J. Range Manage.
49:270–276

Public land policy and the market value of New Mexico ranches, 1979–94

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Abstract

Proposals outlined in *Rangeland Reform '94* have been perceived to greatly alter grazing use on public lands. In addition to new rules and regulations, the grazing fee would double under this reform proposal. The debate about these controversial policies would be expected to affect the market value of public land grazing permits. Regression models were developed using over 700 ranch sales to determine recent trends in market value for New Mexico ranches, including public land ranches. After 1988, nominal deeded ranch values were found to have increased by 3% per annum, but remained unchanged in 1992 constant dollars. This follows a 50% decline in real value from 1982-88. Ranches heavily dependent on Bureau of Land Management (BLM) land for grazing capacity decreased in real value by about 1.8% per annum over the 1988-94 study period. The United States Forest Service (USFS) has recently had the most controversial land use polices and the highest average total grazing costs. This has been reflected in the market value of USFS ranches, with a continued decrease in permit value; USFS ranches in New Mexico have lost 75% of their real value since 1982. Doubling grazing fees on New Mexico state trust lands contributed to a downward trend in leasehold value. Somewhat surprising, given the higher grazing fee on state trust lands, these permits increased in market value in both real (1.7% per year) and nominal (5% per year) terms after controversy about state lands subsided and federal land policies became more controversial.

Key Words: land values, economics, grazing fees, appraisal, *Rangeland Reform '94*

Ranch values have been relatively unstable during the past decade. After steadily increasing for more than 20 years, values increased rapidly during the 1970s and then fell precipitously during the 1980s. Torell and Doll (1991) determined that the nominal value of a deeded animal unit yearlong (AUY) on New Mexico ranches declined by 30% between 1982 and 1987. The market value of ranches with public lands and New Mexico state trust lands fell by an even greater percentage (45–65%) because of higher grazing fees on state trust lands and proposals to increase fees on Bureau of Land Management (BLM) and U.S. Forest Service (USFS) lands (Torell and Doll 1991). Ranch values in other western states also fell over this period (Rowan and Workman 1992).

Market value is usually estimated by a site-specific appraisal with consideration given to comparable ranch sales negotiated between willing buyers and willing sellers, and the income earning potential of the subject property. A comparable sale is considered to be a property similar to the subject property in type of land, organization, date of sale, location, size, productive capacity, and level of improvement. The greatest problem in using the market appraisal approach is the lack of homogeneous properties. Adjustments are necessary to make the subject property and comparable properties similar in characteristics. These adjustments usually include recognizing differences in property features, nontypical sale price, and fluctuations in land values over time. One technique used to determine desired price adjustments for market appraisal is regression analysis. It is often a preferred technique because a greater number of comparable sales can be used and it provides an objective measure of factors that influence price.

This paper identifies and quantifies factors influencing New Mexico ranch values and trends in value between January 1979 and April 1994. Because a proposal to substantially change the way public lands are administered and priced (*Rangeland Reform '94*, USDI/USDA 1994) has been so controversial and publicized, it would be expected that the market value of federal grazing permits would have diminished. Special emphasis is placed on quantifying the difference in value trends between deeded and public land ranches[1]. Regression equations that predict both nominal and real values for 2 different time periods are estimated.

Methods

Appraisal data for 429 New Mexico ranch sales recorded between January 1987 and April 1994 were obtained from Farm Credit Services (FCS). Information collected for each ranch sale included the month and year sold, sale price, county, township and range location, private land acreage, cultivated and irrigated acres, type of livestock produced, rangeland carrying capacity, public land grazing leases attached to the ranch (expressed in

This article is published cooperatively with the New Mexico Agr. Exp. Sta., New Mexico State University, Las Cruces, N.M.
Manuscript accepted 27 May 95.

[1]In this report a public land ranch is considered to include BLM, USFS, and/or New Mexico state trust lands. Technically, New Mexico state lands are not public lands; they are trust lands generating revenue for beneficiary institutions in New Mexico.

acres and AUY[2]), an appraiser's estimate of house and building value, and other qualitative factors.

The purpose of this research was to estimate the market value of livestock-producing ranches. Correspondingly, the analysis excluded ranches with a carrying capacity of less than 25 AUY because the sale prices of these small ranches are influenced by many confounding nonproduction-related factors. Ranches that, by the judgement of Farm Credit Services (FCS) appraisers, were significantly affected by recreation and/or development potential were also excluded from the analysis. These exclusions left 417 bona fide sales that were used in regression model formulation. Prices paid for the ranches were for the land (including public land grazing permits), buildings, and improvements. The value of livestock and other personal property included with some sales were subtracted from the total price by FCS appraisers.

A major downward trend in New Mexico ranch values that overshadows any recent changes in value occurred from 1982 to 1987. Because of this, trends in market value over this earlier period were also estimated using ranch sales data collected and described by Torell and Doll (1989). This earlier regression model was re-estimated using a truncated nonlinear model specification developed by Xu et al. (1994), as described below. A total of 452 ranch sales were used in this second estimation with the same exclusion criteria used as in the 1987–94 data set. The data overlapped in 1987 and 1988, and sales for these years were included in both data sets.

Equations defined over both time periods were estimated on both a real and a nominal basis. For the real price models, the consumer price index (CPI) was used to adjust the economic variables to constant 1992 levels (USDC 1994). The per AUY ranch sale price and house and building values at the time of the ranch sale were divided by the ratio CPI_t / CPI_{1992} to adjust for inflation. Nominal values were taken from the data as recorded.

Factors influencing New Mexico ranch prices were defined based on real estate appraisal theory and previous ranch value models developed at New Mexico State University (NMSU). These included 1) ranch size, 2) grazing capacity and rangeland productivity, 3) dollar value of houses and buildings, and 4) the proportion of grazing capacity from deeded, BLM, USFS, and state trust lands. Other factors such as distance to town, distance to a paved road, level of range improvement, and terrain influence ranch values, but could not be easily measured or were not consistently and explicitly defined in the data set.

Explanatory variables considered in the ranch value regression analysis are defined in Table 1. Ranch values were predicted on a \$/AUY basis using nonlinear regression routines found in the SAS statistical package (SAS 1984). The Xu et al. (1994) model formulation that was used in the analysis recognizes land values cannot be negative. In this case the normal assumption about the disturbance term that allows for positive and negative values of the dependent variable is a model misspecification. The Xu model corrects for this misspecification by truncating the distribution of the disturbance term to exclude negative dependent variable values. This adjustment primarily affects predictions for relatively low-valued ranches such as those with considerable public lands (Xu et al. 1994).

Time trend variables were included in the models to measure the differential in trends between private and public land grazing values. Including time in the model did not explain why ranch values changed through time; it only quantified that they had in fact changed. Several different functional forms for the trend variables were evaluated including linear, cubic, exponential, and a linear spline model that allowed the trend in market value to change at various points. The linear model fit the data best for the 1987-94 period; a cubic function fit the data best for the 1979–88 period. The time trend variables were specified as follows:

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

Variable	Variable Description
PRICE	Total ranch price ($) measured either on a nominal or real basis.
PRICEAUY	Ranch sale price on a real or nominal $/AUY basis (PRICE/TOTAUY).
TOTAUY	Total carrying capacity of the ranch, including deeded, public, and state land forage sources. (TOTAUY = DEEEDAUY + BLMAUY + USFSAUY + STATEAUY)
TIME	Time trend variable measured as number of years from January 1986 that the ranch sold (i.e., January 1980 = -6, January 1986 = 0, July 1990 = 4.5).
DEEDAUY	AUY carrying capacity from deeded land.
BLMAUY	AUY carrying capacity from BLM land.
PERBLM	Percent of ranch carrying capacity from BLM land (BLMAUY/TOTAUY)X100.
TRDBLM	Slope shifter for PERBLM, computed by multiplying PERBLM by TIME.
USFSAUY	AUY carrying capacity from USFS land.
PERUSFS	Percent of ranch carrying capacity from USFS land (USFSAUY/TOTAUY)x100.
TRDUSFS	Slope shifter for PERUSFS, computed by multiplying PERUSFS by TIME.
STATEAUY	AUY carrying capacity from state trust land.
PERSTATE	Percent of ranch carrying capacity from state trust land, (STATEAUY/TOTAUY)x100
TRDSTATE	Slope shifter for PERSTATE, computed by multiplying PERSTATE by TIME.
SECTION	Ranch size expressed in sections (including deeded and public lands).
ACCULT	Acres of cultivated land on the ranch.
ACCULTAUY	Acres of cultivated land per AUY on the ranch, (AACULT/TOTAUY).
HBVAL	Appraised value of houses and buildings on the ranch.
HBVALAUY	Appraised value of houses and building on the ranch expressed in $/AUY. Measured either on a nominal or real basis.
PROD	Productivity of the ranch. Defined as TOTAUY/SECTION.

[2]An AUY (Animal Unit Yearlong) is a common measure of carrying capacity for southwestern rangelands. It is defined to be the forage resources needed to sustain one mature cow or the equivalent for 1 year.

1) $f(TIME) = \beta_{12}TIME + \beta_{13}TIME^2 + \beta_{14}TIME^3$ 1979–88 Period
$= \beta_{12}TIME$ 1987–94 Period

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

$$g(X;\beta) = \beta_0 + \beta_1 PERBLM + \beta_2 PERUSFS + \beta_3 PERSTATE + \beta_4 ACCULTAUY + \beta_5 HBVALAUY + \beta_6 PROD + \beta_7 TRDBLM + \beta_8 TRDUSFS + \beta_9 TRDSTATE + \beta_{10} SECTION + \beta_{11} SECTION^2 + f(TIME) + \mu$$

To estimate the truncated model it was assumed the error term μ was distributed normally with mean zero and scale parameter τ. The truncated model was then estimated as:

$$PRICEAUY = g(X;\beta) + \tau \frac{\phi(-g(X;\beta)/\tau)}{\Phi(g(X;\beta)/\tau)} + \mu$$

where $\phi(\bullet)$ and $\Phi(\bullet)$ are the probability density and cumulative density functions for the standard normal distribution, $\beta = \{\beta_0, \beta_1, \ldots, \beta_{14}\}$ and τ are parameters to be estimated.

The explanatory variables in the model are hedonic in nature and relate the value of a ranch to local and specific ranch characteristics and attributes at various points in time. Model parameters (βs) have the following interpretation.

β_0 = the base value of an AUY of grazing from deeded land. This value is adjusted up and down depending on the time of the ranch sale, ranch size and rangeland productivity.

$\beta_1, \beta_2, \beta_3, \beta_7, \beta_8, \beta_9$
= the price discount or price reduction if some of the AUYs on the ranch are from leased public land instead of deeded land. Interpretation of β_1 and β_7, for example, is that when ranch size and productivity are held constant, a 1% increase in the proportion of the ranch carrying capacity from BLM land causes a reduction in the per AUY selling price of $\beta_1 + \beta_7 \times$ TIME. For January 1986, when TIME = 0, the price discount for BLM is β_1. The discount in January 1980 is $\beta_1 + \beta_7 (-6)$, and in July 1990 it is $\beta_1 + \beta_7 (4.5)$. This model specification allows the relative value of public lands to change through time, as might be expected as altered land use policies were proposed and implemented by federal and state land agencies. The negative estimates for the discount parameters does not mean public land grazing permits have negative value; rather, it means that grazing capacity on public lands sells for less than grazing capacity on deeded lands.

β_4 = the marginal value of an additional acre of cultivated land included with the ranch sale. Most New Mexico ranches do not have cultivated and irrigated lands, but when present, they increase the sale price of a ranch.

β_5 = the amount that a dollar's worth of house and building value changes the sale price of the ranch.

β_6 = the change in per AUY ranch selling price as rangeland productivity is increased. It would be expected a more productive ranch would sell for more, implying a positive value for β_6. However, as described by Torell and Doll (1989), a more productive ranch, or a larger ranch, will generally sell for less on a \$/AUY basis. The total value of the ranch will in fact increase—more AUY are valued at a slightly lower per unit price.

β_{10}, β_{11} =
linear and quadratic parameters for ranch size. The per AUY ranch price was hypothesized to vary as a quadratic function of ranch size measured in sections. Larger ranches generally sell for less per AUY (but more in total) than do smaller ranches.

$\beta_{12}, \beta_{13}, \beta_{14}$ =
linear, quadratic, and cubic parameters for time of ranch sale. Time variables capture time trends in ranch prices as influenced by ranch earnings and other undefined market price influences.

As described by Torell and Doll (1991), after canceling and collecting terms, total ranch selling price can be estimated as:

$$\hat{PRICE} = \hat{PRICEAUY} \times TOTAUY = \beta_0 TOTAUY + (\beta_1 \times 100)BLMAUY + (\beta_2 \times 100)USFSAUY + (\beta_3 \times 100)STATEAUY + \beta_4 ACCULT + \beta_5 HBVAL + \beta_6 \frac{TOTAUY^2}{SECTION} + (\beta_7 \times 100)\ TIME\times BLMAUY + (\beta_8 \times 100) TIME\times USFSAUY + (\beta_9 \times 100) TIME\times STATEAUY + \beta_{10} SECTION\times TOTAUY + \beta_{11} SECTION^2 \times TOTAUY + f(TIME)\ TOTAUY + \tau \frac{\phi(-g(X;\beta)/\tau)}{\Phi(g(X;\beta)/\tau)} + TOTAUY$$

This equation can be used to estimate the total value of a particular New Mexico ranch at various points in time over the study period. Also, by differentiating this function with respect to each X_i the marginal impact of altering size, productivity, house and building values, and grazing capacity can be estimated. Xu et al. (1994) show how to take these derivatives for the truncated model used in the analysis.

A spreadsheet program that used parameter estimates from each of the estimated regression equations to predict the value of a defined ranch over each of the study periods was used to facilitate graphing and analysis for alternative types of ranches. This program is available from the senior author.

Results

Ranch Characteristics

Ranches in the sample ranged from the 25 AUY minimum to more than 3,000 AUY. The average ranch size supported grazing for 325 AUY on 20.6 sections, yielding an average rangeland carrying capacity rating of 15.75 AUY/section. House and building values averaged \$86.16/AUY over the 1979–94 study period.

Federal and state land dependency varied widely by area of the state. The northeast is largely deeded (private) land with some intermingled state land sections. Ranches in the southern part of the state are heavily dependent on BLM land with intermingled state and private lands. The northwest and central regions are mountainous and have USFS lands along with private, BLM, and state trust lands. As a statewide average, ranches depended on deeded land for 60% of grazing capacity, BLM for 20%, USFS for 5%, and state trust land for 15%. Torell et al. (1992) provide a more complete analysis of land-use patterns based on the ranch sales data used here.

Ranch Value Model Parameters

Table 2 gives parameter estimates for the nominal and real price regression models. Also shown in the table are parameter estimates when price discounts for public lands were restricted to be the same. These restricted models were used to test whether

Table 2. Parameter estimates for nominal and real regression models.

		Unrestricted Model Parameters							
		Nominal Ranch Values ($AUY)				Real Ranch Values ($AUY)			
		1979–88		1987–94		1979–88		1987–94	
Variable	Parameter	Estimated Coefficient	S.E.	Estimated Coefficient	S.E.	Coefficient	S.E.	Estimated Coefficient	S.E.
Intercept	β_0	3,689.90**	110.43	2,925.71**	126.42	4,671.21**	147.54	3,750.40**	138.15
PERBLM	β_1	-26.52**	2.53	-15.41**	2.33	-34.27**	4.01	-20.38**	2.30
PERUSFS	β_2	-23.80**	2.97	-11.07**	3.68	-29.88**	4.50	-16.08**	3.90
PERSTATE	β_3	-24.17**	2.49	-17.57**	3.02	-30.47**	3.79	-22.74**	3.17
ACCULTAUY	β_4	89.63**	28.18	129.90*	50.4	126.24**	39.78	133.08*	55.82
HBVALAUY	β_5	1.21**	0.13	1.22**	0.13	1.37**	0.14	1.19**	0.12
PROD	β_6	-20.96**	4.51	-19.26**	4.67	–30.64**	5.73	–20.02**	5.14
TRDBLM	β_7	0.77*	0.40	-1.09*	0.48	2.24**	0.65	-0.30	0.51
TRDUSFS	β_8	-0.27	0.65	-2.17**	0.78	0.958	0.93	-1.38	0.88
TRDSTATE	β_9	-1.25*	0.55	-0.34	0.60	-0.38	0.82	0.46	0.65
SECTION	β_{10}	-4.88**	1.22	-10.27**	2.03	-6.82**	1.69	–10.89**	2.23
SECTION^2	β_{11}	0.007*	0.0024	0.04**	0.011	0.01**	0.003	0.045**	0.013
TIME	β_{12}	-281.24**	21.4	123.34**	18.27	-506.17**	30.31	-1.19	20.16
TIME^2	β_{13}	23.68**	10.12			44.67**	14.35		
TIME^3	β_{14}	9.98**	1.53			11.63**	2.07		
Scale Parameter	τ	988.48**	186.97	510.85	324.08	1,253.45**	307.19	505.81	460.11
R^2		0.80			0.74	0.84		0.72	
Sample Size	n	452			417	452		417	
Root Mean Square Error (RMSE)		524.19			497.16	740.56		550.81	

		Restricted Model Parameters							
		Nominal Ranch Values ($AUY)				Real Ranch Values ($AUY)			
		1979–88		1987–94		1979–88		1987–94	
Variable	Parameter	Estimated Coefficient	S.E.	Estimated Coefficient	S.E.	Coefficient	S.E.	Estimated Coefficient	S.E.
Intercept	β_0	3,650.85**	108.01	2,895.75**	125.86	4,606.34**	145.21	3,719.86**	137.30
PERBLM	β_1	-25.17**	2.13	-15.38**	1.89	-31.91**	3.35	-20.44**	1.87
PERUSFS	β_2	-25.17**	2.13	-15.38**	1.89	-31.91**	3.35	-20.44**	1.87
PERSTATE	β_3	-25.17**	2.13	-15.38**	1.89	-31.91**	3.35	-20.44**	1.87
ACCULTAUY	β_4	86.76**	28.85	132.17*	50.40	121.41*	40.90	135.33*	55.77
HBVALAUY	β_5	1.19**	0.13	1.22**	0.13	1.34**	0.14	1.19**	0.12
PROD	β_6	-17.95**	4.17	-18.50**	4.63	-25.72**	5.29	-19.28**	5.10
TRDBLM	β_7	0.003	0.33	-1.02**	0.36	1.31*	0.58	-0.23	0.34
TRDUSFS	β_8	0.003	0.33	-1.02**	0.36	1.31*	0.58	-0.23	0.34
TRDSTATE	β_9	0.003	0.33	-1.02**	0.36	1.31*	0.58	–0.23	0.34
SECTION	β_{10}	-4.47**	1.23	-10.17**	2.01	-6.18**	1.70	10.77**	2.20
SECTION^2	β_{11}	0.005*	0.0023	0.04**	0.011	0.007*	0.003	0.044**	0.013
TIME	β_{12}	-284.13**	21.75	128.31**	18.03	-509.81**	30.33	3.77	19.88
TIME^2	β_{13}	21.97**	10.27			42.43*	14.58		
TIME^3	β_{14}	9.69**	1.54			11.27**	2.10		
Scale Parameter	τ	970.57**	187.90	478.10	357.11	1,204.95**	314.93	466.02	555.0
R^2		0.79			0.74	0.83		0.72	
Sample Size	n	452			417	452		417	
Root Mean Square Error (RMSE)		538.18			497.68	740.56		550.78	

**/Significant at 0.005 levelor higher.

**/Significant at .05 level or higher.

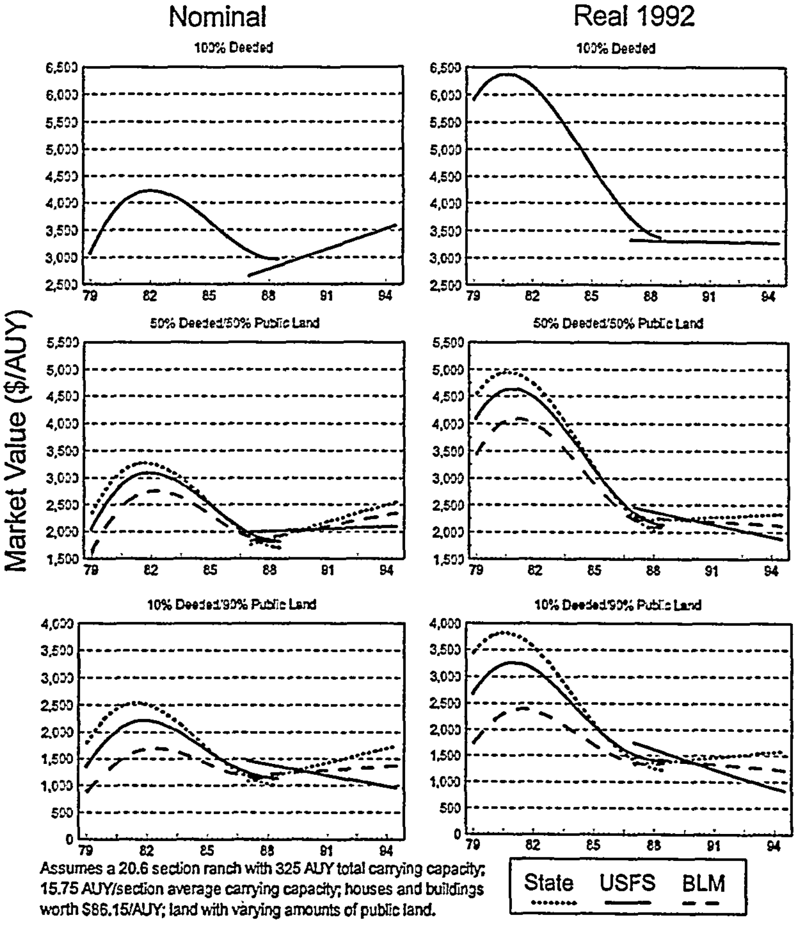

Fig. 1. Average value of New Mexico ranches with different amounts of public land dependency.

the different types of permits (BLM, USFS, and state) had different values through time.

The equations explained a significant amount of the variation in ranch selling prices as indicated by the estimated R^2 values, which exceeded 70% in all cases. Most variables were significant at the $\alpha = 0.005$ level or higher. The scale parameter (τ) was statistically significant over the 1979–88 period but not the 1987–94 period.[3] Multicollinearity was not determined to be a problem using appropriate tests available with the SAS software package.

Average Ranch Values

Figure 1 presents average $/AUY ranch values estimated from the regression models. Both nominal and real values are shown for the average New Mexico ranch described above with 325 AUY on 20.6 sections of rangeland. The graph shows 3 different types of ranches including a 100% deeded land ranch, a 50% deeded and 50% public land ranch, and a 10% deeded and 90% public land ranch. Lines are shown for BLM, USFS, and state trust land, assuming each of these land types was the public land portion of the ranches' carrying capacity.

Trends in ranch values were different depending on the ownership structure considered. The 100% deeded land ranch peaked in nominal value at $4,200/AUY in 1982 ($6,375/AUY real 1992 value). Nominal and real values decreased by about 30% and 50% respectively by 1988. Deeded land ranches increased in nominal value by about 3% per year from 1988 through April 1994[4]. This was just equal to the average rate of inflation, as indicated by the flat line estimated for deeded land ranches on a real basis (Fig. 1).

The US Forest Service permits have continued to decline in both real and nominal terms. A ranch depending on USFS for 90% of grazing capacity decreased in nominal value by about 4% per year from 1988 through April 1994. On a real basis, values decreased from 6% to 8% per year over this period. From peak market values reached in 1982, the 90% USFS permit ranch decreased in value by 75% on a real basis ($3,262/AUY to $839/AUY) and by 57% on a nominal basis ($2,221/AUY to $964/AUY).

This declining market value for USFS ranches would be expected based on average grazing costs reported by the BLM-

[3]As described by Xu et al. (1994), an asymptotic one-sided t-test is appropriate to test the null hypothesis (H_0: $\tau = 0$) versus the alternative hypothesis (H_a: $\tau > 0$). A significant t-statistic provides statistical evidence against an untruncated error distribution specification for the model, suggesting the Xu model truncation was an important consideration

[4]A linear function does not change at a constant percentage rate, thus, the rate of change was more than 3% in 1988 and slightly less than this amount by 1994.

and USFS-funded Grazing Fee Task Group Report (Bartlett et al. 1993). This three-state study compared grazing costs between BLM, USFS, and private leased lands in Idaho, New Mexico, and Wyoming in 1992. The USFS was found to have a significantly higher grazing cost when all fee and non-fee grazing costs were considered. As a three-state average, cattle grazing costs (excluding the $1.92/AUM 1992 grazing fee) were estimated to be $15.41/AUM, $21.89/AUM, and $19.04/AUM for BLM, USFS, and private leased land, respectively (Torell et al. 1994). By comparison, in 1966 when a major grazing cost study was completed and used to justify the current federal grazing fee formula (Housemann, C.E., and others. Special report on the grazing fee survey. Unpublished report. USDA Statistical Reporting, November 12, 1968), a $0.62/AUM grazing cost differential between BLM and USFS was not statistically different when differences in permit size and season of use were considered. This suggests that grazing costs have increased faster on USFS lands and it would be expected that permit values would react to this changing cost structure.

Over the 1988–94 period, BLM permit ranches increased in nominal value (1.4% average annual change) but decreased in real terms (-1.8% average annual change). Values decreased substantially over the earlier study period (30% decline nominal, 42% decline real). Torell and Doll (1991) attribute this earlier decline to the controversial policies of the BLM at this time, including the release of environmental impact statements (EIS's) across the West and designation of potential wilderness areas.

Ranches heavily dependent on New Mexico state trust lands have seen wide variation in market value. State land permits had higher market value in 1982 when compared to BLM and USFS (Fig. 1). What had been a laissez-faire attitude on the part of the state land office changed considerably with the 1982 election. The newly elected administration made it clear the state land office planned to fulfill its fiduciary responsibilities to maximize state land revenues. The administration proposed to increase grazing fees, consolidate small scattered parcels, implement trespass laws on state lands similar to those on federal lands, and inventory range improvements on state lands. Some of these proposals, including higher grazing fees, were eventually implemented. State land fees have been over $3/AUM since 1989. They were $3.51/AUM in 1994, which was about 1 3/4 times the federal fee ($1.98/AUM), but slightly less than the $3.96/AUM base fee suggested for federal lands under the proposed action alternative of Rangeland Reform '94 (USDI/USDA 1994).

Since 1987, New Mexico state land permits have increased in value while federal permits have decreased in value (Fig. 1). This would not be the case if permit value resulted only because of a capitalized cost advantage, as economists have traditionally argued (Roberts 1963; Gardner 1962, 1963; Nielsen and Wennergren 1970; Torell and Doll 1991; Workman 1988). In addition to many other economic and hedonic factors, expectations of what the grazing cost advantage will likely be in the future also influences ranch values.

Several related explanations are also possible for the recent increase in New Mexico state trust land leasehold values and the declining value of federal land permits. First, many of the ranches in northeast New Mexico have only deeded and state trust lands attached to them, but state land is usually a small part of the total land base. Thus, the value of state land permits would be expected to be strongly influenced by deeded land values. Second, future state land grazing fees are defined by a formula, and ranch buyers know approximately what fees will be in the immediate future. Compare this to the uncertain future of federal lands, where annual attempts have been made to increase fees since 1985 and new restrictive grazing regulations have been proposed but not yet implemented. The New Mexico state land office has also initiated a rangeland stewardship program, and ranchers can reduce grazing fees by participating.

As shown in Figure 1 and discussed above, relative values of different types of grazing permits have changed as the policies of the land agencies changed. But, were permit values statistically different at various times? This question is equivalent to asking whether the price discount and trend variables were the same for BLM, USFS, and state permits. This was evaluated using restricted least squares by imposing the restrictions $\beta_1=\beta_2=\beta_3$ and $\beta_7 = \beta_8= \beta_9$. Using the residual sum of squares from the restricted (RSS_R) and unrestricted (RSS_{UR}) models, the appropriate test statistic is given by an F-distribution with m and N - k degrees of freedom. The F-statistic is computed as:

$$F = \frac{(RSS_R - RSS_{UR})/m.}{RSS_{UR}/(N - k)}$$

Subscripts UR and R stand for unrestricted and restricted, respectively. The parameters m, N, and k are the number of restrictions imposed, the number of observations, and the number of parameters estimated in the unrestricted model. For nonlinear estimation, neither the numerator nor the denominator has exactly the necessary chi-squared distribution, so the F distribution is approximate and only asymptotically valid (Green 1993, p. 336).

Computation of F-statistics for the 2 study periods is shown in Table 3. The calculated F-statistic was not significant for either the nominal or real models over the 1987–94 period, implying acceptance of the hypothesis that BLM, USFS, and state trust land permits were of equal value over this period. The F-statistic was statistically significant for both the real and nominal price models over the earlier 1979–88 period. This suggests that at least one of the imposed restrictions was not true over this study period, i.e., not all permit values were equal over this period. Further analysis with successively fewer restrictions imposed (not shown) indicated the significant restrictions for the 1979–88 period were $\beta_1 =\beta_2$ and $\beta_7 = \beta_8$.[5] These restrictions forced BLM and USFS permit values to be equal. Because the restrictions were significant, this implies BLM permit values were significantly less than USFS over this period. However, state land permits were not statistically different from either USFS or BLM over this period.

Discussion

Farm and ranch values increased continually from the 1940s through the early 1980s. Especially during the inflationary 1970s, ranch values increased at a rapid pace. Buying land was considered a good investment because land values continually increased in real terms. In addition to producing livestock, ranchers were also successful land speculators. All that changed when land values began declining around 1981–82. As shown in Figure 1, deeded ranch values in New Mexico decreased substantially before they once again started to increase in nominal terms in about 1987. After adjusting for inflation, deeded land values have

[5]These 2 restrictions were not individually significant.

Table 3. Restricted least squares analysis of the similarity of grazing permit values over time.

Study Period Statistic	Real/ Nominal	RSS_{UR}	RSS_R	m	N-k	F-
1979-88	Nominal	1.198E+08	1.274E+08	4	436	6.95*
1979-88	Real	2.391E+08	2.565E+08	4	436	7.94*
1987-94	Nominal	9.961E+07	1.003E+08	4	403	1.22
1987-94	Real	1.223E+08	1.235E+08	4	403	0.99

RSS_{UR} = the residual sum of squares for the unrestricted model, RSS_R = the residual sum of squares for the restricted model, m = the number of linear restrictions imposed, N-k = the number of observations less the number of parameters in the unrestricted regression model.
*/Significant at the 0.05 level or higher.

remained constant, and on average the land appreciation benefit of ranch ownership has not yet returned.

The value of public land grazing permits has been suppressed relative to deeded land values. Differentials in permit values, while not statistically different in all cases, have been influenced by the policies of federal and state land agencies, as would be expected. When BLM was doing EISs and planning documents in the early 1980s, BLM permits had the lowest market value (Fig. 1). As New Mexico state land policy moved to the spotlight in 1982 and grazing fees were increased, these permits decreased in relative value. However, the current upward trend in state leasehold value suggests that state permits now appear stable and secure relative to federal grazing permits.

The USFS and BLM have recently had the most controversial policies, and this is reflected in a continued downward trend in federal permit values. While no direct cause and effect can be assigned for certain, the controversy about new rules and regulations and higher grazing fees as proposed in Rangeland Reform '94, has likely contributed to the downward trend in value for ranches dependent on federal grazing permits. It would be anticipated that this suppression of market value will continue as long as the uncertainty about future public land grazing policies remains. Additional decreases in permit value would be expected if grazing fees are significantly increased, or if many of the controversial policies in Rangeland Reform '94 are eventually implemented.

It is important to move forward in defining what grazing fees and land-use policies will be on federal lands. The ranch real estate market has been suppressed by the uncertainty surrounding Rangeland Reform '94, a trend which will likely continue until decisions are finally made about future grazing regulations.

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