Is the Profit Motive an Important Determinant of Grazing Land Use and Rancher Motive?

L. Allen Torell and Scott A. Bailey[1]

Paper presented at the Western Agricultural Economic Association Annual Meeting, Vancouver, British Columbia, June 29 - July 1, 2000.

Abstract

We build our economic models and estimate grazing policy impacts based on the standard economic model of profit maximization. Yet, over 30 years of research and observation has shown that, for many, consumptive and quality of life values are the most important reasons for the purchase of western ranches. Ranch buyers want an investment they can touch, feel and enjoy, and they have historically been willing to accept low returns from the livestock operation. Profit maximization appears to be an inadequate model for explaining rancher behavior; in estimating what impacts altered public land policies will have; and in describing grazing land use and value. In this study, only 27% of the value of New Mexico ranches in the most productive rangeland areas was explained by livestock production potential. Economists and policymakers must take the influences of both traditional livestock production and quality of life values into account when determining appropriate policies for western rangelands.

[1]/L. Allen Torell is Professor, New Mexico State University, Department of Agricultural Economics and Agricultural Business, Las Cruces, NM 88003, atorell@nmsu.edu. Scott A. Bailey is former Research Assistant at New Mexico State University and currently with Farm Credit Services, Las Cruces, NM 88005.

Introduction

> Traditional Rocky Mountain ranches have become "pearls of great value". Scenic ranches with privacy, fishing and wildlife have vaulted in value and it has nothing to do with the value of the grass or livestock that might be produced on the ranch. It appears that a new type of land baron, the Wall Street moneyed and the computer-industry rich has driven this upward movement in value. People are buying ranches for personal reasons. While stocks pay dividends, they are just a piece of paper. Land is real. You can visit it, walk on it and enjoy it. Investors like the sense of place that comes from owning land in the country (Sands 1998, Henderson 2000).

The above observations from the popular press highlight recent increases in ranchland values and the apparent reasons for these increases. This increase in value and the non-production reasons for ranch purchase are not new. William Martin and various coauthors (Martin 1966, Smith and Martin 1972, Martin and Jeffries 1966) drew similar conclusions about the ranch real estate market in Arizona over 30 years ago. Arden Pope (Pope 1985, 1987, 1988, and Pope and Goodwin 1984) documented non-production values for Texas ranches over 15 years ago. In these earlier studies, non-livestock ranch outputs, including tax shelters, land appreciation, and especially the way of life, were found to be the most important reasons for ranch purchase and investment. People desire to own rural properties for a place to recreate and relax. They desire to live in a rural environment, obtain and maintain the lifestyle of a farmer or rancher, and have an investment they can touch, feel, experience and enjoy (Pope 1987). In many cases, beef production and profit have been shown to be of only secondary importance in the ranch purchase decision.

Martin portrayed non-livestock ranch outputs in a negative way, calling them conspicuous consumption, farm fundamentalism, and consumptive/speculative attitudes and beliefs. Similarly, Pope (1987, 1988) referred to the additional quality of life (QOL) values as "romance values" as he discussed the role of agrarian values in policy decisions and the public land use debate. Yet, whether one views these QOL values in a negative or positive way is not important. The important observation is that even 30-years ago an apparent market disparity existed between the livestock income earning potential and market value of western ranches, and this disparity exists because ranch buyers are typically people that value the way of life and romanticize the carefree, independent life of the cowboy.

Pope and Martin noted the significant policy and rural development implications of having an additional QOL value associated with the ownership of rural lands. They noted that based on livestock production value most range improvements show a negative benefit/cost ratio and that rates of return from the livestock operation are low by any standard investment criteria. They argued that economic models that attempt to explain rancher behavior based only on the profit motive are inadequate and will lead to ill-conceived land use policies and policy assessments (Smith and Martin 1972, Pope 1987).

In this paper we revisit the question about the relative importance that livestock returns and QOL values have had in determining the market value of New Mexico ranches. We explore whether QOL market influences have become more or less important since Martin's work in the 1960's and evaluate whether these values are only observed for scenic and desirable ranch properties. We first review the historic and current evidence that profit is not the underlying motive of rural landowners, and especially for western ranches. We develop and present a hedonic pricing model and use that model to estimate the market value of New Mexico ranches and to explore the relative contributions of profit and QOL factors to ranch market value. We then reiterate, as Martin and Pope did, the inappropriate public land policy conclusions that can and have been reached by ignoring the QOL reasons for why ranches are purchased.

Historic Rates of Return

There is strong evidence that livestock production returns have historically been and continue to be less than what could be made by investing in alternative investments of comparable risk. As noted by Martin and Jeffries (1966, p. 233) "research on costs and returns in the western range cattle industry shows returns to capital and management ranging from very low to negative in all areas studied." Similarly, reviewing data prepared by several researchers from 1926-1968, Agee (1972) reported real rates of return for western cattle ranches ranged from negative values to 6.5%. Workman (1986, p.13) noted that only during a short period in the 1880s were livestock production returns exceptionally high (25 to 40%).

Low livestock returns have continued in more recent times. A comparison of 306 herds in Texas, Oklahoma and New Mexico, using the Standardized Production Analysis (SPA) computer program and analysis procedure (McGrann 2000), found that over the 1991-98 period the average livestock production rate of return on the current market value of assets was 0.91%. Those ranches in the lowest net income quartile realized an average rate of return of –6.02%, while those in the top quartile made an average return of 7.46%.

A similar range of returns has been reported for New Mexico. Since 1986, livestock cost and return estimates have been prepared annually for five New Mexico ranching areas and for three different ranch sizes in each ranching region. These five ranching areas are defined based on vegetation type and topographical characteristics that closely follow Natural Resource Conservation Service (NRCS) major land resource and sub-resource areas described later. Figure 1 shows the average nominal and real rates of return realized from both livestock production and land appreciation over the 1986-97 period in each of the five New Mexico ranching areas. These returns were summarized from the NMSU livestock cost and return series for each region [See for example Torell, Hawkes and Bailey (2000)]. Land values and annual changes in land values were estimated using previous ranchland value models developed at NMSU (Torell and Owen 1998). The total nominal rate of return is shown along with the real rate once the average annual inflation rate was subtracted[1]. As shown in the figure, annual rangeland appreciation averaged 2.1% over the 1986-97 period. This is in contrast to the 1982-86 period when the market value of New Mexico ranches fell by over 50% (Torell and Kincaid 1996).

As would be expected, with economies of scale, average annual livestock returns increase with ranch size. Large and extra-large ranches (300 to 500 cows) in eastern New Mexico had an average 2% to 3% annual nominal rate of return from livestock production, while medium size ranches (200 cows) made about 1% as a nominal livestock return on total ranch investment (including land, houses and buildings, equipment and cattle investments). Small ranches (< 100 cows) lost money on the investment over the 1986-97 period.

Representative ranches in western New Mexico, with more public land (Bureau of Land Management (BLM) and U.S. Forest Service (USFS), averaged negative rates of return from the livestock enterprise over the 1986-97 period. Nominal rates of return, considering both land appreciation and livestock returns, ranged from -1% to 6.6%. After adjusting for the 3.2% average annual inflation rate experienced over the period, real rates of return were negative in most cases.

The range of returns reported by McGrann (2000) for livestock operations in the southwest U.S., and in the NMSU Cost and Return Series are similar to those reported for ranches throughout the West in other Agricultural Experiment Station and Cooperative Extension Service reports. However, they are lower than comparable rates reported by the Economic Research Service (ERS) for all of U.S. agriculture, including both farms and ranches. As summarized by the American Agricultural Economics Association report on commodity cost and return (CAR) estimation (AAEA 1998, Table 2.5) the average rate of return on current assets in U.S. agriculture was 3.29% over the 1964-96 period.

The AAEA CAR Task Force also estimated the opportunity rate that agricultural investors could have made by investing their money in other non-agricultural investments with similar risk. They estimated a reasonable riskless rate for U.S. investments was in the range of 2% to 3.5% (p. 2-35). They further concluded that an appropriate risk premium for agricultural investments was from 3 to 6%. Adding these two rates, the estimated long-term risky real opportunity rate of investment was estimated to be from 5% to 9%, which was considerably higher than average agricultural rates of return, and especially higher than the rates of return historically found for western livestock producers. One can only conclude, as Martin and Jeffries (1966) did, that "raising beef is not a profitable operation given current ranch sale prices" (p. 233). The profit-maximizing hypothesis has to be considered suspect as a motivation for ranch investors.

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[1]/Real rates of return were computed using the Fisher equation described in AAEA (1998, p. 2-19). This equation relates the real rate (r) to the nominal rate (i) and the inflation rate (π) as $r = \frac{(i-\pi)}{(1+\pi)}$.

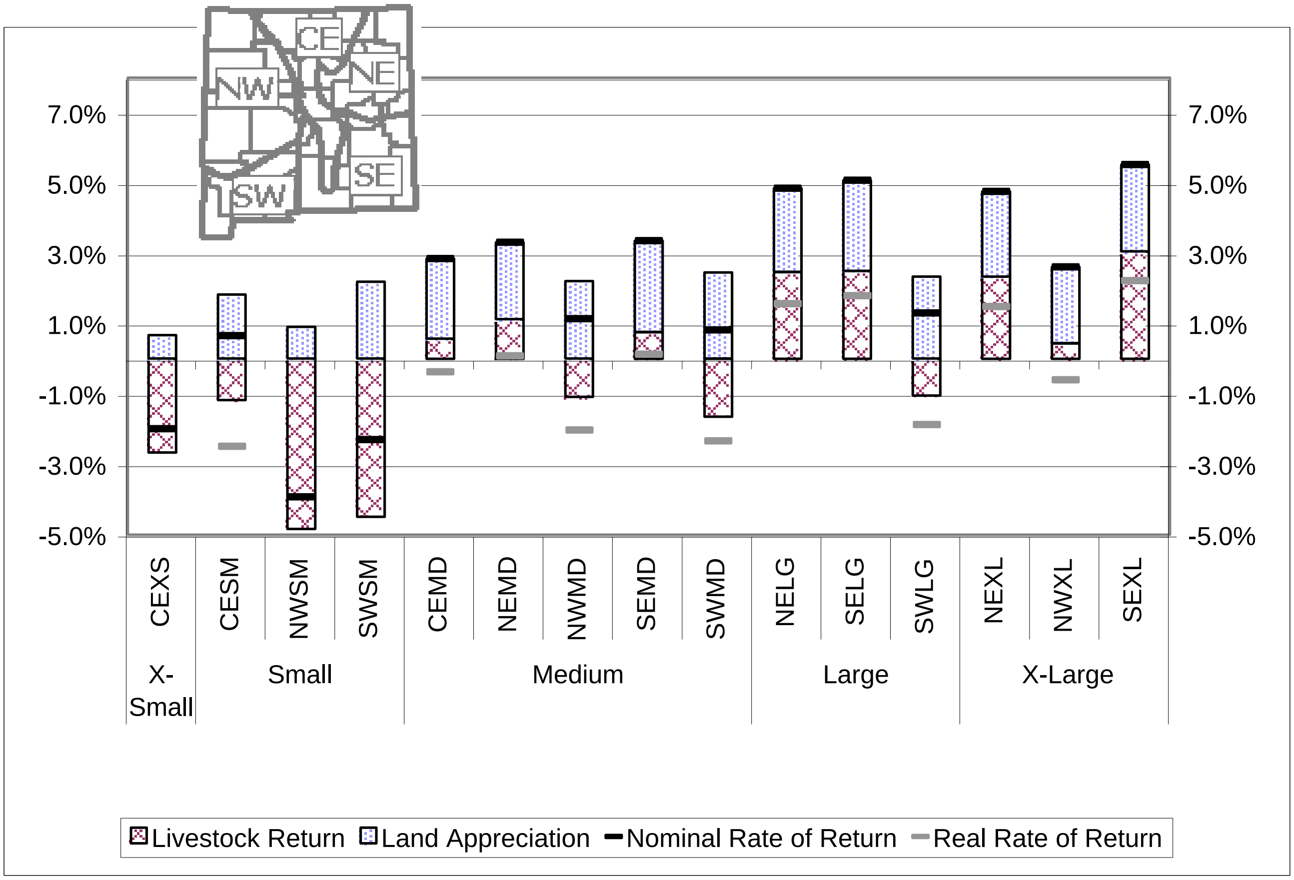


Figure 1. Nominal and real rates of return computed from NMSU livestock cost and return series, 1986-97.

The Motives of Ranchers

Various authors have studied the motives of farmers and ranchers (Smith and Martin 1972, Harper and Eastman 1980, Biswas et al 1984, Sullivan and Libbin 1987, Young and Shumway 1991, Bartlett et al. 1989, Gentner 1999). These studies have shown that for many agricultural producers the desirable QOL attributes associated with rural living rank much further up the goal hierarchy than does profit maximization. The relative importance of profit has varied from study to study.

Similar to the findings of Smith and Martin (1972), a strong desire to own ranches for consumptive or QOL reasons was found to be prevalent in Colorado. Over half of the survey respondents in a Bartlett et al. (1989) study stated that rate of return on investment was of little or no importance to the ranch ownership decision. Instead, Colorado ranchers assigned high importance to land ethics and family life on the ranch. The profit motive was important in classifying ranchers as to their willingness to sell the ranch, but other job opportunities and beliefs about the difficulty in selling the ranch in the current market better differentiated ranchers into groups using cluster analysis.

Harper and Eastman (1980) developed a goal hierarchy for a randomly selected sample of small farm and ranch operators in north central New Mexico. Both family goals and agricultural goals were considered. In the goal ranking, maintenance and improvement of the quality of life through involvement in agriculture was found to be the primary motivation for owning the farm or ranch business. Profit and the motive to increase net worth were the fourth and third goal rankings, respectively.

With the objective of defining social and economic characteristics of western public land ranchers, Gentner (1999) conducted a west-wide mail survey of a sample of Bureau of Land Management (BLM) and U.S. Forest Service (USFS) permittees. Using cluster analysis, western public land ranchers were grouped as either hobbyist or professional ranchers. Eight additional subgroups emerged with various socioeconomic factors used as clustering variables. The goals and objectives of public land ranchers varied from a high ranking for QOL factors, especially for identified hobby ranchers, to a strong emphasis on profit maximization for professional ranchers more dependent on ranch income. Gentner (1999) found that all types of public land ranchers ranked QOL factors above profit maximization. All groups listed the complementary relationship between land ownership and family tradition, culture, and values as a primary reason for owning the ranch. Profit maximization was ranked in the middle of all possible objectives for ranch ownership.

Others have found the profit motive to be a strong motivation for farming and ranching. Young and Shumway (1991) found a high proportion of Texas cow-calf producers' perceived themselves as having profit maximization as a primary goal. Similarly, Harman et al. (1972) found profit was the primary motive for farming in Oklahoma and Texas, followed by the desire to increase net worth.

Biswas et al. (1984) used producer rationality tests common in studies of less-developed countries to evaluate whether "the behavior of livestock ranchers in southeastern Montana conformed to the standard producer rules and, in particular, whether profit maximization is a reasonable postulate for their production behavior (p. 187)." They concluded that profit maximization is a reasonably good postulate relative to the behavior of ranchers in the western United States, but noted that the test of rationality used would be consistent with a variety of other behavioral postulates, because goals like staying in business, increasing net worth and expanding farm or ranch size are all consistent with profit maximization.

It is apparent that the literature does not provide a clear and consistent picture for what motivates farmers and ranchers to continue in agriculture; many multiple and inter-related goals are involved. Agricultural producers continue in business despite the relatively low economic returns they make. They want to improve and enjoy the desirable attributes of rural living, and more profit and net worth are obviously preferred to less. Different amounts are paid for ranches because alternative ranches provide different levels of profit potential and have different scenic and recreational qualities.

An Economic Model of Land Values

Hedonic pricing models are built on the premise that goods traded in the market place have different bundles of attributes or characteristics. Rosen (1974) suggested that these differentiated characteristics can be defined by the vector $Z = (z_1,\ldots,z_n)$, and it is how the market values these different attributes that determines economic value. For land values, this vector can further be differentiated into factors that affect agricultural production returns, $Z_a = (z_{a1},\ldots,z_{an})$, and factors that affect amenity or quality of life (QOL) values, $Z_q = (z_{q1},\ldots,z_{qm})$ (McLeod et al. 1999).

Consider first production value (PV), which includes the value of agricultural products, recreation and hunting income, minerals, timber sales, and other production income. Let R_t be the expected net return to land at time t. This net return is expected to vary from ranch to ranch because of alternative characteristics that influence income-earning potential:

$$R_t = R_t(z_{a1},\ldots,z_{an}). \quad (1)$$

Recognizing the difference in earning potential between ranches, and expanding the land value model of Pope (1985), agricultural productive value can be defined in the traditional way by computing the discounted value of expected returns to land:

$$PV(Z_a, i) = \sum_{t=1}^{\infty} \frac{R_t(z_{a1},\ldots,z_{an})}{(1+i)^t}, \quad (2)$$

where i is the real discount rate.

If R_t is expected to increase (or decrease) over time at a constant rate g, because of technological change or increasing (decreasing) agricultural prices, then the equation can be rewritten by expressing PV as a function of current period returns:

$$PV(Z_a, i, g) = \sum_{t=1}^{\infty} \frac{R_0(z_{a1},\ldots,z_{an})(1+g)^t}{(1+i)^t}. \quad (3)$$

Expected current period returns (R_0) could be estimated as the most recent return, or some simple or weighted average of past returns. If $i > g$, and for a ranch with characteristics defined by Z_a, equation 3 can be simplified to:

$$PV(Z_a, i, g) = \frac{R_0(z_{a1},\ldots,z_{an})}{(i-g)}. \quad (4)$$

As noted by Pope (1985), the determinants of the consumptive or quality of life (QOL) values of rural land ownership are considerably more complex. Define the set of QOL values to be $Q(z_{q1},\ldots,z_{qm})$. It follows, then, that the observed market value (MV) of rural lands would be estimated as the summation of production and QOL values, and that this value would depend on the ranch characteristics that affect production earning potential (Z_a), the characteristics that affect QOL values (Z_q), the real discount rate (i), and the assumed rate of growth of future earnings (g):

$$MV(Z_a, Z_q, i, g) = PV(Z_a, i, g) + Q(Z_q). \quad (5)$$

Several different problems arise in estimating equation 5. First, cross-sectional data are not available to estimate how ranch returns vary with ranch characteristics (equation 1). It is known that various ranch specific factors affect grazing costs, animal production and potential ranch returns. Many believe, for example, that non-fee grazing costs increase as the amount of public land increases on the ranch, and broadly defined estimates of these cost differences are available (Torell et al. 1992, Bartlett et al. 1984, Obermiller and Lambert 1984). However, data limitations preclude using anything but a broadly defined estimate of net returns from either USDA or university sources. The paired comparison of ranch selling price coupled with ranch-specific estimates of past or expected net returns will likely never be available.

The inability to estimate equation 1 leads to a second problem; namely, the elements of Z_a and Z_q are not necessarily independent. A particular factor can have either a negative or positive affect on ranch returns, and also be valued positively or negatively for QOL purposes. Consider wooded areas as an example. It is well established that an increasing tree overstory decreases forage production (Bartlett and Betters 1983) and thus livestock grazing returns. Yet, it is also widely recognized that scenic mountain ranches with forested areas demand a premium price because of desirable QOL attributes (Sands 1988). In many cases it may be possible to establish that a particular factor does in fact affect the market value of ranches, but it will not be possible to determine whether the influence resulted from altered ranch income, QOL values, or both.

Methods

Data Sources and Description

Appraisal data for New Mexico ranch sales were obtained from Farm Credit Services (FCS). Ranch sales data included 951 agricultural land sales from 30 of 33 New Mexico counties (excluding San Juan, Bernalillo and Los Alamos). All ranch sales occurred or were recorded over the period January 1987 to May 1999.

Information collected for each ranch sale included the seller, buyer, month and year sold, county, ranch location (township and range), appraiser's judgmental assessment of non-farm influence on value, appraiser assigned contributory value of principal dwelling and other improvements, cultivated acres, total deeded acres, purchase price, irrigated acres, livestock grazing capacity, percent capacity from leased public lands, and type of public lease(s).

Starting with the township and range definition of ranch location, as recorded by FCS appraiser, the location of the ranch headquarters was plotted using Geographic Information Systems (GIS) procedures. This allowed the visualization of ranch location within the state and further allowed for definition of the potential vegetation type included with each ranch sale. This was done by overlaying the Natural Resource Conservation Service (NRCS) map titled "Major Land Resource and Subresource Areas" for New Mexico. Austin (1981) describes the major land resource areas (MLRA) as separated by different patterns in soils (including slope and erosion levels), climate, water resources, land use, and type of agricultural production. A separate area designation (i.e. Area 1, Area 2, … , Area 9) was added to this MLRA map to simplify the area designations defined in the hedonic regression models described below (Figure 2).

Population density (population per square mile) for New Mexico counties were defined from data reported at the ESRI website from the 1990 census (ESRI 1999). An estimate of the distance from the ranch headquarters to the nearest small town was visually made using the GIS map and a large quadrant map. Distance from this small town to a larger town or trade center was calculated using the Rand McNally computer program (Rand McNally 1997). Distances were calculated as the shortest distance following established roads. Trade centers were considered to be large enough to provide the purchase of ranch supplies and to provide cultural and shopping opportunities. Bailey (2000) provides additional detail about which cities were considered to be trade centers.

Hedonic Regression Model Definition

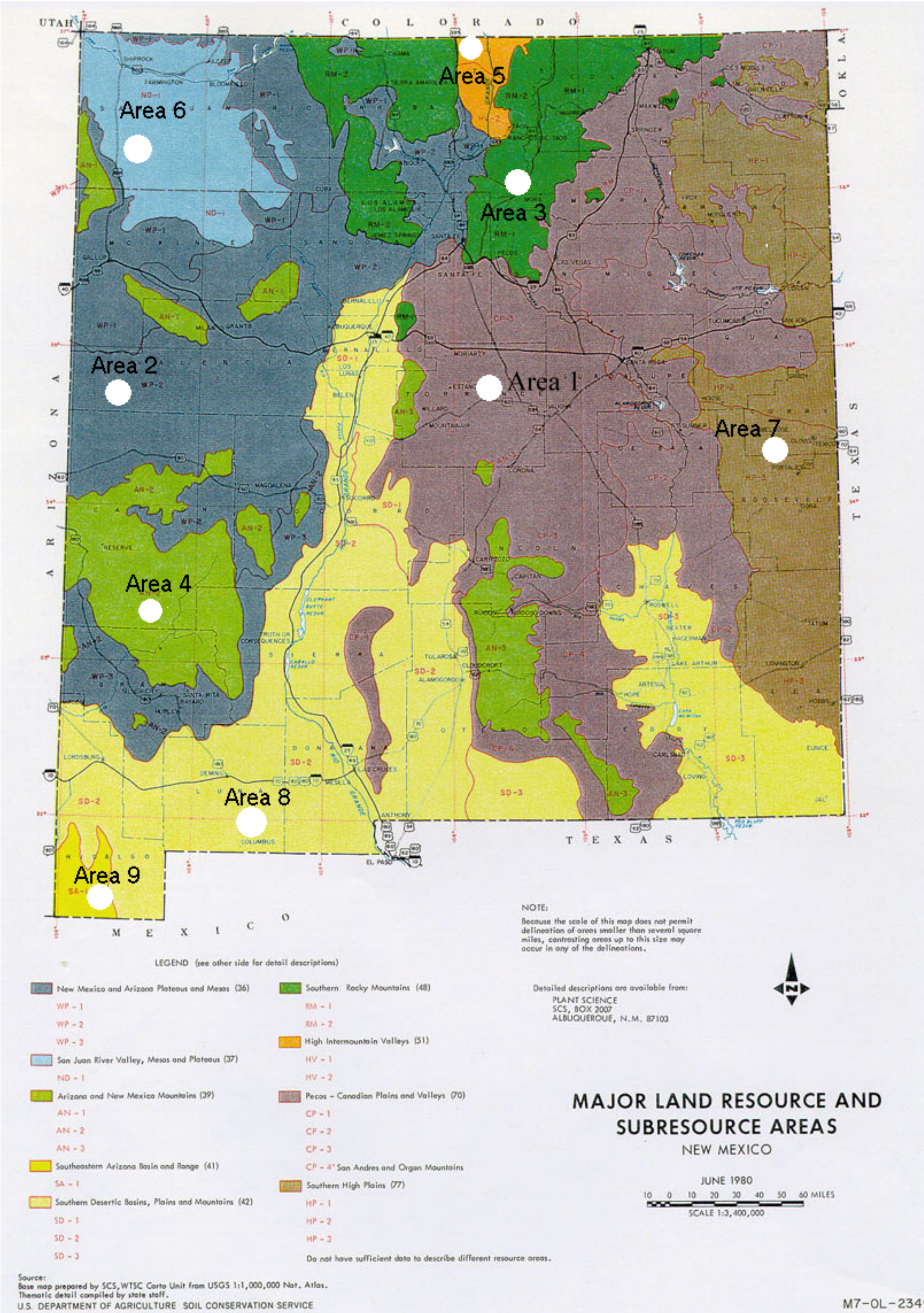
Of the total 951 ranch sales in the FCS dataset, 81 ranches had a carrying capacity of less than 20 AUY[2] and were found to have extremely high and variable selling prices (average of $21,425/AUY, $398/acre). These ranches were obviously purchased for reasons not related to livestock production. They had very little if any public leased land and were small tracts averaging about 1 section in size. Attempts to explain value differences for this set of ranches were not successful and they were excluded from further analysis

Initial attempts to combine the remaining 870 ranch sales resulted in a relatively poor fit of regression models. After plotting selling price and attempting several initial regression models it was determined that 100 AUY provided a reasonable breaking point for model definition. Two alternative models were developed for ranches where 20 $<$ AUY $\leq$ 100 and AUY $>$ 100.

Another variable that was recorded in the FCS database was a subjective assessment by the recording FCS appraiser as to whether the sale was greatly influenced by non-farm influences (NFI), including an exceptional scenic view, recreational and hunting opportunities, industrial and residential development potential, minerals or a combination of influences. The NFI variable was defined to be true for those ranches where an outside influence was felt to be exerting a significant price effect and the influence was very apparent. The binary variable was coded as a one (1) when present and zero (0) otherwise. When present, the NFI price influence captures a combination of added earnings potential from hunting, minerals and development potential, and QOL influences from desirable ranch location. Most of the ranches with a positive NFI were located in the mountainous and scenic parts of the state, and especially in Northern New Mexico in or near areas 2, 3, and 4 in Figure 2. Bailey (2000) provides additional detail about the location of these ranches.

While it would have been possible to combine data and use the NFI dummy variable directly in

[2]/An animal unit (AU) is considered to be one mature cow with calf or the equivalent. An AUM (Animal Unit Month) is the amount of forage required by an AU for one month. An AUY (Animal Unit Yearlong) is the forage requirement for an AU for the year. A cow unit represents one mature brood cow. Generally, the number of AUYs on a western ranch will be about 1.35 times the number of brood cows with a cow/calf operation and 1.7 times with a cow/calf-yearling operation (Workman 1986).



Source: NRCS(1981) with alternative area designations added.

Figure 2. NRCS definition of major land resource and subresource areas in New Mexico.

the regression models, this procedure was not used. Sample size was adequate and different slope parameters were found to exist for the "with" and "without" NFI models. Better statistical fits were obtained by running separate regression models.

As shown in Figure 3, the size and NFI categorizations resulted in 4 different regression models. For 17 ranches (13 with 20 < AUY ≤ 100 and 4 with AUY > 100), recognizing that a positive non-farm influence existed was still inadequate for explaining the exceptional sale price. These 17 ranches sold for in excess of $25,000/AUY and had an average selling price of $45,000/AUY ($818/deeded acre). They were clearly outliers relative to other ranch sales that also had an identified NFI. These sales were all 100% deeded land ranches with either a recreational price influence or a combination of price influences. By comparison, the average price of the other sales with identified NFI was $8,781/AUY ($231/deeded acre). These 17 ranch sales were excluded from further analysis because as apparent outliers they had a major influence on the results of the regression models. Though these ranches were excluded, they do give an indication of the upper end of the current New Mexico ranch real estate market. With the various exclusions the final number of ranch sales included in the regression analysis was 853 (Figure 3).

Ranch sale price, house and building values, and measures of expected ranch returns, as described below, were adjusted to constant 1998 levels using the consumer price index (CPI). Other variables potentially included in hedonic ranch price models (Table 1) were developed based on real estate appraisal theory and previous hedonic price models. Torell and Kincaid (1996) and Bailey (2000) provide additional detail about parameter interpretation and the expected sign of the explanatory variables.

Definition of the dependent variable for land value estimation is a problem for western ranches, because leased public and state lands are attached to the base ranch property. This problem follows because the ranch purchaser buys the privilege to graze public land permits and does not acquire title to these lands. For public land-dependent ranches, it is not possible to compute a valid per acre price, which is the standard dependent variable used for farm and ranch sales analysis. A price per deeded acre can be computed, but this is misleading because small deeded acreages with large public land permits attached have a very high price per deeded acre when the added value comes largely from acreages (grazing permits) not counted in the denominator. As a solution, total ranch value has been used as the dependent variable in some hedonic land value models (Rowan and Workman 1992, McLeod et al. 1999, Spahr and Sunderman 1998, Torell and Fowler 1986), but this creates problems because beta coefficients measure average adjustments across all ranch sizes, and this adjustment will be too large for small ranches and too small for large ranches.

Other dependent variable definitions have been $/cow, $/AUM and $/AUY selling price (Torell and Kincaid 1996, Torell and Doll 1991, Martin and Jeffries 1966, Workman and King 1982). The $/AUY definition was judged to be most appropriate for New Mexico ranches with public land grazing permits and where yearlong grazing is common.

A major factor potentially influencing the sale price of western ranches is ranch location. In New Mexico, this location effect could largely result for QOL reasons if mountainous, scenic areas with enhanced recreation potential are found to have higher market values. Or, ranch location could influence values largely for productive reasons if values are inflated in the more productive rangeland areas, like in eastern New Mexico. Oil and gas revenues also vary across the state.

To evaluate how ranches located in various MLRAs varied in price, dummy variables were defined for the areas shown in Figure 2. Some areas were combined because of sample size limitations, as described in Table 1.

Time of sale was incorporated into the models using two different procedures. First, models developed when there was not an observed non-farm influence had adequate sample size to define dummy variables following the procedure used by Spahr and Sunderman (1998). By this procedure, a date of sale dummy variable is defined to be a linear combination of the start and end points for the year in which the sale occurred. If the ranch sale occurred at the end point (Dec. 31), the dummy variable for that year is assigned the value zero (0), but at sale dates earlier in the year the dummy variable defines the proportion of the year that still remains. The dummy variable for year t+1 is defined as the remaining difference. For example, if a ranch sale occurred in September 1990 then the 1990 dummy variable (D90) would be assigned the value 0.25 and D91 would be 0.75. Because the sale occurred closer to the beginning of 1991, D91 is given more weight. Points within the year are expressed as a linear weighting of the two end

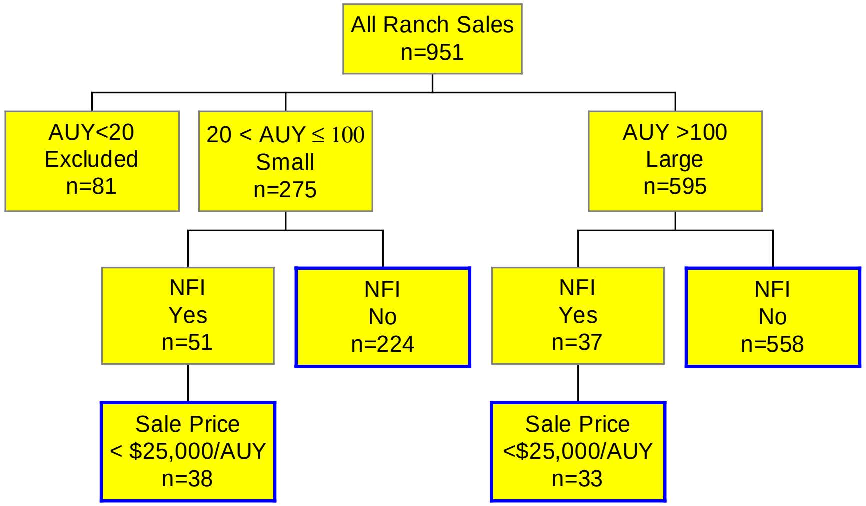


Figure 3. Number of ranch sales and hedonic price model definitions.

Table 1. Explanatory variables used in defining and predicting New Mexico ranch values.

Variable	Variable Description
RPRICEAUY	Real (inflation adjusted to constant 1998 prices) ranch sale price on a $/AUY basis.
SECTION	Ranch size expressed in sections (including deeded, public and state trust lands).
LNSECT	Natural logarithm of the number of sections.
TIME	Time trend variable measured as number of years from January 1999 that the ranch sold (i.e., Jan. 1999 = 0, Jan. 1998 = -1, July 1996 = -2.5).
%BLM	Percent of ranch carrying capacity from BLM leased land times 100.
%USFS	Percent of ranch carrying capacity from USFS leased land times 100.
%STATE	Percent of ranch carrying capacity from State leased land times 100.
LIVCAP	Total ranch livestock carrying capacity (AUY).
ACCULTAUY	Acres of cultivated land per AUY on the ranch.
TRDFS	Slope shifter for %USFS, computed by multiplying %USFS by TIME.
TRDBLM	Slope shifter for %BLM, computed by multiplying %BLM by TIME.
TRDST	Slope shifter for %STATE, computed by multiplying %STATE by TIME.
RHBVALAUY	Real (inflation adjusted to constant 1998 prices) appraised value of houses and buildings on the ranch expressed as $/AUY.
PROD	Average productivity of the ranch. Defined as LIVCAP/SECTION.
D_i	Dummy variable for year i (i = 1987 to 1997). See text for a description of how dummy variables were defined. 1998-99 was excluded, so D_i shifts sales value for year i relative to the 1998-99 period.
$DAREA_j$	Dummy variable for NRCS Major Land Resource and Subresource area j. The dummy variable was set to 1 when it was in the area and 0 otherwise. Due to the lack of ranch sales in certain areas, some areas were combined. $DAREA_1$ = Area 1 in Figure 2; $DAREA_2$ = Area 2 and Area 6; $DAREA_3$ = Area 3, Area 4 and Area 5; $DAREA_4$ = Area 7; and $DAREA_5$ = Area 8 and Area 9. $DAREA_1$ was excluded so $DAREA_j$ shifts sales value for area j relative to $DAREA_1$.
TRADE	Mileage from the ranch to the nearest market trade center.
POPDEN	Population density for the county where the ranch headquarters was located.
RNETRET	Real (inflation adjusted to constant 1998 prices) net annual returns from NMSU cost and return series.
t	Scale parameter as estimated for the Xu et al. (1994) truncation.

points. This approach allows the rate of change in ranch prices to be different for each year and allows for a price continuum rather than a step function. This was the preferred estimation procedure. However, sample size was not adequate to use the dummy variable procedure when there was a significant non-farm influence. For the ranch models with an identified non-farm influence, a linear trend variable (TIME) was included (or excluded if it was found to be statistically insignificant at the α=0.05 level). The different definitions of the time variables are described as f(TIME) in the discussion below.

Using data from Torell and Doll (1991), Xu et al. (1994) demonstrated that dependent variables modeled in empirical economic analysis are often non-negative random variables in nature. The dependent variable for land price cannot theoretically be negative. Thus, distributions for the disturbance term that allow negative dependent variables to occur with non-zero probability are by definition a model misspecification. Xu et al. (1994) demonstrated how to correct this misspecification by truncating allowable dependent variable estimates at zero. This truncated model is an important adjustment when ranch prices are relatively low and less important as values move further from zero (Xu et al. 1994).

The truncated model was estimated using nonlinear regression procedures (PROC MODEL in SAS 1984) and includes a scale parameter (τ) as one of the parameter estimates. If τ is statistically significant then the truncation is an important model adjustment. The Xu et al. (1994) truncation was included when τ was found to be statistically significant but the simpler ordinary least squares (OLS) estimation was used when it was not statistically significant.

For larger size ranches (AUY > 100), ranch size was entered into the models in log (base e) form (LNSECT), because previous research has shown the price discount for ranch size to decrease at a decreasing rate (Torell and Kincaid 1996). For small size ranches with AUY carrying capacity over the narrow range of 20 < AUY ≤ 100 the ranch size variable was entered as a linear function (SECTION), because initial analysis indicated a better statistical fit with this functional form. The different definitions of the size variables are described as f(SIZE) in the discussion below.

Other variables measuring percent public and state land, cultivated acres per AUY, house and building values per AUY, and rangeland productivity were included following the definitions of Torell and Kincaid (1996). Two additional explanatory variables, TRADE and POPDEN, were also added to the models. It was anticipated that increasing TRADE, the distance to a market or trade center, would negatively affect ranch selling price. However, the a priori sign of population density (POPDEN) is uncertain; it depends on whether people desire to live near or away from other people.

The model of per AUY ranch sale price was then defined as:

$$g(X;\beta) = \beta_0 + \beta_1 \%BLM + \beta_2 \%USFS + \beta_3 \%STATE + \beta_4 TRDBLM + \beta_5 TRDFS$$

$$+ \beta_6 TRDST + \beta_7 PROD + \beta_8 ACCULTAUY + \beta_9 TRADE + \beta_{10} POPDEN + \beta_{11} RHBVALAUY$$

$$+ \sum_{j=2}^{5} \beta_{10+j}\, DAREA_j + f(SIZE) + f(TIME) + f(RETURNS) + u,$$

where explanatory variables are defined in Table 1 and the various other functions are defined as follows:

$$f(SIZE) = \begin{cases} \beta_{16}\ SECTION & \text{Used when } 20 < AUY \le 100 \\ \beta_{17}\ LNSECT & \text{Used when } AUY > 100 \end{cases}$$

$$f(TIME) = \begin{cases} \sum_{i=1987}^{1997} \beta_i D_i & \text{Without NFI Large Model} \\ \beta_{18} TIME & \text{All other models} \end{cases}$$

$$f(RETURNS) = \begin{cases} \beta_{19} RNETRET_t + \beta_{20} RNETRET_{t-1} \\ \beta_{19} RSTEER_t \end{cases}$$

RETURNS considered one of several alternative measures of expected net annual agricultural returns, including direct estimates of net ranch returns by ranching area and annual beef prices. The NMSU cost and return series provided a historical annual estimate (1986-97) of ranch returns by ranch size and ranching area. Using the GIS map and definition of ranch location it was determined which NMSU ranching area (Figure 1) was most appropriate for each ranch sale. The livestock carrying capacity of the ranch sale was then matched to the most appropriate size designation in the NMSU cost and return series.[3] Various combinations of current period, average and lagged estimates of net ranch returns were evaluated in the regression models as alternative model formulations.

As further described by Bailey (2000), grazing fee payments are different for each ranch depending on the amount of public and state trust land included on the ranch. Thus, to estimate annual net returns for a particular ranch, grazing fee payments for the representative ranch were adjusted for the specific AUMS leased on that particular ranch. This procedure provided regionalized estimates of annual livestock returns but it did not consider specifically how livestock returns varied with ranch characteristics, as detailed by equation 1.

Hunting and mineral income by ranch were also not known. These other income sources are important for some New Mexico ranches but lack of site specific data precluded consideration.

To estimate the truncated model described by Xu et al. (1994) it was assumed the error term was distributed normally with mean zero and scale parameter τ. The truncated model was then estimated as

$$\text{RPRICEAUY} = g(X;\beta) + \frac{\varphi(-g(X;\beta))/\tau}{\Phi(g(X;\beta))/\tau},$$

where $\varphi(\bullet)$ and $\Phi(\bullet)$ are the probability density and cumulative density functions for the standard normal distribution and $\beta = \{\beta_0, \beta_1, \ldots, \beta_k\}$ and τ are parameters to be estimated.

The explanatory variables in the model are hedonic in nature and relate the value of a particular ranch to local and specific ranch characteristics and attributes at various points in time. Ranch value estimates were made for each of the MLRA areas, corresponding to the definitions in Figure 2. These estimates were made based on the varying characteristics found in each MRLA area classification. To estimate average ranch values by area, explanatory variables were set at the average levels computed for each area (Table 2).

[3]/Only three size classifications are used in the NMSU cost and return series. If a ranch was larger or smaller than a specific size designation then the nearest NMSU size classification was used.

Most of the ranches with NFI were in or on the fringes of areas 2 through 6 (Figure 2). Ranch size, livestock carrying capacity and productive values varied between areas (Table 2). The most productive ranches, as measured by rangeland carrying capacity (PROD), were in eastern New Mexico (Area_1 and Area_2).

Results

Hedonic Ranch Value Models

Livestock Returns Excluded

Parameter estimates for the various regression models are presented in Tables 3 through 6. The alternative tables are for large and small ranches both with and without appraiser noted non-farm price influence. Each table shows the estimated parameters when lagged and current period net annual livestock returns were included as explanatory variables and also when these return variables were excluded. All prices in the estimation have been adjusted to constant 1998 levels.

Because the models include many explanatory variables the potential existed for problems with multicollinearity. As shown in the parameter estimate tables, the large ranch models without NFI (table 3) had estimated condition indices that exceeded 30 and thus indicated potential problems with multicollinearity. But, additional analysis of the structure of relationships among the variables did not indicate a significant problem with multicollinearity. The PROC MODEL procedure needed to estimate the Xu et al. (1994) truncation in SAS only allows the COLLIN option (noncentered data) for detecting multicollinearity. This option includes the intercept in the structure analysis and it was the intercept that was correlated with the ranch size variable in the model. In this application the intercept represents an extrapolation far beyond the reach of the data. Reverting to the COLLINOINT (centered data) option using PROC REG resulted in condition indices of less than 15. Estimated condition indices for other small ranch models were less than 5.

The data were a combination of cross sectional and time series data, thus, autocorrelation was not considered to be a problem. Heteroscedasticity

Table 2. Average ranch characteristics and variable definitions by MLRA.

MLRA Area[a]	Area[a]	NFI	Size Category	# of Ranches	Size (Sections)	LIVCAP	Cultivated Acres	Cultivated Acres per AUY	Total House Building Value	Real House and Building Value ($/AUY)	% BLM	% USFS	% STATE	PROD	TRADE	POPDEN	January 1999 Market Value[b]
RM, AN, AND HV	3, 4, 5	None	Large	43	72.57	607	4.30	0.01	73,208	165.16	14.2	39.6	13.1	9.6	59.2	3.6	2,613
WP AND ND	2, 6	None	Large	81	50.01	413	9.32	0.01	31,519	94.15	26.7	25.6	12.7	9.2	45.5	6.2	2,562
SD AND SA	8, 9	None	Large	121	48.14	430	6.56	0.02	35,513	104.36	50.5	2.6	20.9	9.5	31.4	8.6	2,225
HP	7	None	Large	74	18.16	301	71.46	0.36	29,739	118.48	1.2	0.8	23.8	16.6	38.7	5.9	3,868
CP	1	None	Large	239	30.29	421	16.82	0.07	46,223	147.84	11.0	0.7	13.4	15.2	44.6	3.7	3,711
RM, AN, AND HV	3, 4, 5	None	Small	13	4.63	59	0.00	0.00	10,481	263.28	2.6	10.8	15.9	12.9	59.2	1.9	5,320
WP AND ND	2, 6	None	Small	24	5.47	57	0.00	0.00	9,715	281.64	16.4	4.0	20.2	10.5	49.7	5.1	5,378
SD AND SA	8, 9	None	Small	39	8.21	61	0.00	0.00	7,407	183.72	47.4	0.0	16.9	9.2	30.4	11.5	2,895
HP	7	None	Small	60	3.34	56	11.33	0.18	3,893	118.96	0.0	1.0	14.4	18.0	38.1	4.9	4,168
CP	1	None	Small	88	3.77	56	3.19	0.09	8,556	157.46	3.6	0.0	7.9	15.5	42.9	3.7	4,655
RM, AN, AND HV	3, 4, 5	Yes	Large	13	25.64	223	22.92	0.09	97,535	417.65	1.0	37.8	5.5	15.2	58.9	2.5	8,479
WP AND ND	2, 6	Yes	Large	6	28.12	312	0.00	0.00	21,733	57.69	37.8	0.0	5.5	12.2	73.2	2.6	4,531
CP	1	Yes	Large	12	4.41	532	231.83	0.67	86,468	218.13	4.4	0.0	9.5	17.3	32.5	15.7	9,348
RM, AN, AND HV	3, 4, 5	Yes	Small	11	3.86	52	4.36	0.06	42,464	711.72	0.0	17.9	2.9	18.6	62.3	4.5	14,305
WP AND ND	2, 6	Yes	Small	11	5.49	57	0.00	0.00	26,091	646.94	17.7	0.0	6.4	10.4	63.1	1.9	7,058
CP	1	Yes	Small	12	3.93	57	4.67	0.10	83,375	1686.05	11.9	0.0	7.8	14.7	35.3	13.0	9,043

[a]/From figure 2. Averages are not reported when there were less than 5 ranches in that classification. The 6 ranches not shown were used in model estimation.

[b]/Estimated using the appropriate hedonic regression model. The estimate excludes the value of livestock, machinery and equipment.

Table 3. Parameter estimates for large ranches (AUY > 100) without NFI.

		Annual Livestock Return Variables			
		With ($/AUY)		Without ($/AUY)	
Variable	Parameter	Estimated Coefficient	Standard Error	Estimated Coefficient	Standard Error
Intercept	β_{0}	5,063.81 ***	300.90	5,252.35 ***	193.08
%BLM	β_{1}	-32.22 ***	2.60	-31.35 ***	2.20
%USFS	β_{2}	-38.35 ***	3.78	-38.99 ***	3.82
%STATE	β_{3}	-26.97 ***	2.91	-26.94 ***	2.55
TRDBLM	β_{4}	-0.43	0.298	-0.43	0.270
TRDFS	β_{5}	-1.02 **	0.428	-1.14 ***	0.437
TRDST	β_{6}	-0.159	0.389	-0.25	0.364
PROD	β_{7}	-24.70 ***	4.22	-28.22 ***	4.44
ACCULTAUY	β_{8}	138.42 ***	46.55	157.40 ***	48.47
TRADE	β_{9}	-5.28 ***	1.30	-3.68 ***	1.29
POPDEN	β_{10}	-8.04 *	4.35	-9.26 **	4.55
RHBVALAUY	β_{11}	1.86 ***	0.157	1.78 ***	0.156
$DAREA_2$	β_{12}	268.33 ***	91.497	312.42 ***	87.10
$DAREA_3$	β_{13}	380.45 ***	117.500	488.30 ***	119.21
$DAREA_4$	β_{14}	198.21 **	83.553	155.16 *	83.88
$DAREA_5$	β_{15}				
SECTION	β_{16}				
LNSECT	β_{17}	-71.41 *	40.32	-130.26 ***	38.47
TIME	β_{18}				
D_{87}	β_{87}	-464.79	293.90	-594.27 ***	213.40
D_{88}	β_{88}	-572.78 **	282.20	-685.44 ***	167.99
D_{89}	β_{89}	-581.97 *	301.00	-697.32 ***	166.56
D_{90}	β_{90}	-538.53 *	280.70	-644.26 ***	148.13
D_{91}	β_{91}	-583.30 **	281.40	-681.59 ***	158.66
D_{92}	β_{92}	-625.61 **	303.70	-741.93 ***	172.47
D_{93}	β_{93}	-610.29 **	285.90	-710.00 ***	157.12
D_{94}	β_{94}	-345.78	279.40	-415.97 **	162.58
D_{95}	β_{95}	-411.74	296.50	-493.21 ***	147.02
D_{96}	β_{96}	-644.38 **	317.50	-603.23 ***	149.31
D_{97}	β_{97}	-300.93	291.60	-232.85	153.07
$RNETRET_t$	β_{19}	-0.613	0.837		
$RNETRET_{t-1}$ [a]	β_{20}	-0.212	0.883		
Scale Parameter	t	742.38 ***	223.30	729.52 ***	236.40
R^2		0.80		0.78	
Sample Size	n	514		558	
Largest Condition Index		41.89		24.28	
Root Mean Square Error (RMSE)		552.77		591.62	

Footnotes follow Table 6.

Table 4. Parameter estimates for large ranches (AUY > 100) with NFI.

		Annual Livestock Return Variables					
		With ($/AUY)			Without ($/AUY)		
Variable	Parameter	Estimated Coefficient		Standard Error	Estimated Coefficient		Standard Error
Intercept	$ß_0$	5177.22	***	1673.819	7081.71	***	1,434.33
%BLM	$ß_1$	-62.58		46.854	-66.89	**	30.91
%USFS	$ß_2$	-108.24	***	26.034	-112.64	***	23.75
%STATE	$ß_3$	-96.96		66.990	-134.62	**	54.74
TRDBLM	$ß_4$						
TRDFS	$ß_5$						
TRDST	$ß_6$						
PROD	$ß_7$						
ACCULTAUY	$ß_8$						
TRADE	$ß_9$						
POPDEN	$ß_{10}$	214.64	***	56.217	192.60	***	53.23
RHBVALAUY	$ß_{11}$	4.85	**	2.001	3.76	**	1.78
$DAREA_2$	$ß_{12}$						
$DAREA_3$	$ß_{13}$	5531.19	**	1950.084	4411.14	**	1,861.36
$DAREA_4$	$ß_{14}$						
$DAREA_5$	$ß_{15}$						
SECTION	$ß_{16}$						
LNSECT	$ß_{17}$						
TIME	$ß_{18}$						
D_{87}	$ß_{87}$						
D_{88}	$ß_{88}$						
D_{89}	$ß_{89}$						
D_{90}	$ß_{90}$						
D_{91}	$ß_{91}$						
D_{92}	$ß_{92}$						
D_{93}	$ß_{93}$						
D_{94}	$ß_{94}$						
D_{95}	$ß_{95}$						
D_{96}	$ß_{96}$						
D_{97}	$ß_{97}$						
$RNETRET_t$	$ß_{19}$	2.99		16.543			
$RNETRET_{t-1}$[a]	$ß_{20}$	3.40		13.357			
Scale Parameter	t						
R^2		0.74			0.70		
Sample Size	n	28.00			33.00		
Largest Condition Index		4.18			2.34		
Root Mean Square Error (RMSE)		3981.32			3941.79		

Footnotes follow Table 6.

Table 5. Parameter estimates for small ranches (20< AUY <= 100) without NFI.

		Annual Livestock Return Variables			
		With ($/AUY)		Without ($/AUY)	
Variable	Parameter	Estimated Coefficient	Standard Error	Estimated Coefficient	Standard Error
Intercept	ß$_0$	6,427.14 ***	569.94	6,928.92 ***	522.92
%BLM	ß$_1$	-28.31 ***	4.75	-26.51 ***	4.64
%USFS	ß$_2$	-36.71 ***	8.94	-37.98 ***	9.16
%STATE	ß$_3$	-32.94 ***	4.66	-30.72 ***	4.62
TRDBLM	ß$_4$				
TRDFS	ß$_5$				
TRDST	ß$_6$				
PROD	ß$_7$	-97.77 ***	27.31	-112.47 ***	27.07
ACCULTAUY	ß$_8$	465.47 ***	147.50	476.42 ***	148.45
TRADE	ß$_9$				
POPDEN	ß$_{10}$	-21.73 *	11.88	-23.11 *	11.95
RHBVALAUY	ß$_{11}$	1.80 ***	0.154	1.82 ***	0.156
DAREA$_2$	ß$_{12}$	667.51 **	328.01	1,025.25 ***	295.13
DAREA$_3$	ß$_{13}$	369.42	415.18	872.26 **	387.39
DAREA$_4$	ß$_{14}$				
DAREA$_5$	ß$_{15}$				
SECTION	ß$_{16}$	-82.23 **	40.82	-106.55 ***	38.02
LNSECT	ß$_{17}$				
TIME	ß$_{18}$	23.35	34.13	58.61 **	26.48
D$_{87}$	ß$_{87}$				
D$_{88}$	ß$_{88}$				
D$_{89}$	ß$_{89}$				
D$_{90}$	ß$_{90}$				
D$_{91}$	ß$_{91}$				
D$_{92}$	ß$_{92}$				
D$_{93}$	ß$_{93}$				
D$_{94}$	ß$_{94}$				
D$_{95}$	ß$_{95}$				
D$_{96}$	ß$_{96}$				
D$_{97}$	ß$_{97}$				
RNETRET$_t$	ß$_{19}$	-5.22 ***	1.53		
RNETRET$_{t-1}$[a]	ß$_{20}$	4.21 **	1.63		
Scale Parameter	t				
R^2		0.65		0.61	
Sample Size	n	210		224	
Largest Condition Index		1.89		1.73	
Root Mean Square Error (RMSE)		1,227.03		1,264.23	

Footnotes follow Table 6.

Table 6. Parameter estimates for small ranches (20< AUY <= 100) with NFI.

		Annual Livestock Return Variables					
		With ($/AUY)			Without ($/AUY)		
Variable	Parameter	Estimated Coefficient		Standard Error	Estimated Coefficient		Standard Error
Intercept	$ß_0$	14,900.00	***	2,398.16	13,756.00	***	2,009.65
%BLM	$ß_1$	-53.63		33.74	-61.25	*	31.66
%USFS	$ß_2$	-157.63	***	32.30	-145.10	***	30.62
%STATE	$ß_3$	-104.78		61.42	-89.56		60.02
TRDBLM	$ß_4$						
TRDFS	$ß_5$						
TRDST	$ß_6$						
PROD	$ß_7$	-135.98	**	62.20	-116.77	*	58.42
ACCULTAUY	$ß_8$						
TRADE	$ß_9$						
POPDEN	$ß_{10}$						
RHBVALAUY	$ß_{11}$	1.01	***	0.330	0.958	***	0.309
$DAREA_2$	$ß_{12}$						
$DAREA_3$	$ß_{13}$	8,761.70	***	1,783.35	8,021.50	***	1,549.87
$DAREA_4$	$ß_{14}$						
$DAREA_5$	$ß_{15}$						
SECTION	$ß_{16}$	-1,067.14	***	374.86	-809.09	**	352.27
LNSECT	$ß_{17}$						
TIME	$ß_{18}$						
D_{87}	$ß_{87}$						
D_{88}	$ß_{88}$						
D_{89}	$ß_{89}$						
D_{90}	$ß_{90}$						
D_{91}	$ß_{91}$						
D_{92}	$ß_{92}$						
D_{93}	$ß_{93}$						
D_{94}	$ß_{94}$						
D_{95}	$ß_{95}$						
D_{96}	$ß_{96}$						
D_{97}	$ß_{97}$						
$RNETRET_t$	$ß_{19}$	-9.60		10.02			
$RNETRET_{t-1}$[a]	$ß_{20}$	6.57		8.78			
Scale Parameter	t						
R^2		0.75			0.71		
Sample Size	n	35			38		
Largest Condition Index		4.81			2.13		
Root Mean Square Error (RMSE)		3,704.22			3,730.93		

Footnotes for Tables 3 through 6.

[a]/Because annual real net ranch returns were lagged one year prior to ranch sale date, sample size was reduced for the first year of sales included in the database (1987) when lagged variables were included.

*/Significant at .10 level or higher.

**/Significant at .05 level or higher.

***/Significant at .01 level or higher.

NOTE: Not all variables are included in all models. Different functional forms were used for the various models, as previously described. Statistically insignificant variables were excluded when there was not a strong theoretical justification for inclusion.

was not visually apparent from residual plots, but the Whites test indicates that a problem exists for some of the models. Corrections were not taken at this point.

As shown in Table 3, for large size ranches without NFI (the type of ranch many would call a "working New Mexico ranch") a strong relationship between the dollar per AUY selling price and the included explanatory variables was found. The Xu et al. (1994) scale parameter was statistically significant and the models were estimated using nonlinear regression routines in SAS. The estimated R^2 was 78%.

Large ranches without NFI in the southern deserts (Area 8 and Area 9) were not statistically different from Area 1 (Figure 2) and the corresponding dummy variable was removed from the final regression model. Dummy variables were significant for other ranching areas. As shown in Table 2, ranch characteristics such as percent public land, rangeland carrying capacity and ranch size were quite different between the different MLRA regions, and ranch values between areas were found to vary because ranch characteristics were different between MLRA areas. Statistical significance of dummy variables further indicates value differences even when ranch characteristics were the same between areas.

Considering only large ranches without NFI, ranch buyers apparently discount more distant ranches but desire to live in sparsely populated areas. Increasing the distance to a trade center by one mile was estimated to decrease ranch value by \$3.68/AUY for large no NFI ranches ($\hat{\beta}_9$ in Table 3). Increasing POPDEN by 1 person/sq. mi. was found to decrease the value of large no NFI ranches by over \$9/AUY ($\hat{\beta}_{10}$). This result was different for large ranches with noted NFI (Table 4) where distance to a trade center was not statistically significant (and thus excluded) and POPDEN had a large positive coefficient ($\hat{\beta}_{10}$ in Table 4). Buyers of high-priced New Mexico ranches with very obvious QOL attributes responded favorably to a denser population in the vicinity. Many of these NFI ranches were in northern New Mexico near Santa Fe. Small no NFI ranch purchasers discounted ranch price from increased population similar to the large no NFI purchasers. Neither POPDEN nor TRADE was statistically significant for the small with NFI model.

There was generally a significant but relatively flat upward trend in real ranch prices over the 1987-99 period for all estimated ranch models without NFI. Those ranches with a noted NFI did not exhibit an upward trend in real value over the study period. Most of the value increase for non-NFI ranches occurred between 1996 and 1999. Large ranches in Area 1 (Pecos – Canadian Plains and Valleys), for example, increased in value at an annualized rate of 6.4% from January 1996 through January 1998, but remained relatively unchanged in value from January 1987 through January 1996. Bailey (2000) provides more detail about the estimated trends in ranch values from the various hedonic models.

Price discounts for public land grazing permits were negative as expected a priori[4]. The discount varied greatly depending on the size and type of ranches considered, and the discount was not statistically significant in all cases. Many of the ranches with NFI were nearly 100 percent deeded land and the sample size may not have been adequate to fully capture the discount for public land in this case.

Livestock Returns Included

We could find no relationship between variation in current and lagged livestock returns and New Mexico ranch values. Various other regression models were also estimated (not shown), including models that considered two year average returns, current period returns only, and current and lagged beef prices reported at the Clovis, NM livestock sale. The main conclusion from these regression models was that the trends of New Mexico ranch values observed over the 1987-99 period has had nothing to do with variation in livestock returns or the price of beef. Livestock return variables were either statistically insignificant or significant but not of the expected positive sign. The general trend of real ranch values over the study period was increasing while the trend in ranch returns over the same period was decreasing, especially during 1995-98 when drought conditions forced partial liquidation of herds statewide. Similar to the statement by Sands (1998), this analysis shows that "ranch values appear to be impervious to market forces based on the price or value of beef production."

[4]/This does not mean that public land grazing permits are estimated to have negative value. Rather, as described by Torell and Kincaid (1996) it means that public land ranches are less valuable than deeded land ranches and the estimated beta coefficient is the per AUY discount relative to deeded land.

Even though trends and regional variation in ranch returns apparently do not explain any part of the variation in New Mexico ranch values, this is not to say that livestock earning potential is not an important consideration, or that the available cost and return data used are adequate for the analysis. With the dependent variable specified as real price on a $/AUY basis, this necessarily means that ranches that carry more animal units sell for more money. Ranch buyers may consider only some long run average expectation of livestock income from the ranch purchase. While the NMSU return estimates were specific to different areas of the state and for different points in time, they did not consider the unique characteristics of each ranch, nor did they include mineral revenue, returns from hunting and fishing enterprises, and other non-agricultural returns. The data limitations described earlier, which precludes estimation of equation 1, means the regionally defined NMSU cost and return estimates may not be specific enough to measure how ranch income earning potential influences ranch values.

While this data limitation is recognized, NMSU cost and return estimates can still be used to estimate what part of average market value by MLRA is justified by livestock production. Results of this analysis are displayed in Table 7. The January 1999 market value of ranches by MLRA was computed using the appropriate hedonic regression model for the average ranch characteristics defined in Table 2 (Column D in Table 7).[5] Total average ranch investment was then calculated by adding the average investment in livestock and equipment to this average land value. Net annual investment return from livestock production (Column G) was then divided by column F to compute the implied capitalization rate needed to equate annual returns to ranch market value (equation 4). The computed capitalization rate is similar to the livestock rates of return summarized for the NMSU costs and return series in Figure 1, except land values have been updated and ranching areas have been redefined with the MLRA designation.

As noted earlier, AAEA (1998) estimated the long-term risky real opportunity rate for investments in agriculture were from 5% to 9%. Using the 7% mid-point value as the opportunity cost of capital, the next column in Table 7 shows what investment level would be justified if a 7% rate of return were desired. When average annual returns were negative (mostly the small sized ranches) this suggests that none of the investment value could be justified by livestock returns.

At a 7% capitalization rate, about 27% of the market value of large New Mexico ranches is justified by long-term average livestock returns in the grasslands of northeast New Mexico (CP and HP). About 16% of the value is explained for small ranches in these areas. Because the CP and HP MLRA areas have the most productive rangelands in the state for livestock production, and the flat terrain gives little QOL value (at least by our judgment), it is not surprising that the largest percentage of ranch market value is explained by livestock production in these areas. Very little of the market value is explained by livestock production for other areas of the state, and especially for small ranches and those with noted NFI. These results are similar to the findings of Pope and Goodwin (1984) where they found agricultural productive values and the relative importance of QOL versus agricultural values to be different by area. They found that the productive value of ranches in the Hill Country of Texas accounted for only 10% of the ranch market value, but in the High Plains the productive value accounted for nearly 50% of market value.

Discussion and Rangeland Policy Implications

QOL market influences were very evident for the New Mexico ranch sales studied here. When the FCS appraiser noted that recreation, aesthetic, mineral, and development values were apparent on the ranch, average ranch values were inflated by 2 to 3 times depending on the area of the state. For large ranches with similar characteristics, when the ranch was located in the scenic mountain areas of New Mexico (area 3, 4 and 5 in Figure 2) ranch price was inflated by $488/AUY when there was no noted NFI (β_{13} in Table 3) and by $4,411/AUY when there was a noted NFI ((β_{13} in Table 4). Similarly, the value of small size ranches were inflated in the scenic mountains by $476/AUY and $8,021/AUY for non-NFI and NFI ranches, respectively (Tables 5 and 6). Similar shifts in value were found for the plateaus and mesas of western New Mexico. These areas are not the productive livestock areas of the state and QOL values are the only apparent reason for the increased ranch value in these areas. Ranch values were also inflated in the Southern High Plains (area 7). Because this is the most productive livestock area in the state this

[5]/Models without livestock return variables were used in the analysis.

Table 7. Proportion of 1999 ranch market value attributed to livestock production by MLRA.

A		B	C	D	E	F= D+E	G	G/F	G/7%	(G/7%)/F
									7%	Rate of Return
MLRA[a]	Area[a]	NFI	Ranch Size	Average Real Market Value[b]	Value of Livestock And Equipment[c]	Total Land, Livestock and Equip. Investment	Average Real Net Annual Return[d]	Implied Cap Rate	Average Capitalized Value from Livestock Production	Percent of Market Value from Livestock Production
RM, AN, AND HV	3, 4, 5	None	Large	2,613	986	3,599	23.36	0.6%	334	9.3%
WP AND ND	2, 6	None	Large	2,562	1,049	3,611	-4.44	-0.1%	-63	0.0%
SD AND SA	8, 9	None	Large	2,225	894	3,119	29.59	0.9%	423	13.6%
HP	7	None	Large	3,868	921	4,789	90.18	1.9%	1,288	26.9%
CP	1	None	Large	3,711	921	4,632	90.18	1.9%	1,288	27.8%
RM, AN, AND HV	3, 4, 5	None	Small	5,320	1,240	6,560	-54.32	-0.8%	-776	0.0%
WP AND ND	2, 6	None	Small	5,378	1,137	6,515	-31.28	-0.5%	-447	0.0%
SD AND SA	8, 9	None	Small	2,895	1,006	3,901	-38.03	-1.0%	-543	0.0%
HP	7	None	Small	4,168	999	5,167	62.87	1.2%	898	17.4%
CP	1	None	Small	4,655	999	5,654	62.87	1.1%	898	15.9%
RM, AN, AND HV	3, 4, 5	Yes	Large	8,479	986	9,465	23.36	0.2%	334	3.5%
WP AND ND	2, 6	Yes	Large	4,531	1,049	5,580	-4.44	-0.1%	-63	0.0%
CP	1	Yes	Large	9,348	921	10,269	90.18	0.9%	1,288	12.5%
RM, AN, AND HV	3, 4, 5	Yes	Small	14,305	1,240	15,545	-54.32	-0.3%	-776	0.0%
WP AND ND	2, 6	Yes	Small	7,058	1,137	8,195	-31.28	-0.4%	-447	0.0%
CP	1	Yes	Small	9,043	999	10,042	62.87	0.6%	898	8.9%

[a]/From Figure 2..

[b]/Average estimated January 1, 1999 real market value from Table 2.

[c]/Average investment in breeding livestock and equipment from NMSU Cost and Return Series, 1986-97. Adjusted to constant 1998 levels.

[d]/Average net annual returns from NMSU Cost and Return Series, 1986-97. Adjusted to constant 1998 levels. MLRA areas were mapped to the NMSU budget regions as an approximation to compute average net returns.

increased value may be related to added livestock production potential.

All New Mexico ranches appear to be inflated in value relative to livestock production value. This includes the highly developed and scenic ranches as well as those without exceptional scenic or production qualities. As noted above, if a 7% rate of return is desired on the investment, 27% of the average New Mexico ranch value can be attributed to livestock production potential, but only in the most productive rangeland areas of the state. Livestock production represented a smaller share of value in other areas. We attribute these inflated values to the QOL reasons for why ranches are purchased.

There are significant rangeland policy implications from having the market-driven value of western ranches greater than what the livestock justify. Over 30 years ago Martin and Jefferies (1966) noted that Arizona ranchers had been willing to pay too much for ranches, grazing permits and private grazing leases. They concluded that for grazing fee policy only a competitive bid would be able to accurately solicit the willingness to pay for forage. We should have listened to them. Consider the 1992 Incentive Based Grazing Fee Study as an example. In this grazing fee study, the federal land agencies contracted with economists from four western land grant universities to help determine the apparent fair market value for public land forage. It was anticipated that this value would be high enough that BLM and USFS could devise incentives to compensate those ranchers that where managing and improving the public lands to their satisfaction. In this study, the Grazing Fee Task Group determined that an appropriate valuation of public land forage would be to follow the same procedure that had been used to set the $1.23/AUM base fee of the current Public Rangelands Improvement Act (PRIA) fee formula. Fee and non-fee grazing cost data were gathered from those leasing both public land and private land forage. The conclusion was that for total grazing costs to be equal on private and public lands, the grazing fee would have to be reduced from the 1992 level of $1.92/AUM to $0.13/AUM (Torell et al. 1992, Van Tassell et al. 1997). It was further concluded, based on the inflated value of public land grazing permits, that public land forage was worth from $3 to 5/AUM and the study did not suggest that grazing fees actually be reduced.

As would be expected, public land ranchers wanted to concentrate on the $0.13/AUM cost difference and to tell the uninformed public that they were already paying enough in total to graze the public lands, and that this was without even considering the substantial cost of buying public land grazing permits. Why would a profit maximizing livestock producer be willing to pay the same total amount for grazing public and private land forage and then pay an additional premium to buy the public land grazing permit? With recognition of the substantial QOL values that are reflected in the ranch real estate market, and in grazing permit values, the answer to this question is not nearly so puzzling.

Based on returns from livestock and with inflated grazing permit investments, public land ranchers can justifiably argue that they are already paying too much to graze the public lands. Livestock production value does not justify even the current grazing fee when permit investments are recognized. Yet, inflated permit values also demonstrate a willingness to pay even higher grazing fees if permit value is redirected to the land agencies.

As noted by Martin and Jeffries (1966), a competitive bid system is perhaps the only way to redirect permit value to the land agencies. There are obvious questions about whether the federal government is entitled to this permit value and whether current ranchers should be compensated for the value of the grazing permit if grazing fees are increased.

Another common policy question is "How many people will be forced out of business if a certain land use policy is implemented?" The standard procedure used to answer this question has been to set a minimum rate of return or return level, and using budgeting and economic modeling techniques estimate if returns will likely fall below this critical level after policy implementation. The obvious limitation for studies about the western ranching industry is that based on any reasonable assumption about minimum acceptable investment returns, many ranchers should not be in business even before the policy change. Again, the QOL values inflating the ranch real estate market are the key to understanding the apparent disparity. One cannot estimate how many ranchers will quit, go bankrupt, retire, or sell unless you know the wealth position of each impacted rancher and how committed they are to maintaining the desirable lifestyle they have paid so dearly to acquire. For the most part, ranchers have demonstrated their willingness to accept below market rates on the ranch investment, and it is the unobservable level of satisfaction and utility obtained from being a rancher that must be considered for this policy question.

Our conclusions match those of both Martin and Pope who show consumptive factors and QOL values have existed in the ranch real estate market for years. In fact, livestock production value may now represent an even smaller part of market value for many western ranches. There were, and continue to be, strong policy implications of ranch values inflated above the value of use for livestock production. Ranch investment and policy analysis requires a great deal more thought than is offered by traditional cost-and-return studies about the economic value of livestock production. Answers to important policy questions are elusive when it is recognized that ranchers maximize not profit but utility. We can measure costs, beef prices and net returns, and estimate how these economic variables might change under alternative policy scenarios. But, we can only guess about what motivates a person to pay a premium price for a New Mexico ranch, and to continue in business when alternative investments would yield a higher rate of return. Perhaps it is not the value of the beef produced but rather the New Mexico sunset.

Literature Cited

American Agricultural Economics Association (AAEA). 1998. A report of the AAEA Task Force on Commodity Costs and Returns. Iowa State University, Ames, Iowa.

Agee, D.E. 1972. Rates of Return to Investment for Western Cattle Ranches. J. Amer. Soc. of Farm Man. And Rural Appraisers. 36:53-58.

Austin, M.E. 1981. Land Resource Regions and Major Land Resource Areas of the United States. U.S. Dept. of Agr. Handbook 296.

Bailey, S.A. 2000. Factors Influencing the Disparity Between Market Values and Agricultural Productive Values of New Mexico Ranches. Master's Thesis, New Mexico State Univ., Las Cruces, NM.

Bartlett, E.T. and D.R. Betters (Eds). 1983. Overstory-Understory Relationships in Western Forests. Western Regional Res. Pub. No. 1, Colorado State Univ., Ft. Collins, Co.

Bartlett, E.T., R.G. Taylor, J.R. McKean and J.G. Hof. 1989. Motivation of Colorado Ranchers with Federal Grazing Allotments. J. Range Manage. 42(6):454-457.

Bartlett, E.T., R.G. Taylor and R. Gruen. 1984. Costs of Grazing on Federal Lands: A Survey of Colorado Ranchers. Colo. State Univ. Coop. Ext. Serv. Bulletin 532A.

Biswas, B., J.R. Lacey, J.P. Workman and F.H. Siddoway. 1984. Profit Maximization as a Management Goal on Southeastern Montana Ranches. West. J. Agr. Econ. 9(1):186-194.

Environmental Systems Research Institute, Inc. (ESRI). 1999. website: http://www.esri.com/data/online/tiger/index.html Downloaded October 19, 1999.

Gentner, B. 1999. Characteristics of Public Land Grazing Permittees. Masters Thesis, Oregon State Univ., Corvallis, Ore.

Harman, W.L., R.E. Hatch, V.R. Eidman and P.L. Claypool. 1972. An Evaluation of Factors Affecting the Hierarchy of Multiple Goals. Oklahoma Agr. Exp. Sta. Tech. Bull. T-134.

Harper, W.M. and C. Eastman. 1980. An Evaluation of Goal Hierarchies for Small Farm Operators. Amer. J. Agr. Econ. 62:742-747.

Henderson, P. 2000. The Lure of Land: Investors are Buying Their Own Piece of Heaven. Top Producer Magazine, Feb. 2000. Accessed online at http://www.agweb.com. Downloaded June 8, 2000.

Martin, W.E. 1966. Relating Ranch Prices and Grazing Permit Values to Ranch Productivity. J. Range Manage. 19(5):248-252.

Martin, W.E. and G.L. Jefferies. 1966. Relating Ranch Prices and Grazing Permit Values to Ranch Productivity. J. of Farm Econ. 48:233-242.

McGrann, J.M. 2000. Cow-calf SPA Key Measures Summary for the Southwest, 1991-98. *In*: Integrated Resource Management (IRM) Commercial Cow-calf SPA Handbook Educational Material, Texas Agr. Ext. Service, College Station, Tx. April 6, 2000.

McLeod, D.M., C.T. Bastian, M.J. Germino, W.A. Reiners and B.J. Blasko. 1999. The Contribution of Environmental Amenties to Agricultural Land Values: Hedonic Modelling Using Geographic Information Systems Data. Paper presented at the Western Agr. Econ. Assoc. Meetings, July 1999.

NRCS. 1981. Major Land Resource and Subresource Areas New Mexico. USDA-SCS-National Mapping Division, FT. Worth, TX.

Obermiller, F.W. and D.K. Lambert. 1984. Costs Incurred by Permittees in Grazing Livestock on Public Lands in Various Western States. Oregon State Univ. Ext. Serv. EM 8283.

Pope, C.A. 1985. Agricultural Productive and Consumptive Use Components of Rural Land Values in Texas. Amer. J. Agr. Econ. 67:81-86.

Pope, C.A. 1987. More Than Economics Influences Allocation of Rangeland Resources. Choices. Fourth Quarter 24-25.

Pope, C.A. 1988. Romance of Rangeland Resource Management. Rangelands. 10(4):168-171.

Pope, C.A., and H.L. Goodwin. 1984. Impacts of Consumptive Demand on Rural Land Values. Amer. J. Agr. Econ. 66:750-754.

Rand McNally. 1997. Rand McNally Trip-Maker™ 1997 Edition. Skokie, Illinois.

Rosen, S. 1974. Hedonic Prices and Implicit Markets: Product Differentiation In Pure Competition. J. of Political Economy. 82:32-55.

Rowan, R.C. and J.P. Workman. 1992. Factors Affecting Utah Ranch Prices. J. Range Manage. 45:263-266.

Sands, L. 1998. Pearls Beyond Price: The West's Pristine Ranches set New Highs. Top Pro-

Sullivan, R.P. and J.D. Libbin. 1987. Goals of New Mexico Farmers. New Mex. State Univ. Agr. Exp. Sta. Rep. 606.

Torell, L.A. and J.P. Doll. 1991. Public Land Policy and the Value of Grazing Permits. West. J. Agr. Econ. 16(1):174-184.

Torell, L.A. and J.M. Fowler. 1986. A Model for Predicting Trends of New Mexico Grazing Land Values. New Mex. State Univ. Agr. Exp. Sta. Bulletin 723.

Torell, L.A., J.M. Hawkes, and S.A. Bailey. 2000. Range Livestock Cost and Return Estimates for New Mexico, 1997. New Mex. State Univ. Agr. Exp. Sta. Rep. 738.

Torell, L.A. and M.E. Kincaid. 1996. Public Land Policy and the Market Value of New Mexico Ranches. J. Range Manage. 49:270-276.

Torell, L.A. and L.P. Owen. 1998. RANVAL98: A Computer Program for Calculating the Market Value of New Mexico Ranches. New Mex. Coop. Ext. Service, Las Cruces, NM.

Torell, L.A., L.W. Van Tassell, N.R. Rimbey, E.T. Bartlett, T. Bagwell, P. Burgener, and

ducer Magazine, Aug. 1998. Accessed online at http://www.agweb.com. Downloaded June 8, 2000.

SAS Institute Inc. 1984. SAS/ETS user's guide, version 5 edition. SAS Institute, Inc. Cary, NC. 344 p.

Smith, A.H., and W.E. Martin. 1972. Socioeconomic Behavior of Cattle Ranchers with Implications for Rural Community Development in the West. Amer. J. Agr. Econ. 54:217-225.

Spahr, R.W. and M.A. Sunderman. 1998. Property Tax Inequities on Ranch and Farm Properties. Land Econ. 74(3):374-389.

J. Coen. 1992. The Value of Public Land Forage and the Implications for Grazing Fee Policy. New Mex. State Univ. Agr. Exp. Sta. Bulletin 767.

Van Tassell, L.W., L.A. Torell, N.R. Rimbey, and E.T. Bartlett. 1997. Comparison of Forage Values on Private and Public Grazing Leases. J. Range Manage. 50:300-306.

Workman, J.P. 1986. Range Economics. New York, N.Y. Macmillian Publishing Company.

Workman, J.P. and K.H. King. 1982. Utah Cattle Ranch Prices. Utah Agr. Exp. Sta. 43(3):78-81.

Xu, F., R.C. Mittelhammer, and L.A. Torell. 1994. Modeling Nonnegativity via Truncated Logistic and Normal Distributions: an Application to Ranch Land Price Analysis. J. Agr. and Resource Econ. 19:102-114.

Young, K.D. and C.R. Shumway. 1991. Cow-calf Producers' Perceived Profit Maximization Objective: A Logit Analysis. Southern J. Agr. Econ. 23:129-136.