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Measuring Amenity Benefits from Farmland: Hedonic Pricing vs. Contingent Valuation

RICHARD C READY, MARK C. BERGER,
AND GLENN C. BLOMQUIST

ABSTRACT The amenity value to Kentucky residents from horse farm land was estimated using both the contingent valuation method and the hedonic pricing method The hedonic pricing model included both the housing and labor markets. A value function estimated from dichotomous choice contingent valuation responses showed that the value of a change in the level of the horse farm amenity was sensitive to the size of the change, with no evidence of value that is independent of the size of the change The two methods generated estimates of the external benefits from horse farm land that were within 20 percent of each other

Introduction

Concern over the loss of productive farmland to development associated with the expansion of urban and suburban areas has led to policies aimed at preserving farm land, including favorable taxation and purchase of development rights. While these policies have most often been motivated by concern over the nation's food supply (Lopez et al. 1994b), they have been motivated also by the external benefits that non-farm dwellers receive from the existence of nearby farm land (Fischel 1982) Consideration of these external benefits also has implications for optimal design of farm price and income support programs (Lopez et al 1994a).

Richard C Ready is a professor of economics and social sciences at Agricultural University Norway, Ås, Norway, and Mark C Berger and Glenn C Blomquist are professors of economics at the University of Kentucky, Lexington, KY *This research was financially supported by a grant to the University of Kentucky Center for Business and Economics Research by the Greater Lexington Chamber of Commerce Opinions expressed are those of the authors Thanks go to Georges Abbey and Lynne Kelley for their help in survey design and administration Three anonymous referees provided helpful comments*

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Non-farm dwellers experience myriad external benefits and costs from nearby farm operations. External costs can include offensive odors from livestock operations, windblown dust, pesticide drift, and groundwater contamination by agricultural chemicals. External benefits to non-farm dwellers from farmland can include use and non-use benefits. Use benefits would include enjoyment of scenic views, wildlife habitat, outdoor recreation, and protection from all of the external costs associated with urbanization, including traffic congestion, air pollution, noise pollution, and crime (Halstead 1984) Non-farm dwellers may also enjoy non-use benefits from knowing that farm families can continue in their chosen profession, and can hand down that profession and their land to their children. In addition, non-farm dwellers in an area that has historically been predominantly agricultural may place some value on simply knowing that this important piece of the character and heritage of the area still exists (Bergstrom et al. 1985). On balance, these benefits mean that farmland can provide positive amenities to non-farm dwellers

Two methods that can be used to estimate the monetary value of these external benefits and costs are contingent valuation and hedonic pricing models.[1] In a contingent valuation (CV) study, survey respondents are placed in a hypothetical situation where they must make a decision that affects the amount of farmland that will continue to exist. If respondents choose to preserve more farmland, they must give up some income. The choices made in this hypothetical situation reveal the respondent's compensating variation for changes in the amount of farmland. CV has been used to measure the external benefits from farmland in South Carolina (Bergstrom et al. 1985), Massachusetts (Halstead 1984), Alaska (Beasley et al. 1986), Great Britain (Willis et al. 1993; Willis and Garrod 1993; Bateman et al. 1994), and Sweden (Drake 1992).

In a simple hedonic pricing model (HPM), households are assumed to migrate into or out of geographic regions based on tradeoffs between quality of life in those regions and differences in housing prices. More complex models also include consideration of differences in wages. Quality of life is influenced by a number of factors, one of which is the amount of farm land in the region. By looking at the available combinations of farmland amenities, house prices and wage rates, we can infer a representative household's marginal rate of substitution between quality of life and net income. While the HPM approach has been widely used for other location-specific amenities, we know of no prior studies that have used it to value farmland. The closest analogues are studies by Garrod and Willis (1992a, 1992b) that use the HPM approach to value woodlands and other natural countryside amenities.

The CV method has come under some criticism lately because it relies on answers to hypothetical questions, rather than on observed economic choices One concern regarding CV is that respondents express a value that is motivated, at least in part, by the good feeling that they get simply from giving to a worthy cause regardless of whether the monetary contribution results in any change in the level of the desired amenity. This good feeling has been referred to as warm glow (Andreoni 1989, 1990) or moral satisfaction (Kahneman and Knetsch 1992a). A related concern regarding CV is that responses are not always sensitive to the quantity and quality (scope) of the proposed change (Diamond and Hausman 1993). Whether these concerns necessarily contaminate all contingent valuation estimates has been the subject of debate (Smith 1992, Kahneman and Knetsch 1992b). At a minimum, it is advisable to test for these potential problems in CV repsonses (NOAA 1993). This can be done by estimating a value function from the CV data, and assuring that it has a positive slope (indicating sensitivity to the scope of the change) and does not have a non-zero intercept (which would be consistent with a warm glow motivation for responses)

The hedonic method is based on observed economic choices, and is widely recognized as a valid valuation approach. However, HPM approaches can only measure those values that are tied to location. These would include the use values listed above, but may not include values associated with altruism toward farm families or with preservation of our cultural heritage Where such non-use values are large, CV may be the preferred method in spite of its reliance on hypothetical answers (Young and Allen 1986)

This study will estimate the value associated with preservation of horse farms in Kentucky. Horse farms in Kentucky are noted for their scenic beauty, with lush green rolling hills, distinctive stone and plank fences, opulent farm houses and picturesque barns. In addition, Kentuckians take pride in the history of horse breeding and racing in Kentucky, and may therefore enjoy some amount of existence value from the preservation of the equine industry. This particular type of farmland is of interest, as there is a perception that the horse industry in Kentucky has been in decline. State and local governments have several policy tools available to slow or stop this decline, for example zoning and/or subsidies, but those tools cost money The value of preserving horse farms in Kentucky is estimated here using both CV and a multimarket HPM. A value function will be estimated from the CV data, and tested for positive slope and non-zero intercept. A comparison of the CV and HPM estimates serves as a consistency check for both methods.

A Multi-Market Hedonic Pricing Model

Theoretical Model. The multimarket hedonic model used here is developed in more detail in Blomquist et al. (1988) and presented here in abbreviated form. Several simplifying assumptions are made to make the theoretical model manageable. The empirical analysis follows from the model but also accounts for additional complexity encountered in the data.

In the model, households attempt to maximize utility and firms attempt to minimize costs by their location decisions. A fixed number of urban areas in which individual households and firms may locate is assumed. Before locating, households and firms are freely mobile. Each urban area is composed of a set of counties. Each county has a fixed amount of land and offers a different set of amenities that resident households and firms enjoy. Counties in an urban area are linked together by agglomeration effects in that the population of the entire urban area affects the production costs of a firm, regardless of the county in which it is located.

Households gain utility through use of local residential land, local amenities, and a composite commodity representing all other market goods consumed Households gain access to the amenities of the kth county through the purchase of residential land q_k. Land and the composite commodity are purchased out of labor earnings. Each household is endowed with one unit of labor.[2] A household in county k sells its labor to local firms and earns a wage w_k. Earnings comprise all of income and all labor is alike. Labor transportation costs within a county are assumed to be negligible

A household in the kth county has an indirect utility function given by

$$v^k = v^k(w_k, r_k, a_k) \tag{1}$$

where r_k is the rental price of land in county k and a_k is an index of local amenities. The fixed, unit price of the composite commodity is suppressed If a_k is a positive amenity, then $\partial v^k / \partial a_k > 0$. The amount of land within county k is fixed at Q_k, so that the population of county k is $N_k = Q_k/q_k$. Given that households maximize utility, this implies that a county's population is a function of its own wage, rent, and amenity levels.

Firms combine local labor and capital to produce the composite commodity. The prices of capital and the composite commodity are fixed by international markets Prices and wages are normalized on the price of the composite good, which is set to unity. Production technology is constant returns to scale in labor and capital. Local amenities enter production as shift parameters. There are K^i counties in urban area i. For a firm located in the kth county of the ith urban area, unit production costs are

$$c^k = c^k(w_k; a_k, N^i) \tag{2}$$

The price of capital is left implicit. N^i is the population of the entire urban area, and reflects agglomeration or congestion effects (Tolley 1974).

As individuals and firms locate across different urban areas and across counties within urban areas, wages and rents adjust to clear their respective markets. A spatial equilibrium implies that households cannot improve utility and firms cannot reduce their costs by relocating. The set of wages, land rents, and city sizes that sustains a spatial equilibrium must therefore satisfy three conditions. First, unit production costs, given by (2), must equal the price of the composite commodity (which is unity) in all urban areas. Second, households must attain a common level of utility, u^0, across all counties and all urban areas. Third, population in each urban area equals the sum of population in each county within the urban area. This last condition links equilibrium wages and rents within an urban area through the effect of city size on firms' productivity

Using the set of wages and rents that satisfy these three conditions, one can solve for (a) the implicit price of the amenity a_k, and (b) the comparative static effects of a change in a_k on the equilibrium set of wages, land rents, and city size. Equilibrium wage and land rent differences are used to compute the implicit prices of amenities.[3] These implicit prices, f_k, are obtained by setting (1) equal to a constant, u^0, taking the total differential, and rearranging to obtain

$$f_k = q_k\left(\frac{dr_k}{da_k}\right) - \frac{dw_k}{da_k} \tag{3}$$

where dr_k/da_k is the equilibrium rent differential and dw_k/da_k is the equilibrium wage differential. Comparative static analysis shows that the expected sign of the two differentials depends on assumptions regarding 1) the effect of amenities on households, 2) the impact of amenities on production costs, and 3) the effects of agglomeration. In general, it is not true that the wage differential will always be negative and that the land rent differential will always be positive for a positive amenity. A hedonic price analysis that only looks at land rents, and does not also consider wage differentials, may therefore misidentify positive amenities as disamenities, or vice versa (Roback, 1982, Blomquist et al. 1988).

One problem that arises in empirically implementing the above model is that the amenity price given in (3) depends in part on residential land rents. But, residential land is typically bundled into a package of housing characteristics, making land rents difficult to observe. The model is extended by introducing housing instead of land in the utility function and adding a production function for housing. The amenity price equation then becomes

$$f_k = h_k\left(\frac{dp_k}{da_k}\right) - \frac{dw_k}{da_k} \tag{4}$$

where h_k is the quantity of housing purchased by a household in county k and p_k is the price of housing in county k.

In equilibrium, the implicit price given by (4) is equal to the household's willingness to pay (WTP) to avoid a marginal decrease in the level of the amenity. For non-marginal decreases in the amenity, however, the household's

TABLE 1 REGRESSION ESTIMATES OF HEDONIC HOUSING EXPENDITURES EQUATION
DEPENDENT VARIABLE LOG (MONTHLY HOUSING EXPENDITURES)[a]

Explanatory Variable	Mean	Coefficient	T-statistic
Intercept	1	5 501	(68 61)
Characteristics of Housing Unit			
Renter (yes =1)	410	- 269	(9 46)
Units at Address	2 667	00246	(70)
Age of Structure (Years)	23 729	- 0054	(23 80)
Height of Structure (Stories)	2 443	0327	(8 55)
Rooms	5 395	0815	(38 46)
Bedrooms	3 510	0132	(3 76)
Bathrooms	1 486	251	(50 18)
Condominium (yes=1)	032	- 186	(10 08)
Central Air (yes=1)	314	128	(19 34)
Sewer (yes=1)	886	0188	(2 30)
Lot Larger than an Acre (yes=1)	062	153	(14 04)
Central City (yes=1)	329	- 0919	(15 75)
Renter X Unit	1 992	- 00446	(1.22)
Renter X Age	9 964	00173	(5 21)
Renter X Height	1 220	- 0376	(9 41)
Renter X Rooms	1 623	00128	(29)
Renter X Bedrooms	1 112	00272	(39)
Renter X Bathrooms	479	- 0361	(3 88)
Renter X Condominium	008	283	(9 64)
Renter X Central Air	103	123	(11 70)
Renter X Sewer	395	- 087	(4 47)
Renter X Acre Lot	014	- 196	(9 31)
Amenities Related to Climate, Urban Conditions and Environmental Quality			
Precipitation (inches/yr)	32 021	- 00262	(7 43)
Humidity (percentage)	68 223	- 00557	(9 64)
Heating Degree Days (degree days/yr)	4222 784	- 0000312	(12 98)
Cooling Degree Days (degree days/yr)	1185 171	- 000169	(34 93)
Windspeed (mph)	8 872	0232	(11 27)
Sunshine (percentage of days)	61 358	00415	(7 57)
Coast (yes=1)	349	0769	(13 53)
Violent Crime (crimes/100,000 pop /yr)	681 611	0000925	(13 85)
Teacher/pupil ratio	080	1 468	(8 86)
Visibility (miles)	15 662	- 00189	(7 47)
Total Suspended Particulates (μg/m^3)	73 717	- 00115	(8 68)
Water effluent dischargers (#/county)	1 564	- 0179	(16 69)
Landfill Waste (metric tons x 10^8/county)	467 226	0000208	(10 97)
Superfund Sites (number/county)	858	0310	(19 39)
Treatment, Storage, and Disposal Sites (#/county)	47 591	00057	(9 62)
Equine Amenity			
Horse Farms (#/county)	279 128	- 0000582	(5 13)
R^2			6454
n			3,414

[a] Estimated as annual earnings divided by the product of weeks worked last year and usuall hours per week last year The sample mean hourly wage is $8 04

marginal rate of substitution between the amenity and the composite commodity will increase as the level of the amenity decreases. The constant implicit price given by (4) will therefore underestimate total WTP to avoid a non-marginal decrease in the amenity.

Data Sources and Regression Methods. The core of the housing and wage data are individual records from the 1 in 1000 Public Use A Sample of the 1980 Decennial Census. This large national sample has records for approximately 225,000 individuals and 88,000 households from 350 counties in 285 Standard Metropolitan Statistical Areas (SMSA). In all, 46,004 individual workers and 34,414 housing units from 253 counties for which there are complete amenity data are included in these estimated wage and housing equations.

Retained in the housing sample are housing units on 10 acres or less for which value of the unit or contract rent is reported. The dependent variable in the housing equation is monthly housing expenditure. For renters, this is defined as gross rent including utilities For owners, reported house value is transformed into monthly imputed rent using a 7 83 percent discount rate, based on a study by Peiser and Smith (1985). Monthly expenditures for utilities are then added

Retained in the wage sample are individuals aged 16 and over who reported their earnings, hours worked, and weeks worked, and had positive wage and salary earnings and positive total earnings. The dependent variable in the wage equation is average hourly earnings. It is calculated by dividing annual earnings by the number of hours worked.

The housing equation includes variables from the Census for structural characteristics, central city status, whether the unit is rented or owner-occupied, and interaction terms These are listed in Table 1. The wage equation has variables from the Census for personal characteristics, occupational group, central city status, and interaction terms. These are listed in Table 2 Also included in the wage equation is the percent of the occupational group covered by unions as reported in Kokkelenberg and Sockell (1985).

Several amenity variables are included in both equations. Six climate variables come from the National Climatic Data Center Coast is a dummy variable for whether the county of residence touches an ocean or a Great Lake A violent crime variable comes from the FBI. Teacher-pupil ratios based on school district and county data comes from the Census of Governments. Six environmental quality variables come from the U S EPA

The amenity provided by horse farms might be measured several different ways. Ideally the measure would capture the visual, ecological, and landscape characteristics which are valued by people who do not own the horse farms but who do live in the vicinity The preferred proxy measure, horse farm acreage

TABLE 2 REGRESSION ESTIMATES OF HEDONIC HOURLY WAGE EQUATION
DEPENDENT VARIABLE LOG (HOURLY WAGE)[a]

Explanatory Variable	Mean	Coefficient	T-statistic
Intercept	1	545	(4 68)
Characteristics of Worker			
Experience (age-schooling-6)	17 437	0396	(37.94)
Experience Squared	1513 928	- 000591	(28 72)
Gender X Experience	7 598	- 0156	(10 20)
Gender X Experience Squared	221 286	000277	(9 08)
Schooling (years)	12 76	0567	(44 08)
Race (nonwhite=1)	153	- 127	(10 66)
Gender X Race	0745	135	(8 09)
Gender (female=1)	452	- 0448	(3 45)
Enrolled in School (yes=1)	149	- 0834	(8 78)
Marital Status (married=1)	586	185	(18 47)
Gender X Marital Status	237	- 174	(12 58)
Gender X Children	1 118	- 0339	(10 29)
Health Limitations (yes=1)	0482	- 122	(8 71)
Professional or Managerial (yes=1)	232	322	(28 17)
Technical or Sales (yes=1)	336	165	(16 70)
Farming (yes=1)	012	00524	(18)
Craft (yes=1)	113	196	(15 34)
Operator or Laborer (yes=1)	173	0960	(8 34)
Industrial Unionization (percent)	23 349	00495	(27 48)
Amenities Related to Climate, Urban Conditions and Environmental Quality			
Precipitation (inches/yr)	32 005	- 00216	(4.23)
Humidity (percentage)	68 267	000716	(.86)
Windspeed (mph)	8 895	0102	(3 45)
Sunshine (percent of days)	61 117	- 00164	(2.04)
Violent crime (crimes/100,000 pop /yr)	646 38	0000787	(8 08)
Teacher/pupil ratio	0799	- 653	(2 7)
Visibility (miles)	15 797	- 000321	(89)
Total Suspended Particulates (μg/m^3)	73 242	- 000322	(1 67)
Coast (yes=1)	334	- 00189	(23)
Treatment, Storage, and Disposal Sites (#/county)	46 44	000219	(2 56)
Cooling Degree Days (degree days/yr)	1161 68	- 00000683	(3 90)
Heating Degree days (degree days/yr)	4326 02	- 00000483	(1 42)
Superfund Sites (#/county)	883	0140	(6 25)
Water Effluent Discharges (#/county)	1 51	- 00134	(.85)
Landfill Waste (metric tons x10^8/county)	477 49	0000109	(4 12)
Central City (yes=1)	290	- 0595	(7 04)
Equine Amenity			
Horse Farms (number/county)	277 66	- 0000280	(1 75)
R^2			3070
n			46,004

[a] Estimated as annual earnings divided by the product of weeks worked last year and usual hours per week last year The sample mean hourly wage is $8 04

by county, was not available. Further, there do not exist consistent data that distinguish types of horse farms. Different horse farm types (racing thoroughbreds, show horses, riding stables, working draft horses, etc.) likely generate different levels of external benefit. The 1982 Census of Agriculture provides consistent data for four imperfect proxies of the horse farm amenity: (1) number of horses, (2) number of horses sold in the previous year, (3) number of farms that sold horses in the previous year and (4) number of farms with horses. Number of farms with horses, the fourth measure, is used because it performed better statistically than other proxy measures. The standard errors in the wage and housing price regressions were smaller relative to the size of the coefficients. The number of farms with horses is also the most appealing of the four measures *a priori*. Number of horses or number of horses sold may not be a good indication of the amount of horse farm land valued as an amenity by residents. The number of farms that have sold horses would leave out farms that may be valued as an amenity but did not sell horses in the survey year. The number of farms with horses is the most likely to include all of the farms in a county generating horse farm amenities for residents

Over the 253 metropolitan counties used in the hedonic pricing model, the average number of farms with horses was 279. The counties with the five largest number of farms with horses were vast counties concentrated in the western U.S : Weld (821), CO; Los Angeles, CA; Clackamas, OR; San Diego, CA and Maricopa (983), AZ. The counties with the five smallest number of farms with horses were more eastern, central city counties Ramsey (6), MN, Union, NJ; Essex, NJ; Philadelphia, NJ and Orleans (1), LA. The three Kentucky metropolitan counties included in the hedonic pricing model did not have much higher levels of horse farms than the national sample. Fayette (Lexington) had 403 farms with horses, Jefferson (Louisville) had 169, and Kenton (Cincinnati suburb) had 117. A limitation of using number of farms with horses beyond lumping all types of farms with horses together is that it does not distinguish among farms with various mixtures of horses with other livestock such as cattle. Lancaster, PA with a concentration of Amish people who rely upon horse power has 621 farms with horses. This number is much greater than average and even than Fayette, KY. To the extent the mixture affects the amenity associated with horse farms, then there is measurement error in the proxy variable, and this represents a limitation of our comparison between the hedonic and contingent valuation estimates.

A semi-log functional form was used for both equations with logged dependent variable and a linear combination of the independent variables This form typically provides a good statistical fit,[4] and allows easy interpretation Each of the estimated coefficients represents the percent change in wages or housing prices associated with a one unit change in the independent variable. The total implicit price of the horse farm amenity is then calculated from equation (4) The housing price differential is calculated by multiplying the coefficient from the housing regression by the average annual housing expenditure From this value the wage differential term is subtracted, calculated as the coefficient from the wage regression multiplied by the average annual household earnings.[5]

The resulting implicit price measures the additional annual income that the household would receive if it relocated in a county with one fewer horse farm In equilibrium, the household is willing to pay this amount each year to avoid a one unit decrease in the number of horse farms in its county of residence.

Results. Regression results for the housing price equation are presented in Table 1. The regression is highly significant and explains 65 percent of the variability in monthly housing expenditures. Of particular interest is the coefficient on number of horse farms. In an analysis that only considers the housing market, the coefficient on this variable might be expected to be positive However, in a multimarket analysis, the coefficient in any one market can be negative even if the variable measures a positive amenity. The estimated coefficient on number of horse farms is found to be negative, and significantly different from zero at 0.05 level.

Regression results for the wage equation are presented in Table 2 Again, the regression is highly significant, and explains over 30 percent of the difference in workers' wages. The negative sign (significant at the 0.10 level) on Horse Farms indicates that people are willing to work for lower wages in areas with greater levels of equine amenities.

To calculate the implicit price for an additional horse farm for the typical household residing in Kentucky, estimates of the average value of annual housing expenditures and of annual household earnings are needed. The average privately owned housing unit building permit value in Kentucky for 1990 can be calculated from U S. Bureau of the Census (1992, Table 1209). An estimate of 1990 household earnings in Kentucky was calculated by dividing total earnings by Kentucky residents obtained from U S. Department of Commerce (1994) by the number of households in Kentucky obtained from U.S. Bureau of the Census (1992, Table 60). The estimated implicit price of one horse farm for the average Kentucky resident as defined in equation 4 is then $0.43. A typical Kentucky household would therefore be willing to pay $0 43 each year to prevent the loss of one horse farm in its county of residence.[6]

A Contingent Valuation (CV) Survey

Survey Instrument Design. A CV survey was conducted in 1990 to estimate WTP to prevent a decrease in the number of horse farms in Kentucky.[7] The hypothetical scenario used in the CV survey was constructed based on discussions with equine industry leaders and focus groups consisting of non-farm dwellers living near urban/rural boundaries. Focus group participants were willing to believe that the number of horse farms in Kentucky would decline without government intervention. This perception was also held by respondents to the CV survey, 72 percent of whom agreed with the statement, "The number of horse farms in Kentucky is declining." Kentucky residents also felt that horse farms were a positive amenity. Ninety percent of survey respondents disagreed with the statement "Kentucky would be a nicer place to live if less land was used for horse farms." Survey respondents and focus group participants identified three main reasons why Kentuckians like horse farms. First, horse farms are pretty to look at and drive through. Second, horse farms serve as an impediment to urban and suburban sprawl. Third, horse breeding and racing is an important part of the heritage of Kentucky. The possibility of a state program to preserve horse farms was therefore credible to respondents.

Application of the CV method to land use issues such as this one is complicated by public attitudes toward government control of land use. Many citizens hold strong opinions that the government should not restrict or try to influence land owners' decisions regarding their own land. They are opposed on principle to government involvement including not only zoning and planning efforts, but also public subsidies to private land owners. The aversion to public subsidies was particularly strong in this situation, due to the widely-held perception that many horse farm owners are very wealthy. The challenge, then, was to construct a hypothetical scenario where non-farm dwellers would be financially impacted by farm preservation efforts, but that was not philosophically objectionable to respondents with a free enterprise bent.

A hypothetical horse farm preservation program was constructed that is similar to existing programs in other states. Under this program, a fund would be set up using money from wagers placed at racetracks. Owners of Kentucky-bred horses that won races would receive bonuses from this fund. The fund would therefore provide horse breeders an incentive to breed and raise their horses in Kentucky, stemming the perceived loss of farms.

Under this program, money would not pass directly from non-farm dwellers to farm owners. Rather, it would come from gamblers at racetracks. This distinction was important to focus group participants. However, holding constant the amount of land used in horse farming would preclude other development that might generate higher state and local taxes and more jobs, which would in turn generate even more tax revenues. Preservation of the horse industry at its current level would therefore require higher state and local taxes. Most focus group participants viewed this payment vehicle as unobjectionable.[8] Two years after the implementation of this survey, Kentucky adopted such a program, providing further evidence that the program was not philosophically objectionable to residents.

Survey Methodology. Three hundred ninety-four households were contacted by telephone, using random digit dialing. Those who agreed to participate in the survey were sent a mail questionnaire. Followup mailings consisted of one reminder postcard and one repeat mailing of the questionnaire Two hundred eighty-two (71.6 percent) phone-contacted households agreed to participate. Of those, 202 (71 6 percent) returned the questionnaire, for a two-stage response rate of 51.3 percent. Of the returned surveys, 8 (4 percent) were incomplete and unusable, resulting in 194 completed surveys.

Respondents were asked a dichotomous choice question whether they would be in favor or opposed to the proposed program The size of the annual tax increase was set at one of eight bid levels, chosen based on 70 open-ended responses to a presurvey. Equal numbers of surveys were assigned bids of $5, $15, $30, $50, $80, $135, $200, and $500 Four different survey versions differed in the number of horse farms that would be lost without the program (25, 50, 75 and 100 percent of current numbers)

Although the scenario was constructed to be as value-neutral as possible, there still were some respondents who objected to the prospect of government intervention in private land use decisions Forty-three returned surveys (22.2 percent) were identified as protest responses These were respondents who did all of the following. 1) indicated that they would support the program if it cost them no money, 2) chose the no-program option in the dichotomous choice valuation question, 3) gave as a reason "I care about the horse industry, but I should not have to pay to preserve it," and 4) stated in an open-ended followup question that their maximum WTP for the horse farm preservation program was $0 00. Given the variety of opinions about external control of private land use decisions, some level of protest responses is inevitable when valuing amenities associated with land uses. The protest rate would undoubtedly have been higher had the scenario involved planning and zoning for rural areas.

Based on comments from focus group participants, there was also concern that some respondents might view the 100 percent loss scenario as implausible Initial data analysis that estimated values for the four loss levels independently (using dummy variables for loss level) showed that median WTP increased as the loss increased from 25 percent to 75 percent, but then decreased from 75 percent to 100 percent (see Ready et al. 1995) A similar pattern was observed in the open-ended responses to the pretest surveys. It was concluded that the responses to the 100 percent scenario were unreliable due to scenario rejection After excluding protest responses and responses for the 100 percent loss level, the resulting data set included a total of 110 usable surveys

Each respondent was assumed to answer the dichotomous choice question based on whether the household's compensating variation to avoid the specified loss of horse farms was greater or less than the assigned bid level

Compensating variation was assumed to be distributed across households according to a logistic distribution, so that the probability that an individual respondent would support the horse farm preservation program is given by

$$Prob(WTP > Bid) = 1 - \frac{1}{1 + \exp\left[\alpha X_1 + \beta X_2 * Bid\right]} \qquad (5)$$

where X_1 and X_2 are vectors of explanatory variables Shifters to the distribution included the number of horse farms in the household's home county, the percentage of farms that would be lost without the program, and the number of farms that would be lost in the household's home county. Data on horse farms per county for the CV analysis came from the 1992 Census of Agriculture, as that Census was closest in time to the date when the survey was conducted. As it did in the hedonic models, the number of farms with horses on inventory outperformed other equine amenity proxies (number of horses, number of farms selling horses, and number of horses sold) as measured by overall model log-likelihood

The specific variables used in the logistic regression are listed in Table 3 [9] The median of the distribution across households of WTP to avoid a particular loss of horse farms is then given by[10]

$$MedianWTP = -\frac{\alpha_0 + \alpha_1 * (farms) + \alpha_2 * (\%lost) + \alpha_3 * (\%lost)^2 + \alpha_4 * (\#lost)}{\beta_0 + \beta_1 * (\%lost)} \qquad (6)$$

Initial analysis using dummy variables for the different loss scenarios showed that the relationship between WTP and the size of the loss was non-linear (Ready et al. 1995) Two nonlinear terms for percent of farms that would be lost were therefore included (a quadratic term and an inverse term[11]) to allow for either increasing or decreasing marginal values. This form of the regression generates a value function that is very flexible, and allows statistical test for positive slope and for non-zero intercept If $\alpha_0 = \alpha_1 = 0$, then Median WTP goes to zero as the number and percent of horse farms that would be lost *goes to zero.* If $\alpha_2 = \alpha_3 = \alpha_4 = \beta_1 = 0$, then the value function has zero slope and is not sensitive to the amount of horse farm amenity involved.

Results. Results of the logistic regression are presented in the first column of Table 3. With this flexible functional form, the only individually significant coefficients are β_0, which is negative as expected, and β_1 A test for the non-zero intercept is presented in the second column. The null hypothesis that α = $\alpha_1 = 0$ is not rejected. This implies that the median WTP goes to zero as the number of farms and percent of farms that would be lost go to zero. A test for *positive slope* is presented in the third column. Here, the null hypothesis that

TABLE 3 LOGISTIC REGRESSION RESULTS FOR CV DATA

Variable	Parameter	Long Regression	Test for Non-Zero Intercept	Test for Positive Slope	Short Regression
Intercept	α_0	1 205	-	-0 0647	-
		(0 59)		(0 15)	-
Horse farms	α_1	-0 00247		0 00338	
		(0 56)		(2 10)	-
Percent of farms lost	α_2	-2 367	1 509	-	-
		(0 28)	(0 60)		
(Percent of farms lost)^2	α_3	-0 0541	-2 838	-	-
		(0 01)	(0 81)		
Number of farms lost	α_4	0 0123	0 00800	-	0 00686
		(1 47)	(2 45)		(3 35)
Bid	β_0	-0 0178	-0 0176	-0 00405	-0 0142
		(2 66)	(2 65)	(3 02)	(3 04)
Bid*percent of farms lost	β_1	0 0236	0 0233	-	0 0175
		(2 25)	(2 24)		(2 36)
Log-Likelihood		-60 76	-60 98	-69 10	-61 45
χ^2 Test Statistic			0 44	16 70	1 38
(d f)			(2)	(4)	(4)

t-statistics are in parentheses

$\alpha_2 = \alpha_3 = \alpha_4 = \beta_1 = 0$ at a level of 0.01 is rejected, and the conclusion is that the value function has positive slope

The long regression presented in column 1 of Table 3 is too flexible to generate precise estimates of WTP for changes in the horse farm amenity, particularly as it contains many insignificant variables To increase precision when calculting estimates of median WTP, a short regression was estimated. The results of the first three regressions suggest that number of farms that would be lost, bid, and the interaction between bid and percent of farms that would be lost provide most of the explanatory power of the model. A short regression using only these three variables is presented in column 4 of Table 3 All three included variables are significant, and the null hypothesis that $\alpha_0 = \alpha_1 = \alpha_2 = \alpha_3 = 0$, is not rejected, providing reassurance that the short regression does not suffer from omitted variable bias. Using this short regression, median WTP to prevent a loss of horse farms is given by

$$MedianWTP = \frac{0.00686 * (\#lost)}{0.0142 - 0.0175 * (\%lost)} \qquad (7)$$

This function is increasing in number of farms lost and in percent of farms lost, with both coefficients individually significant, suggesting that both are important to households.

Over all 120 Kentucky counties, the population-weighted average number of horse farms per county is 142.3. Using this number as a baseline, and the short regression results, Table 4 shows the median value to a Kentucky household from preventing a loss of 25 percent, 50 percent and 75 percent of farms, as well as the value of preventing the loss of 1 farm. 95 percent confidence intervals were simulated using 1000 bootstrapped estimates of the parameters according to the method described by Park et al. (1991).

For some sets of bootstrapped parameters, the denominator in equation (7) is negative when the percent of farms lost is equal to 0.75. For these parameter values, Median WTP is undefined. This occurred more than 5 percent of the time for the 75 percent loss scenario, implying that the 95 percent confidence interval for Median WTP is unbounded on the right. This result raises concern over the quality of the CV responses to the 75 percent loss scenario. To test for undue influence by responses to the 75 percent scenario, the short regression was re-estimated using only the 25 percent and 50 percent responses. The resulting parameter estimates were similar in magnitude to those presented in Table 4, but with higher standard errors due to the smaller sample size. Estimated Median WTP from this smaller data set was $0.39 to prevent the loss of one farm, $19.87 to prevent a 25 percent loss, and $70.27 to

Table 4 CV Value of Preventing A Loss of Horse Farms

Percent of Farms Lost	Number of Farms Lost	Median WTP
0 0117	1	$0 49 (0 14, 1 12)
0 25	35 6	$24 84 (8 56,50 55)
0 5	71 1	$89 56 (39 34,163 81)
0 75	106 7	$681 05 (171 57, undefined)

95% confidence intervals in parenthesis

prevent a 50 percent loss. Each of these estimates is between 20 and 22 percent lower than the estimate from the larger data set, but all fall well within the estimated confidence intervals presented in Table 4. The estimates of Median WTP shown in Table 4 are therefore fairly robust, at least for loss levels less than or equal to 50 percent.[12]

As theory predicts, the CV value per farm increases as the number of farms lost increases. The first farm lost is worth $0.49 per household. After a 10 percent loss, the marginal value of an additional lost farm is $0.63. However, the marginal value increases quickly past that point. After a 25 percent loss, the marginal value of an additional farm is $1.02 per household. After a 50 percent loss, the marginal value is $3.36.

Discussion and Conclusions

The hedonic pricing model presented in the second section resulted in an estimate of WTP to avoid a decrease of one farm of $0.43. That estimate is 12 percent smaller than the CV estimate for the same loss of $0.49. We might attribute the difference of $0.06 per farm per household to non-use benefits, which are captured by the CV estimate but not by the HPM estimate However, the difference between estimates is not statistically significant, and could be due to random error. The comparison is further complicated by the fact that the measure of the horse farm amenity used in the hedonic analysis, number of farms with horses, includes farms that primarily raise crops or other livestock, but that also have horses on inventory. Such farms likely generate lower external benefits than the Kentucky horse farms that were the focus of the CV study. Still, our results do suggest that non-use values from horse farms are not large relative to use values.

The HPM estimate is strictly valid only for marginal changes in the level of the horse farm amenity. The slope of the value function estimated from the CV data increases substantially as the scope of the loss increases. The marginal estimate from the HPM is most valid for changes less than 10 percent of the baseline. For larger losses, the HPM estimate can underestimate total value substantially. However, even the CV results were unreliable above loss levels of 50 percent The test of the CV value function showed that it was sensitive to the amount of amenity being considered, and did not show any evidence of a non-zero intercept. That the CV and HPM estimates are close in magnitude also increases confidence in both estimates.

The per farm values can be converted to per acre values by dividing by the average size of a farm in Kentucky (130 acres), giving values of $0.00331 and $0.00377 per household per year per acre for the HPM and CV approaches, respectively. Table 5 shows estimated values of farmland preservation from previous studies conducted in the U S., converted into comparable terms and inflated to 1990 dollars These estimates are about one third as large as those

TABLE 5. ESTIMATES OF AMENITY VALUE OF FARMLAND

Study	Location	Annual Value per Acre[a] Per Household[a]
Bergstrom et al 1985	South Carolina	$0 000160 - $0 000410
Beasley et al 1986	Alaska	$0 0134
Halstead 1984	Massachusetts	$0 0136 - $0 0380
Current Study (HPM)	Kentucky	$0 00331
Current study (CV)	Kentucky	$0 00377

[a] Measured in 1990 U S dollars

from the Beasley et al. and Halstead studies. Those studies were conducted in states with lower proportions of total land devoted to agriculture, and might have generated higher values due to scarcity. The estimates here are much larger than those of Bergstrom et al. The proportion of land in agriculture in their study area was similar to that in Kentucky. However, the Bergstrom et al study estimated the value of all prime farmland Horse farms in particular may generate higher external benefits than other types of farms

For policy purposes, these results are important because they demonstrate that farmland does indeed generate positive externalities. In the CV study, a functional form was used that allowed for negative values of individual values of WTP, and negative median WTP. In the multimarket HPM, an individual explanatory variable could measure either a positive amenity or a disamenity. That the estimated external value of horse farm land was positive for both techniques is therefore an important empirical result. Efforts to preserve farmland in America, including property tax relief, price and income support programs, and purchase of development easements, can be justified, in part, by the positive external benefits that accrue to non-farm dwellers. These results also demonstrate that both contingent valuation and hedonic pricing can be useful tools for evaluating external impacts that accompany regional changes in land use.

NOTES

1. Bergland (1993) discusses other approaches to the study of landscape perceptions, including the use of expert judgement The valuation techniques used here are examples of what he calls the psychophysical, non-expert approach to landscape evaluation
2. Although we assume labor supply is completely inelastic with respect to the wage rate, some response to spatial differences in amenities might be expected

Households that choose high amenity areas with low wages can be expected to work fewer hours This reduction in hours would require the compensating difference in the wage rate to be larger to yield a given premium than if hours worked were fixed

3 Greenwood et al. (1991) provide evidence supporting the existence of a spatial equilibrium

4 The semi-log form used here is the limit of a Box-Cox transformation as the parameter goes to 0, while the linear form is the limit as the parameter goes to 1 In previous estimation of similar housing and wage equations, Blomquist, Berger, and Hoehn (1988, p 94) did a modified Box-Cox search and found that Box-Cox parameters of 0.2 and 0 1 provided the best fit for the housing expenditure and wage equations, respectively, along with a linear form of the explanatory variables Garrod and Willis (1992b) and Bender, Grondberg, and Hwang (1980) both found that a Box-Cox parameter of 0 (i e the semi-log form) provided the best fit in single market models.

5 It is possible that wages and thus our amenity valuations are affected by labor demand conditions and other forces unrelated to amenities However, we do include a number of individual, occupation, and industry variables to control for these factors Also, horse farms are only a small part of the pool of potential employers, so that small changes in the number of horse farms are unlikely to greatly affect unskilled wages In Fayette County, Kentucky, in the center of the horse industry, there were 373 horse farms in 1992 (U S Bureau of the Census,1992). There were 7,223 nonagricultural business esatablishments in Fayette County in 1992 (Kentucky Cabinet for Economic Development, 1995) A small decline in the number of horse farms would be unlikely to affect the wage for unskilled labor since there plenty of other potential employers In addition, 48 7% of farms in Fayette County employed four or fewer workers and only 27 5% employed 10 or more workers according to the 1992 Census of Agriculture In other counties in our sample, horse farms are most likely even a smaller share of the pool of potential employers

6 This value was calculated as ($65,339 1990 house value) (0 0785 discount rate) (- 0000582 ln dollars per farm) - ($26,023 1990 annual household earnings) (-0.0000280 ln dollars per farm) = $0 43 per farm The quality of this estimate of course depends on how well the national hedonic represents the housing and labor markets in Kentucky

7 The CV study included two elicitation formats, the dichotomous choice format and the polychotomous choice format Here, we focus on the dichotomous choice data. The polychotomous choice format is discussed in Ready, Whitehead, and Blomquist (1995)

8 Copies of the survey instrument are available from the authors

9 An expanded regression including demographic variables unrelated to the horse farm amenity—income, age, education, and sex—showed that none of these variables was individually significantly related to WTP (significance level > 0 40 for each variable) nor were they jointly significant Income is not significantly related to WTP when it alone is added to the regressions reported in the paper This

is not that uncommon in CV studies, due to a combination of difficulties in measuring income (we used income categories) and the fact that dichotomous choice data contains relatively less information than continuous data. Eight income categories are included in the survey: <10K, 10-20K, 20-30K, 30-40K, 40-50K, 50-75K, 75-100K, and >100K Using the midpoint of the ranges (and 7 5K and 125K for the bottom and top categories) the mean income is $36,900 with a standard deviation of $26,800. The median response is 30-40K

10 With this particular functional form, the median of the distribution of WTP is equal to the mean of the distribution, if we allow negative WTP values (Hanemann 1989)

11 The inverse term results from including an interaction term in the logit regression, equal to percent of farms lost multiplied by bid.

12. It is important to remember that the short model used for estimating the WTP values presented in Table 4 maintains the assumption that the value function has an intercept of zero, that is that the median WTP for a program that has no impact on the amount of the horse farm amenity is 0 Our statistical test for a non-zero intercept showed no evidence contrary to that assumption It is still of interest to explore how robust the benefit esimates are to model specification We calculated the median WTP values implied by the long regression presented in column 1 of Table 3 Because that model contains an intercept, the calculated value of a 0-horse-farm loss is something other than zero It is most appropriate, therefore, to calculate the marginal value of a given farm loss (net of the estimated value of no loss) Using the long regression, the marginal value of a one-farm loss was $0 20 This is slightly less than half the estimate from the short regression, but falls within the 95% confidence interval for the estimate from the short regression. For 25%, 50% and 75% losses, the marginal value calculated from the long regression was $10 53, $40 64, and $3556 12, respectively These are lower than the short regression estimates for the 25 and 50% levels, but higher for the 75% level All long regression estimates fall within the confidence intervals for the short regression estimates We stress the short regression estimates because of their greater precision, and because we have no statistical evidence that the extra parameters included in the long regression are different from zero

13 Average size of farms listed under SIC code 0272, Horses and Other Equine, as reported in the 1982 Census of Agriculture Information is not available on average size of all farms that have horses on inventory The average size of all farms with and without horses in Kentucky was 140 acres

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