Structural Hedonic Prices of Land Parcels in Transition from Agriculture in a Western Community

Jolie B. Pardew, Ronald L. Shane, and John F. Yanagida

A single-equation nonlinear hedonic price function is estimated for parcels of rural land in transition from agriculture in a Nevada community. Empirical results are evaluated relative to the effects of selected government-provided amenities on parcel prices. Utilizing the estimated hedonic equation, bid (demand) and offer (supply) functions are determined for two dependent trait variables of parcel size and closeness to mountains.

Key words: hedonic prices, rural land, transition.

Rural land markets at urban fringes pose many interesting public policy problems. Both agricultural and nonagricultural demands for land are present in the urban peripheries. The rapid transfer of lands away from agriculture has been one issue of continuing concern. These transfers, primarily to residential and commercial uses, often represent third-party losses of scenic and recreational opportunities, wildlife habitat, watersheds, and flood plains. There are equity and efficiency issues in urban fringe areas in the public provision of such services as police protection, fire protection, schooling, and highway construction and maintenance. Additionally, as rural areas are urbanized, there are increased pressures by residents on local governments to expand and extend sewer and water lines and to upgrade county roads. These third-party losses and increased public costs associated with rural-urban fringe lands in transition have prompted government entities to formulate policies and implement programs aimed at controlling rural land development. Typical forms of government intervention have included zoning restrictions and special tax incentives to maintain land in agricultural uses.

Efforts by economists to evaluate effects of government actions on land markets are hindered by the heterogeneity of land parcels in terms of the variability of associated characteristics, such as distance to central business districts, quality of access roads, and soil types. However, each of these individual characteristics can be treated as quantifiable homogenous goods. Under this last assumption, a hedonic approach can be used to evaluate demands for separate homogenous components.

In this study, a single-equation nonlinear hedonic price function is estimated for a western rural community. Empirical results are evaluated relative to the effects of local government activities on parcel prices. Based on these hedonic equation results, bid (demand) and offer (supply) functions are estimated for two traits of parcel size and closeness to mountains.

A few previous studies have examined the effects of parcel characteristics on land values at the rural-urban fringe (Clonts; Hushak; Hushak and Sadr). Two studies of rural-urban fringe land values have been published that specifically cite and utilize the insights of hedonic theory (Chicoine; Dunford, Marti, and Mittelhammer). To date, no published study uses the two-step approach outlined by Rosen to examine a rural-urban fringe land market.

J. B. Pardew is an assistant professor and R. L. Shane is an associate professor, Department of Agricultural Economics, University of Nevada, Reno. J. F. Yanagida is an associate professor, Department of Agricultural Economics, University of Nebraska.

The authors wish to acknowledge constructive contributions of R. Dunford, N. Wallace, R. Mittelhammer, R. Narayanan, and two anonymous reviewers. The authors are grateful to Roger Mann, Marie Ewald-Powell, and Holly King for their efforts as interviewers.

Study Area

Data used for this study were obtained primarily from personal and telephone-administered questionnaires of buyers of small rural parcels in Douglas County, Nevada, who made their purchases between January and June 1977. Buyers and parcels were identified from county records of transferred parcel deeds. Approximately 1,500 rural parcels of 40 acres or less were transferred during the study period. A random sample survey yielded seventy-two respondents with Carson Valley parcels without structures at the time of transfer. Additional information on parcels was obtained from Douglas County tax records and topographic maps. Buyer incomes were estimated using median family income of the SMSA or census tract containing the buyer's home address (U.S. Bureau of the Census 1977).

Land use in Douglas County has been primarily agricultural. In 1974, Douglas County was in the upper fiftieth percentile of Nevada's counties in total dollars of agricultural sales (U.S. Bureau of the Census 1974). However, large portions of land are being converted from agricultural to nonagricultural, primarily residential, uses. The changes in land use reflect employment growth in the adjacent county to the north (location of the state capitol at Carson City) and increased employment from growing tourism and gaming industries at nearby Lake Tahoe. Also, the picturesque quality of Carson Valley increases its appeal as a residential area.

Methodology

Methodology used in this study is based on the seminal work of Rosen, with refinements proposed by Diamond and Smith and by Palmquist (1984). The procedure involves two stages. In the first stage, a single-equation hedonic price function is estimated. The hedonic price function is estimated by regressing market price of a parcel of land, $P(Z)$, on quantities of associated characteristics, Z_is. If the regression equation is in linear form, each regression coefficient estimates a single, constant market price, P_{Z_i}, for additional units of each parcel characteristic, Z_i. Under conditions where there is a possibility of repackaging and arbitrage, this would be sufficient to determine marginal values of characteristics. When these conditions do not hold, as in the case of land parcels, the P_{Z_i}s from a nonlinear hedonic function are used as dependent variables in the second stage to estimate offer and bid functions for characteristics. These second-stage equations (bid and offer functions) reveal information about how buyer and seller characteristics affect prices paid in the land market for specific parcel traits.

Hedonic Price Function Model

The hedonic price function $P(Z) = P(Z_1, \ldots, Z_n)$ assumes that the price of a heterogenous good is a function of the quantities of the characteristics or attributes of the good. Market price of a parcel is treated as an equilibrium price. The market price function $P(Z)$ is assumed to represent points of tangency between prices consumers are willing to bid and prices sellers are willing to accept.

To estimate the hedonic function, characteristics that give a parcel value in the market must be identified. Characteristics employed in this study are suggested from results of previous studies (Adams et al.; Clonts; Hushak; Chicoine). Residential lot traits used in previous research fall into three basic categories: man-made or policy variables, natural attribute variables, and locational or accessibility variables. The general form of the study hedonic function is shown in equation (1).

$$(1)\quad PRICE = f(SIZE, DMNT, ETAXR, SEW, TREE, IMPR)$$

where *PRICE* is parcel market price; *SIZE* is parcel size in tenths of an acre; *DMNT* is distance in tenths of miles to the base of the Sierra Nevada Mountains (the iso-elevation line containing parcels closest to the Sierras); *ETAXR* is effective tax rate, calculated as [(total 1977 property tax)/(parcel price)] × 100; *SEW* = 1 if presence of sewer hookup to parcel, otherwise = 0; *TREE* = 1 if presence of mature trees on property, otherwise = 0; and *IMPR* = 1 if presence of improved road, either paved or gravelled, otherwise = 0.

Theory does not specify a particular form of the hedonic equation. As noted previously, to use Rosen's two-step technique, the estimated hedonic function must be nonlinear. The functional form selected may have important effects on estimated parameter values. Bender, Gronberg, and Hwang found that changes in functional form can result in estimates varying by as much as 252%. Based on previous research by Linneman; Blomquist and Worley; and Palmquist (1980, 1982), a log-linear functional form is used in this study.

Hedonic Price Function Results

The estimated log-linear hedonic function and associated statistics are shown in equation (2):

$$\text{(2)} \quad \ln PRICE = \underset{}{9.1365} + \underset{(.0681)}{.2493} \ln SIZE - \underset{(.0675)}{.2971} \ln DMNT - \underset{(.136)}{.5356} \ln ETAXR + \underset{(.196)}{.5053}\, SEW + \underset{(.221)}{.3252}\, TREE + \underset{(.152)}{.2895}\, IMPR$$

where adjusted $R^2 = .478$, F-value $= 11.853$, df $= 65$. Standard errors are given in parentheses beneath respective regression coefficients.

Almost one-half of the variation in parcel values is accounted for by six parcel traits. The four statistically most significant traits are parcel size, distance to Sierras, effective tax rate, and presence of a sewer hookup. An increase of one-tenth of one percent in effective tax rate decreases average parcel price by 6.6%. An increase of one-tenth of a mile in proximity to the Sierras increases average price by 6.1%. Access to a paved or gravel road increases average price by 29%. Finally, results indicate that presence of mature trees can increase an average parcel value by an impressive 32.5%.

These findings suggest government-controlled factors, such as sewer hookups, effective tax rate, and presence of an improved road, impact urban fringe land markets. Policies intended to slow the conversion of rural lands to residential uses by manipulating tax rates or withholding improvements are demonstrated to have substantial negative impacts on land values. Conversely, policies aimed at concentrating development in particular areas by providing services at public expense can represent substantial windfall gains to landowners. Information about policy impacts on the land market gained from estimated hedonic prices can be used to adjust more efficiently for these impacts when changes in taxation or user charges are contemplated.

Some previous researchers (Hushak; Ridker and Henning) have labeled increases in characteristic prices estimated by the hedonic function as increases in the consumer's willingness to pay (i.e., direct measures of consumer surplus). This interpretation is not correct. Just as parcel prices $P(Z)$s are the result of market interactions of consumers and sellers, so are the marginal characteristic prices, P_{Z_i}s. The hedonic price function represents an envelope of a family of bid price curves (demand side) and a family of offer price curves (supply side). An envelope function by itself reveals nothing of the underlying members that generate it. However, this information can be obtained by estimating bid and offer price curves.

Bid and Offer Price Functions: Theory and Model

This section of the article discusses the general theory and describes the model used in estimation of the consumer's bid price function and the seller's offer price function for parcel characteristics. As noted previously, marginal prices of characteristics obtained from the estimated hedonic price function are used as dependent variables in the empirical estimation.

A bid (demand) price function is assumed to exist for each household. It indicates the maximum amount a household will pay for alternative parcels, or combinations of Z_is, and remain at the same level of utility (U^o). The household derives utility from consuming a given parcel with the level of utility depending on the bundle of differing quantities of characteristics, Z_is, contained in a given parcel bundle $[Z = (Z_1, Z_2, \ldots, Z_n)]$. In addition to parcel characteristics, the household's bid for a given parcel is also determined by household income (Y) and household tastes.

The household's marginal bid for any parcel bundle characteristic can be derived by taking the first partial derivative of a bid function with respect to the characteristic $\partial\theta/\partial Z_i$. The marginal bid price function is given by

$$\text{(3)} \qquad \frac{\partial\theta}{\partial Z_i} = \theta_{Z_i} = \theta_{Z_i}(Z_i;\, Z^o,\, U^o).$$

This is the amount a consumer is willing to

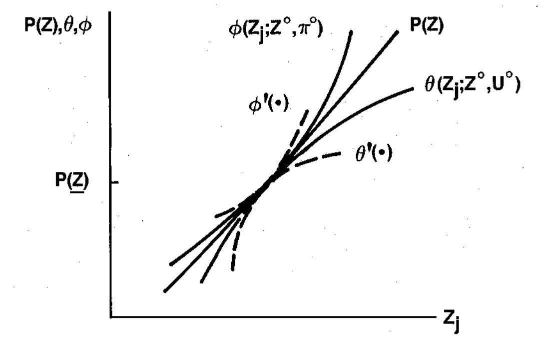

Figure 1. Possible bid and offer curves having the same equilibrium point, observed $P(\underline{Z})$

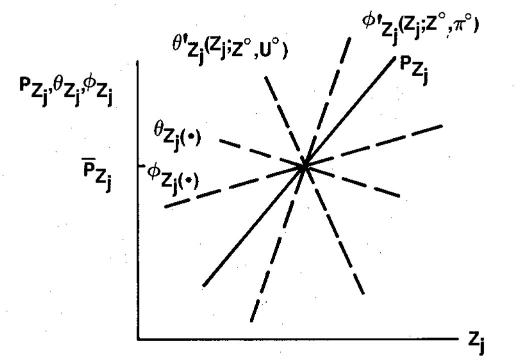

Figure 2. Possible marginal bid and offer curves having the same equilibrium point, $\bar{P}_{Z_j}$

pay for an additional unit of characteristic Z_i, holding the quantities of all other characteristics constant at Z^o and utility constant at U^o. It represents the demand reservation price for an additional unit of Z_i. This is the marginal bid price function estimated in the next section as

$$(4) \qquad P_{Z_i} = P(Z_i, \ldots, Z_n, W)$$

where W is a vector of bid price shifters and consumer characteristics.

The production decision is treated in an analogous manner to the consumption decision. The offer function is assumed to identify the minimum price the profit-maximizing firm will accept for a given parcel bundle. The marginal offer price function is given by

$$(5) \qquad \frac{\partial \phi}{\partial Z_i} = \phi_{Z_i} = \phi_{Z_i}(Z_i; Z^o, \pi^o).$$

This shows the amount a producer can accept for an additional unit of a characteristic to maintain a constant level of profit, π^o. It represents the supply reservation price of a characteristic. This is the marginal offer price estimated in the results section as

$$(6) \qquad P_{Z_i} = P(Z_1, \ldots, Z_n, A)$$

where A is a vector of offer price shifters and supplier characteristics.

Equations (4) and (6) are estimated as a system of simultaneous equations.[1] Previous researchers (Nelson; Witte, Sumka, and Erekson) have also estimated equations (4) and (6) simultaneously on the assumption that the joint interactions of supply and demand in the market must be accounted for. However, data used in their estimations, as in this study, were from individual sales. For such data, necessary conditions for a competitive market equilibrium may not be met. Individual buyers, for example, generally may deal with a schedule of exogenously determined characteristic prices and quantities and choose optimum levels of each from that schedule.

Another problem in using disaggregate buyer and seller sales data from one location at a single point in time is that there is only one observation for each marginal price. With only one bid and offer function tangency point available, an infinite number of associated curve shapes are possible (figures 1 and 2). It is known that unless the hedonic and bid/offer curves have different specified functional forms, estimated bid and offer functions will be an identity, re-creating the hedonic function (Brown and Rosen; Diamond and Smith). Most previous research has not addressed this data-related problem (Nelson; Harrison and Rubinfeld; Witte, Sumka, and Erekson; Blomquist and Worley; Linneman). An exception is Palmquist (1984). One solution is to have data

[1] Researchers applying Rosen's market model for heterogenous goods universally accept that meaningful estimates of characteristic bid and offer functions are feasible; estimates of commodity bundle bid and offer functions are not. In equilibrium, Rosen's model assumes

$$P(Z) = \theta(Z; U^o, Y) = \phi(Z; \pi^o),$$

so that the market clears for both parcels and parcel characteristics. $P(Z)$ is assumed to be a complex function of the distribution of suppliers across products, the distribution of demanders across incomes, and the shapes of individual demand functions and supplier cost functions. Additionally, the equilibrium set of prices are expected to be a complex function of characteristics with multiple cross-effects. Rosen demonstrates that only under prohibitively restrictive assumptions can $\theta(\cdot)$ and $\phi(\cdot)$ be identified.

from enough markets separated by time and space to identify a unique curve through a number of points. Such data were not available for this current study, and resulting coefficient estimates are dependent upon functional form assumptions (Diamond and Smith).

In the second step of the procedure, marginal market values for buyer-associated traits, $[\partial \hat{P}(\theta)]/\partial Z_i$ = bid price, and seller traits, $[\partial \hat{P}(\phi)]/\partial Z_i$ = offer price, are initially estimated for each parcel and for each endogenous parcel characteristic. Shifters of bid and offer functions must also be identified.

Marginal Bid and Offer Function Results

Results for statistical models estimated for bid and offer functions are given below.

Bid functions:

$$\begin{aligned}(7)\quad BSIZE = {} & 375.24 - \underset{(.8978)}{.9094}\,SIZE - \underset{(2.4175)}{1.8619}\,(-1)DMNT - \underset{(10.664)}{16.156}\,ETAXR \\ & + \underset{(164.08)}{678.33}\,SEW + \underset{(192.74)}{93.799}\,TREE + \underset{(135.4)}{224.2}\,IMPR - \underset{(452.66)}{367.16}\,RBUY \\ & + \underset{(.0858)}{.0688}\,IRBUY - \underset{(162.96)}{101.59}\,MBUY;\end{aligned}$$

$$\begin{aligned}(8)\quad B(-1)DMNT = {} & 3{,}196.9 + \underset{(4.9327)}{5.2522}\,SIZE + \underset{(13.282)}{45.586}\,(-1)DMNT - \underset{(59.587)}{33.785}\,ETAXR \\ & + \underset{(901.45)}{274.65}\,SEW + \underset{(1{,}058.9)}{3{,}276.3}\,TREE - \underset{(743.86)}{942.9}\,IMPR - \underset{(2{,}486.9)}{1{,}753.2}\,RBUY \\ & + \underset{(.4712)}{.3293}\,IRBUY + \underset{(895.27)}{112.17}\,MBUY.\end{aligned}$$

Offer functions:

$$\begin{aligned}(9)\quad OSIZE = {} & 335.14 - \underset{(1.0192)}{.7218}\,SIZE - \underset{(2.4909)}{2.4053}\,(-1)DMNT - \underset{(11.502)}{15.940}\,ETAXR \\ & + \underset{(166.2)}{663.02}\,SEW + \underset{(205.53)}{117.39}\,TREE + \underset{(134.01)}{193.75}\,IMPR - \underset{(179.26)}{24.068}\,CSELL \\ & + \underset{(206.42)}{531.21}\,RESD + \underset{(276.21)}{149.45}\,NRESD;\end{aligned}$$

$$\begin{aligned}(10)\quad O(-1)DMNT = {} & 3{,}331.1 + \underset{(5.4921)}{5.0539}\,SIZE + \underset{(13.422)}{50.55}\,(-1)DMNT - \underset{(61.98)}{13.942}\,ETAXR \\ & + \underset{(895.59)}{30.46}\,SEW + \underset{(1{,}107.5)}{3{,}545.3}\,TREE - \underset{(722.14)}{810.33}\,IMPR - \underset{(965.93)}{1{,}055.0}\,CSELL \\ & - \underset{(1{,}112.3)}{85.044}\,RESD + \underset{(1{,}488.4)}{930.45}\,NRESD.\end{aligned}$$

Standard errors are given in parentheses beneath respective regression coefficients. In equations (7)–(10), *BSIZE*, *B*(−1)*DMNT* is bid price per additional .10 acres and .10 miles of the characteristics *SIZE* and (−1)*DMNT*, respectively, computed from estimated hedonic equation (2) as .2493 *PRICE/SIZE* and .2971 *PRICE/DMNT*, respectively; *OSIZE*, *O*(−1)*DMNT* is offer price per additional .10 acres and .10 miles for the characteristics *SIZE* and (−1)*DMNT*, respectively; (−1)*DMNT* = minus one times *DMNT*, amenity closeness or proximity to mountains; *RBUY* = 1 if buyers with addresses outside Douglas County or buyers with addresses in Douglas County who purchased one lot during survey period, otherwise = 0; *IRBUY* = median family income from SMSA or census tract containing home address of *RBUY*, otherwise = 0; *MBUY* = 1 if buyer a corporation, partnership, or company, otherwise = 0; *CSELL* = 1, if seller a corporation, otherwise = 0; *RESD* = 1, if parcel located in a nonresidential development, otherwise = 0; *NRESD* = 1, if parcel located in a nonresidential development for mobile homes or commercial property, otherwise = 0.

For the two-stage least squares estimation of the bid and offer functions, endogenous variables are *BSIZE*, *B*(−1)*DMNT*, *OSIZE*, *O*(−1)*DMNT*, *SIZE*, and (−1)*DMNT*. All other variables are assumed to be exogenous. Thus, it is assumed that implicit markets exist for size (*SIZE*) and proximity to mountains [(−1)*DMNT*]. It is correspondingly also assumed that markets do not exist for other characteristics such as effective tax rate (*ETAXR*), presence or absence of sewer (*SEW*), and presence or absence of an improved road (*IMPR*). Therefore, these latter traits are treated as exogenous variables which act only as shifters of the bid and offer functions for *SIZE* and (−1)*DMNT*. The appropriateness of this specification depends on the accuracy of two assumptions described by Witte, Sumka, and Erekson. They are: (*a*) single suppliers do not have true offer curves for these factors because they are the result of many exogenous decisions and not the individual supplier's actions; (*b*) demanders do not perceive these characteristics as goods to be bid directly upon. Instead, these factors alter the prices they are willing to pay for basic residential attributes, lot size, and lot quality (closeness to mountains). This approach is consistent with other works by Nelson; Blomquist and Worley; Witte, Sumka, and Erekson; and Palmquist (1984).

In the bid-price model, remaining variables are included to capture buyer-related characteristics. Income (*Y*) is hypothesized in the theoretical model to be a bid curve shifter. However, it is believed that whereas variation in income is likely to influence the bid price of residential parcel purchasers, it is not expected to influence the demand price of speculators. The income effect is thus captured by two variables. The first term is an intercept shifter equal to one for buyers assumed to be residential buyers and zero for all others assumed to be speculators (see description for *RBUY*). The second term is a measure of income (see *IRBUY*). Following the work of Witte, Sumka, and Erekson, an intercept shifter is included for multiple buyers (see *MBUY*) on the assumption businesses have better access to information than individuals.

In the offer price model, zero–one variables are included to capture seller characteristics. Corporations are assigned a value of one, and all others are given a value of zero (*CSELL*). Three types of developments are identified: nondevelopment, residential development (*RESD*), and nonresidential developments (*NRESD*). Parcels located outside of any development are assigned a value of zero. Thus, interpretation of coefficients associated with *RESD* and *NRESD* is the difference in value between being a residential development versus no development and being a nonresidential development versus no development, respectively.

Economic theory offers limited guidance in qualitative predictions of the relationships between parcel amenities and dependent marginal price variables in bid and offer functions. For example, in the size bid function, the expected negative sign between quantity (*SIZE*) and own-price (*BSIZE*) is consistent with diminishing marginal value in consumption. The negative sign between *BSIZE* and the parcel trait of (-1)*DMNT* suggests parcel size and closeness to mountains are substitutes in consumption. The positive signs between *BSIZE* and bid function shifters of *SEW*, *TREE*, and *IMPR* indicate complementary relationships. As anticipated, *ETAXR* is negatively related to the bid price for additional acreage, higher effective taxes increase current and future costs of owning land. The income measures of *RBUY* and *IRBUY* are not statistically significant. Significant negative *RBUY* and positive *IRBUY* coefficients would support hypotheses that low income nonspeculative buyers pay less than speculators, but nonspeculators are willing to pay more for an additional unit of land as their income increases. A negative *MBUY* coefficient is expected under an assumption that better informed multiple buyers will pay lower prices for additional acreages than individual buyers.

In the size offer function, declining marginal costs of providing additional acreage, which may exist under restrictive large lot zoning, are consistent with a negative coefficient on *SIZE*. A zero or positive sign indicates market competition and upward-sloping marginal costs. A negative sign between *OSIZE* and (-1)*DMNT* suggests competition between these inputs in production. Positive signs on *SEW*, *TREE*, and *IMPR* are consistent with these supply shifters being complements with size. Their presence increases the cost of providing additional acreage per parcel. A negative sign is expected on *ETAXR* as increasing taxes increase the cost of holding land over time. Corporations are expected to have economies of size in procuring, holding, and marketing residential parcels (Witte, Sumka, and Erekson). Hence, a negative *CSELL* coefficient is expected. A priori signs on *RESD* and *NRESD* are uncertain. If economies of size dominate, developments will sell for less, with negative coefficients. If these development variables capture additional amenities and costs, such as curbs, sidewalks, and electricity, then positive coefficients may be associated with *RESD* and *NRESD*.

In most cases, coefficients in the bid and offer functions for closeness to mountains, (-1)*DMNT*, have similar interpretations in terms of expected signs.

For the dependent variables *BSIZE* and *OSIZE*, standard errors are larger than estimated coefficients for ten of eighteen variables, excluding constants. Estimation results support the general hypothesis that government intervention in rural land markets has important effects on market values of individual traits.

Linear coefficients in offer and bid functions can be interpreted as the marginal value of an additional unit of the parcel trait. For example, a one-unit increase in *ETAXR* decreases the price buyers of unimproved rural lots in Douglas County, Nevada, are willing to pay by \$16.16 for an additional .10 acres [equation (7)]. In the offer function for additional closeness to the Sierra mountains [equation (10)], presence of mature trees (*TREE*) increases the asking price by sellers of unimproved rural parcels for an additional .10 miles closer to the Sierras by \$3,545.30.

In this data set, variation in zoning among parcels is not sufficient to test the effect of zoning (69 of 72 were zoned the same). However, from this second stage some inferences about zoning are possible. The coefficient for parcel size in the bid price function for parcel size is not significantly different from zero. This indicates that parcels are not restricted to be either larger or smaller than consumers want. If parcels are restricted to be larger than consumers prefer, then the coefficient for parcel size in its own equation would be negative and significantly different from zero.[2]

Statistical significance and signs for shifters *SEW* and *IMPR* in the marginal bid price equations indicate if and how the government-provided amenities affect consumption value of privately controlled amenities *SIZE* and (−1)*DMNT*. Results suggest that improved roads may decrease the marginal price consumers are willing to pay for a unit of (−1)*DMNT*, which represents increased accessibility to national forest and mountain views. Estimation results also indicate that by putting in sewers (*SEW*), government is providing an amenity that enhances the value of spacious lots, increasing the willingness of consumers to pay for additional space.

The sign and statistical significance of government-provided amenities *SEW* and *IMPR* in the marginal offer price equations suggest whether these amenities are complements or competitors in purchasing, holding, and marketing parcel amenities (−1)*DMNT* and *SIZE*. Empirical results are consistent with a conclusion that *SEW* acts to increase the cost of providing a larger parcel.

[2] Current research suggests that parcels are generally zoned according to what characteristics they have. Lots in certain locations, of certain sizes, and adjoining specific use areas are zoned in a way compatible with those attributes. This creates sampling problems that may result in biased estimates (Wallace).

Parameter estimates for *RBUY*, and *MBUY* in the marginal bid price equations indicate that type of buyer makes no difference in the price bid. There is no empirical support for the hypothesis that speculators pay higher land prices than nonspeculators. Signs and significances of *CSELL*, *RESD*, and *NRESD* indicate that commercial developments and corporations do not sell land at lower prices than nondevelopers and noncorporations. An interpretation of these study results is that government policies reducing the amount of commercial multiparcel developments will not increase market land prices.

Income coefficients are not statistically significant in this estimation. Wealthier consumers are not more inclined to purchase larger parcels as expected, nor are they inclined to buy parcels nearer the mountains. This suggests that policies encouraging larger parcels or slowing development nearer the mountains will not impact the wealthier more than the less wealthy.

Conclusions

Government intervention in agricultural land markets is taking place to control development of rural lands at the peripheries of urban areas. Government actions, such as setting minimum parcel sizes, zoning development locations, building roads, changing real property tax rates, or providing sewer hookups, can have unintended effects of altering the values of parcel traits which are exchanged when parcels are transferred in the private rural-urban land market. Studies using single-equation approaches to measure values of marginal parcel characteristics do not provide all the information that may be available.

Following the work by Rosen, a two-stage procedure is employed in this study to estimate structural market parameters of bid (demand) and offer (supply) functions for individual traits of parcels. Survey data from Douglas County, Nevada, on seventy-two parcels of 40 acres or less without structures at time of transfer are utilized.

Results of the first-stage estimation indicate that government-provided amenities contribute substantially to parcel value. One-half of average parcel value is accounted for by a single government-provided service, sewer hookup. Also, land taxes are apparently capitalized into the price of a lot.

Second-stage results indicate that availability of sewers increases the price buyers are willing to pay for additional land. Zoning restricting minimum parcel size does not now hinder suppliers from providing parcels of sizes (acreages) that can be effectively utilized by buyers. Results also suggest that government policies designed to encourage holding larger parcels will not have differential effects among different income groups participating in the rural land market. Finally, there is some evidence that policies aimed at encouraging private single-parcel development over multiparcel residential developments will decrease the cost of providing additional parcel acreage.

Research questions remain unanswered in this study about appropriate functional forms as well as appropriate assumptions about sampling distribution and market structure. The two-stage technique outlined in this paper does appear to be a rich source of information about heterogenous goods not otherwise available from single-equation hedonic procedures.

[*Received May 1984; final revision received January 1986.*]

References

Adams, G. F., G. Milgram, E. Green, and C. Mansfield. "Undeveloped Land Prices during Urbanization: A Micro-Empirical Study over Time." *Rev. Econ. and Statist.* 50(1968):248–58.

Bender, B., T. J. Gronberg, and H. S. Hwang. "Choice of Functional Form and the Demand for Air Quality." *Rev. Econ. and Statist.* 64(1981):638–43.

Blomquist, G., and L. Worley. "Hedonic Prices, Demands for Urban Housing Amenities and Benefits." *J. Urban Econ.* 9(1982):212–21.

Brown, J., and H. Rosen. "On the Estimation of Structural Hedonic Price Models." *Econometrica* 50(1982): 765–68.

Chicoine, D. L. "Farmland Values at the Urban Fringe: An Analysis of Sales Prices." *Land Econ.* 57(1981): 353–62.

Clonts, H. A., Jr. "Influence of Urbanization on Land Values." *Land Econ.* 46(1970):489–97.

Diamond, D., Jr., and B. A. Smith. "Simultaneity in the Market for Housing Characteristics." Unpublished manuscript, Dept. of Economics, University of Houston, May 1981.

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

Harrison, D., Jr., and D. Rubinfeld. "Hedonic Housing Prices and the Demand for Clean Air." *J. Environ. Econ. and Manage.* 5(1978):81–102.

Hushak, L. J. "The Urban Demand for Urban-Rural Fringe Land." *Land Econ.* 51(1975):112–23.

Hushak, L. J., and K. Sadr. "A Spatial Model of Land Market Behavior." *Amer. J. Agr. Econ.* 61(1979):697–702.

Linneman, P. "Some Empirical Results on the Nature of the Hedonic Price Function for the Urban Housing Market." *J. Urban Econ.* 8(1980):47–68.

Nelson, J. P. "Residential Choice, Hedonic Prices and the Demand for Urban Air Quality." *J. Urban Econ.* 5(1978):357–69.

Palmquist, R. B. "Alternative Techniques for Developing Real Estate Price Indices." *Rev. Econ. and Statist.* 62(1980):442–48.

———. "Estimating the Demand for the Characteristics of Housing." *Rev. Econ. and Statist.* 66(1984):394–404.

———. "The Demand for Housing Characteristics: Reconciling Theory and Estimation." Unpublished manuscript, Dept. of Economics & Business, North Carolina State University, Raleigh NC, Oct. 1982.

Ridker, R. G., and J. A. Henning. "The Determinants of Residential Property Values with Special Reference to Air Pollution." *Rev. Econ. and Statist.* 49(1967): 246–57.

Rosen, S. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *J. Polit. Econ.* 82(1974):34–55.

U.S. Bureau of the Census. *United States Census of Agriculture: 1974.* Washington DC.

U.S. Bureau of the Census. *County and City Data Book: 1977.* Washington DC.

Wallace, N. E. "The Market Effects of Zoning and the Consistency Doctrine in King County, Washington." Ph.D. thesis, University of Michigan, 1982.

Witte, A. D., H. D. Sumka, and H. Erekson. "An Estimate of a Structural Hedonic Price Model of the Housing Market: An Application of Rosen's Theory of Implicit Markets." *Econometrica* 47(1979):1151–73.