#obs	327	
# of Strata	2	
Number of Clusters	109	
F(15,93)	3.59	
Prob>F	.0001	
% of No Correctly Predicted	82%	
% of Yes Correctly Predicted	52%	

*** signficant at .05 level; **significant at .1 level; * significant at .2 level

scenarios. Thus a model that predicted 100% of the votes to be no would be correct 64% of the time. The percentage of yes's predicted correctly by the model is approximately 52%. The percentage change of no's correctly predicted by the model is 82%.

For ease of interpretation, column 2 in table 2.3, presents the marginal effects for the coefficient estimates at variable means. The following discussion refers to the marginal effects when interpreting the economic significance of the coefficient estimates. As expected the cost of the PACE proposal is an important influence on the probability that one will vote for the program. The estimated beta coefficient for cost had a p-value of .000. For discussion puposes statistical significance refers to coefficient estimates that are considered statistically different from zero using standard significance levels (.05,.1). As hypothesized, increases in the cost of the program are associated with a decreased probability that one will support the initiative. Doubling the cost of the program is expected to reduce the probability of support by approximately 37 percentage points. The income variable was positive indicating that an increased level of family income is also associated with an increased probability of supporting the initiative. The p-value of the income variable is .107. A doubling of the income variable is expected to increase the probability of support by approximately 12%.The consistency of the empirical results with theoretical expectations supports the implicit assumption that the survey respondents took the hypothetical referendum seriously.

Interestingly, the estimated coefficients describing the environmental and productivity variables (coefficients β_2 , β_3, β_4, and β_5) were not statistically different from zero at the .05 significance level. Of these four coefficients only β_3, the coefficient estimate that measures the probability effect of farmland being described as "low

productivity farmland", had a p-value (.106) reasonably close to standard significance levels. Farmland described as low productivity decreased the probability that one would support the farmland initiative by approximately 12 percentage points.

These results may suggest that once cost and other socio-demographic characteristics are accounted for, variation in environmental quality and productivity, as described by the survey are relatively insignificant variables in influencing a respondent's vote for or against the preservation referendum. The lack of statistical significance may be in part due to the high regard that respondents generally hold for farmland. For example, approximately 50% (77%) of the respondents agreed or strongly agreed that farmland protected water quality (wildlife). Perhaps descriptions of 'below' and 'above' average environmental quality are relatively less important than other factors when respondents view farmland, in general, as providing high environmental quality.

The probability that a respondent will support a preservation program was positively influenced if the farmland was described as being in the 'Fruit Ridge' of Kent County. All else equal, a PACE proposal designed to preserve farmland in the Fruit Ridge increased the probability that a respondent would vote for the proposal by 29 percentage points. This finding is consistent with the focus group discussions in which the 'Fruit Ridge' area was identified as an 'important' area in Kent County. The survey language defined the Fruit Ridge as an area in 3 townships whose relative altitude and proximity to Lake Michigan made it well suited for growing fruits. Thus the term Fruit Ridge comprises both a location and a particular agricultural use. In addition, it may reflect any 'brand name' type appeal that has become associated with the area. The other

location variable, farmland located next to the highway, did not statistically influence the probability that one would support the farmland preservation initiative.[7]

All else constant, increases in the quantity of land owned increased the probability of voting for the referendum. The estimated coefficient, B_9, has an associated p-value of .012. However the economic significance of this variable is quite small, a doubling of the quantity of land owned increases the probability that a respondent will vote for the preservation initiative by 1%. The majority of the non-farmland owner respondents, 83%, had acreage of less than 2 acres. The remaining 17%, approximately 7% of the sample had between 2 and 5 acres while nearly 10% owned land of between 5 and 30 acres.

Respondents categorized as owning farmland were less likely to vote for the PACE proposal than other respondents. The coefficient estimate for this category, B_{11}, was negative and statistically significant with a p-value of .002. Moreover, the economic interpretation of this variable suggests that identifying oneself as a farmland owner decreased the probability of supporting the PACE proposal by 33 percentage points.

There are a number of plausible explanations for the inverse relationship between ownership of agricultural land and support for farmland preservation. One explanation, consistent with the theoretical model, turns on the assumption that agricultural land-owners are net-sellers of land. If agricultural land-owners are net-sellers of land and the

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[7]A joint F-test was run to examine whether the aforementioned coefficient estimates (B_1-B_6) varied across respondents' location (rural or urban). A joint F-test examining this hypothesis failed to reject the null hypothesis that urban responses were significantly different than rural responses ($F(6,102)= 1.72$; Prob > F = 0.1248). Individual t-statistics for the interaction of urban-highway and urban-Fruit Ridge suggested that urban respondents were more likely to support preservation programs designed to preserve farmland in the Fruit Ridge or farmland next to highways than their rural counterparts. The t-statistics of the interaction variables were 2.430 and 2.049 respectively.

value of land falls as a result of the proposal, the theoretical model would suggest an inverse relationsip between agricultural land-owners and support for farmland preservation. Several agricultural land-owners suggested that they were uncomfortable with the idea of PACE because they feared it would limit their capacity to sell their own land. This may suggest that farmers link PACE programs to other prominent land use controls like zoning.

An alternative explanation for the inverse relationship between support for farmland preservation and ownership of agricultural land involves the concept of diminishing marginal utility. Agricultural land owners may already enjoy a high level of the non-market benifts associated with farmhand. Thus a proposed PACE program may contribute less to the welfare of an agricultural land owners than other respondents in the survey.

Of the remaining socio-economic variables (age, gender, # of children, education, and renter) only the estimated coefficient on the number of children was statistically significant (p-value of .01). A doubling of the number of children reduced the probability of supporting the PACE initiative by 8 percentage points. One interpretation of this finding is that, all else equal, increases in the number of children reduces the per-capita income and thereby reduces the probability that one is willing to incur the cost to preserve farmland.

2.7. Conclusions

A matrix of public and private institutions which constitute the economy are constantly involved in a process of allocating resources across space and time. Influencing that allocation is a difficult task because agreement on the appropriate

objective and the means of obtaining the objective are seldom clear. In cases where the resource is highly differentiated, the motivations behind competing objectives may be complicated by different understandings of the resource itself which may in turn complicate perceptions of a resource's current and future value. Moreover, different resource allocations may have implications for the distribution of benefits and losses.

This research noted a tendency in previous analyses to examine demand for farmland preservation under an implicit assumption that farmland was a homogenous good. Moreover, theoretical models explaining demand for farmland preservation were often guided by an assumption that farmland preservation did not result in pecuniary gains to some and losses to others. This research relaxed these assumptions and examined the extent to which variation in respondent characteristics and variation in descriptions of farmland attributes influence the likelihood of resident support for farmland preservation.

The survey findings and regression results were consistent with a priori expectations; resident support for farmland preservation was found to be inversely related to the cost of the program and positively associated with a respondent's income. The non-trivial implication of this finding is that public efforts to preserve farmland have an associate opportunity cost. Preservation efforts may want to consider these costs in their proposed design. The regression results from this research suggest that respondents were highly sensitive to the private costs of the proposed initiative to preserve farmland, as costs increased the probability of support for the proposed farmland preservation initiative declined.

The empirical findings also suggested that respondents were more likely to vote for a farmland preservation effort designed to preserve farmland located in a uniquely defined area within Kent County, referred to as the Fruit Ridge. Therefore, current preservation efforts in Kent County may find wider public support for the preservation initiative if they target preservation efforts on land located in the Fruit Ridge rather than the County as a whole.

Future research may be able to gain greater insight into motivations for supporting farmland preservation by further examining respondent's affinity towards the Fruit Ridge. One plausible explanation is that targeting farmland located in the Fruit Ridge provided a brand name recognition which in turn motivated support. This brand name recognition may result from a preference for land involved in fruit production rather than more traditional crops like corn and soy beans. However, it is important to note that a number of different agricultural activities, other than those producing fruits take place in the Fruit Ridge. In addition, fruits are grown in areas of Kent County outside the Fruit Ridge.

An alternative explanation for the strong support for preserving farmland in the Fruit Ridge is that the brand name recognition that people are willing to pay for provides a sense of place. Thus, similar to marketing slogans that urge buyers to "buy American" or "buy local", it may be that farmland located in the Fruit Ridge is uniquely identified and preferred to farmland identified by the boundaries of the County. Future research might clarify the social construction of the Fruit Ridge--- how this term came to be, how and why it is reified. The practical implications of such research might be quite significant because it suggests that agriculture activities can add value by uniquely

informing ones understanding of place. Activities that enhance these relationships can be further examined.

The regression results did not find that variations in the described level of agricultural productivity or environmental quality strongly influenced the probability that a respondent would support the preservation proposal. To some extent this finding may be explained by the small sample and by the limited description of variation (above average, average, below average). Still, the weak influence of these attributes may suggest a need for future research that re-examines the tendency of current State and local governments to prioritize farmland preservation based on the potential agricultural productivity of the land.

In some cases it may be that preference for farmland preservation is motivated by private concerns about the price of land. These concerns may arise if a farmland preservation initiative significantly alters the supply of land for development and thereby alters land prices in a given locality. A theoretical model was developed that categorized residents into three different groups depending on their consumption-endowment pattern: (1) net-buyers; (2) net-sellers; and, (3) those who consume exactly their endowments. The theoretical model suggests that changes in land prices distribute benefits and losses depending on which category a resident is categorized in. In cases where farmland preservation efforts generate a pecuniary externality to private land holders the model suggests that the distribution of costs and benefits will depend on respondents land holdings and land use. The survey and associated empirical analysis were not able to test this aspect of the theoretical model. Empirically testing these relationships will require an improved understanding of the extent to which respondents anticipate a relationship

between private land prices and public efforts to preserve farmland. Moreover, information on the character of both a respondent's land use and level of land ownership will be needed.

In summary this research was designed to address the broad question, 'who supports farmland preservation and why?'. The theoretical model and survey results make marginal contributions to this effort. The theoretical model differentiates respondent support for farmland preservation by differences in land ownership characteristics. The survey method and empirical analysis examine how different descriptions of farmland influence the probability that one will support a public effort to preserve farmland. The results have the potential to help citizens and policy makers as they involve themselves in the on going problem of influencing land uses across time and space. The theoretical model and empirical results emphasize the need to carefully consider the basis for preserving one parcel of farmland rather than another and the potential distribution of gains and loses that may accompany such policies.

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Appendix 2

Copy of Survey In Original Format and Table A2.1.

Survey A

What Do You Think About
Farmland Preservation?

Introduction to the Survey

You have been selected at random to participate in a survey designed to increase understanding of Kent County residents' opinions about farmland and farmland preservation. The survey is being conducted under the supervision of Dr. Patricia Norris who is a faculty member at Michigan State University. The opinions of people like you are important because we are trying to understand County residents' opinions about these issues. Results from the survey will be used to inform policy makers and other researchers about attitudes toward farmland preservation.

This survey is completely voluntary. You may choose not to participate at all or refuse to answer certain questions. However, you may be assured that your responses will remain completely confidential. All survey results will be released as summaries; no individual's answers will be identified; and your privacy will be protected to the maximum extent allowable by law.

The survey is designed to take about 10 minutes to fill out. At the end of the survey there is space for you to provide comments about any thoughts or concerns you might have. In the event that you would like to discuss any questions about the research, please contact the principal researcher, Dr. Patricia Norris (Michigan State University) at (517) 353 - 7856. If you have any concerns about your rights as a participant you may contact Dr. David Wright at Michigan State University's office of Research and Graduate Studies (517) 355 - 2180.

You indicate your voluntary agreement by completing and returning this questionnaire. Thank you very much for helping with this important study.

Survey Language

There are some specific words that are used in the survey. We want you to have a good idea of what we mean when we use these words. **You may want to refer to these definitions as you fill out the survey.**

Farmland	Farmland describes privately-owned land that includes: 1. agricultural land where hay, crops, fruit trees or Christmas trees are grown 2. pastures for farm animals 3. buildings used by farmers
Farmland in Kent County	**There are about 186,453 acres of farmland in Kent County.** Farmland takes up about 30% of the total land area in Kent County. **Between 1992 and 1997** farmland acreage declined by about 2% (about 4,000 acres).
Fruit Ridge	**The Fruit Ridge refers to an area of land** where high elevation, hills, and distance from Lake Michigan make it well suited for growing fruits, mainly apples. **In Kent County, the fruit ridge is located in the northwestern portion** of the County in Alpine, Sparta, and Tyrone townships.
Environmental Quality Index	**Scores farmland** based on its current effect on: (1) *soil erosion*, (2) *wildlife habitat*, and (3) *surface and ground water quality.* **Below average** refers to farmland with an Environmental Quality Index is lower than that of the average acre of farmland in Kent County. **Above average** refers to farmland with an Environmental Quality Index that is better than the average acre of farmland in Kent County.
Productivity	**Below average productivity** refers to farmland where soil type or unique land features contribute to per acre yields or production that are less than the County average. **Above average productivity** refers to farmland where soil type or unique land features contribute to per acre yields or production that are greater than the County average.
Highway	**State and U.S. highways in Kent County.** Specifically: **State #**: 11, 21,37, 44, 45, 46, 50, 57; **U.S. #:** 131; **Interstate #:** 96,196.

Section 1: Opinions about Farmland

In this section we make a number of statements about **farmland in Kent County**. After each statement please check one box that best describes what you think about each statement.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. Farmland protects water quality.	☐	☐	☐	☐	☐
2. The current quantity of farmland is needed to ensure an adequate food supply.	☐	☐	☐	☐	☐
3. Farmland protects wildlife.	☐	☐	☐	☐	☐
4. Farmland provides scenic beauty.	☐	☐	☐	☐	☐
5. Farmland supports the local economy.	☐	☐	☐	☐	☐
6. Farmland provides a sense of local heritage.	☐	☐	☐	☐	☐
7. Farmland protects air quality.	☐	☐	☐	☐	☐
8. Farmland provides open space.	☐	☐	☐	☐	☐
9. Farmland prevents urban sprawl.	☐	☐	☐	☐	☐

Section 2: Characteristics of Farmland

The state of Michigan currently has a program designed to preserve farmland. The State has limited funding, so the program prioritizes farmland based on certain characteristics of the land. In this section we make a number of statements **concerning which farmland should be preserved.** After each statement please check one box that best describes what you think about each statement.

Which farmland should be preserved?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
10. Farmland with above average productivity.	☐	☐	☐	☐	☐
11. Farmland that can be seen from the highway.	☐	☐	☐	☐	☐
12. Farmland on the Fruit Ridge.	☐	☐	☐	☐	☐
13. Farmland faced with development pressure.	☐	☐	☐	☐	☐
14. Farmland that is located near other blocks of protected farmland.	☐	☐	☐	☐	☐
15. Farmland where matching funds are available from local governments or local organizations.	☐	☐	☐	☐	☐
16. Farmland with an above average Environmental Quality Index.	☐	☐	☐	☐	☐

Section 3: A Plan to Preserve Farmland in Kent County

One way to make sure that some farmland remains available for agricultural use in Kent County is for the County government to set up a program to 'Purchase Agricultural Conservation Easements' (PACE) on farmland. In this program farmland is appraised for what it would be worth on the open market and then for what it would be worth if it could only be used for farming. This difference is then paid to farmland owners who want to participate.

In return for the payment, the farmland owner allows the County to place an agricultural conservation easement on the farmland. The easement is a legal arrangement that restricts development of farmland for non-farm uses like new residential or commercial buildings. Participating farmland owners would maintain all other ownership rights. For example, farmland owners would still have the right to live on and farm the land as well as rent or sell the land. However, if the land is sold, the conservation easement will remain with the land and apply to the new landowner.

The Purchase of Agricultural Conservation Easement program (PACE) has five important characteristics:

1. Owners of farmland are free to choose whether they want to sell a conservation easement to the County government.
2. The County reviews offers from farmland owners and decides which land it wants to purchase a conservation easement on.
3. The County and landowners agree on the price of the conservation easement.
4. The County places a conservation easement (a legal restriction) on the farmland, guaranteeing that the land will permanently remain un-developed, as farmland.
5. The farmland owner who sells the easement maintains all other ownership rights.

Section 4: PACE Proposals for Kent County

In this section you are presented with three different proposals for a PACE program in Kent County. Because there are many different cost estimates and types of farmland, the proposals differ by: (1) **Cost** to each household; (2) **Productivity** of farmland preserved; (3) **Location** of farmland in the County, and (4) **Environmental Quality Ranking** of farmland.

Suppose Kent County were to have a vote on whether to place a special County tax on each household to pay for a program to Purchase Agricultural Conservation Easements on 10% (18,000 acres) of the farmland in Kent County. How would you vote?

Please vote on each of the three proposals on the following pages. **Vote on each proposal as if it were the only one you would face in the voting booth.**

Turn Page to Vote

Ballot Proposal

If a majority of Kent County residents vote yes, your household will pay the special County tax and the County Government will purchase agricultural conservation easements on farmland with the characteristics described in the box below.

If a majority of Kent County residents vote no, your household will not pay the special tax and the County Government will not purchase agricultural conservation easements on farmland in the County.

Proposal A summarizes the proposal on which *you* are asked to vote:

Proposal A	
Purchase of Agricultural Conservation Easements (PACE)	
Cost:	$10 **per household each year for the next five years.**
Quantity:	**10% of the farmland** in Kent County (18,000 acres)
Location:	**Anywhere** in the County
Productivity:	**Below average** farmland productivity
Environmental Quality Index Score:	**Below average** Environmental Quality Index

17. Please Indicate Your Vote in one box below:

Vote for Proposal A	Vote against Proposal A
☐	☐

Reminder: Please Vote on Each Proposal

Ballot Proposal

If a majority of Kent County residents vote yes, your household will pay the special County tax and the County Government will purchase agricultural conservation easements on farmland with the characteristics described in the box below.

If a majority of Kent County residents vote no, your household will not pay the special tax and the County Government will not purchase agricultural conservation easements on farmland in the County.

Proposal B summarizes the proposal on which *you* are asked to vote:

Proposal B	
Purchase of Agricultural Conservation Easements (PACE)	
Costs:	$50 **per household each year for the next five years**
Quantity:	**10% of the farmland** in Kent County (18,000 acres)
Location:	**Fruit Ridge**
Productivity:	**Above average** farmland productivity
Environmental Quality Index Score:	**Below average** Environmental Quality Index

18. Please Indicate Your Vote in one box below:

Vote for Proposal B	Vote against Proposal B
☐	☐

Reminder: Please Vote on Each Proposal

Ballot Proposal

If a majority of Kent County residents vote yes, your household will pay the special County tax and the County Government will purchase agricultural conservatrion easements on farmland with the characteristics described in the box below.

If a majority of Kent County residents vote no, your household will not pay the special tax and the County Government will not purchase agricultural conservation easements on farmland in the County.

Proposal C summarizes the proposal on which *you* are asked to vote:

Proposal C	
Purchase of Agricultural Conservation Easements (PACE)	
Costs:	$100 **per household each year for the next five years**
Quantity:	**10% of the farmland** in Kent County (18,000 acres)
Location:	Next to the **Highway**
Productivity:	**Average** farmland productivity
Environmental Quality Index Score:	**Below average** Environmental Quality Index

19. Please Indicate Your Vote in one box below:

Vote for Proposal C	Vote against Proposal C
☐	☐

Section 5: General Information

Note: We use this information to see if our survey sample is similar to that of the entire population of Kent County. Your answers will be kept confidential. Please answer each question.

Please mark each box indicating yes or no to the following questions:

	Yes	No
20. Do you own farmland?	☐	☐
21. Did either of your parents live on a farm?	☐	☐
22. Do you belong to an environmental club or organization?	☐	☐
23. Do you support the Kent County Government's involvement in land use issues?	☐	☐

24. What is the highest grade of school you finished? (Mark one box below)

☐ Grade School ☐ High School ☐ College graduate ☐ Graduate Degree

25. Is the house, apartment or mobile home in which you live:

☐ Owned by you or someone in this household.

☐ Rented for cash rent.

☐ Occupied without payment of cash rent.

26. Approximately how many acres of land in Kent County do you own? (Fill in Blank)

_____

27. How many years have you lived in Kent County? (Fill in Blank)

_____

28. What year were you born? (Fill in Blank)

_____

29. How many children, under 25, do you have? (Fill in Blank)

_____

30. Are you male or female? (Mark one box below)

☐ Male ☐ Female

31. What term best describes where you live? (Mark one box below)

☐ Urban ☐ Suburban ☐ Rural

32. Please mark one box in the table below that best describes what you think your total family income will be this year before you pay taxes. (Mark one box)

☐	$0 to $19,999	☐	$140,000 to $159,999
☐	$20,000 to $39,999	☐	$160,000 to $179,999
☐	$40,000 to $59,999	☐	$180,000 to $199,999
☐	$60,000 to $79,999	☐	$200,000 to $219,999
☐	$80,000 to $99,999	☐	$220,000 to $239,999
☐	$100,000 to $119,999	☐	$240,000 to $259,999
☐	$120,000 to $139,999	☐	$260,000 or greater

33. Please mark one box in the table below that best describes what the State Equalized Value (SEV) of your property is. The State Equalized Value represents the assessors' appraisal of ½ the market value of your property. (Mark one box)

☐	rent/don't own	☐	$140,000 to $159,999	☐	$300,000 to $349,999
☐	$0 to $19,999	☐	$160,000 to$179,999	☐	$350,000 to $399,999
☐	$20,000 to $ 39,999	☐	$180,000 to $199,999	☐	$400,000 to $449,999
☐	$40,000 to $ 59,999	☐	$200,000 to $219,999	☐	$450,000 to $499,999
☐	$60,000 to $ 79,999	☐	$220,000 to $239,999	☐	$500,000 to $599,999
☐	$80,000 to $ 99,999	☐	$240,000 to $259,999	☐	$600,000 or greater
☐	$100,000 to $119,999	☐	$260,000 to $279,999		
☐	$120,000 to $139,999	☐	$280,000 to $299,999		

We w
farml
comr

We welcome any comments or criticisms you might have concerning the survey, farmland preservation, or other issues. Please use the space below to make any written comments you would like to make.

This is the end of the survey! Your participation in the survey is greatly appreciated! Please take the time to check the survey and make sure you have answered all thirty-three questions.

Table A2.1. Description of Orthogonally Variables in Survey

Variable	Description	Valid Percent by Frequency
Cost of Program	$10	27%
	$20	6%
	$50	27%
	$100	33%
	$300	6%
Productivity of Farmland	Low	35%
	Average	33%
	Above	32%
Environmental Quality	Low	38%
	Average	32%
	Above	30%
Location	Anywhere	32%
	Highway	33%
	Fruit Ridge	34%