IMPLICATIONS AND EXISTENCE OF FEDERAL/PRIVATE FORAGE MARKET INTERDEPENDENCE

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ABSTRACT: Market interdependence creates non-zero cross elasticities between federal and private forage markets. Given its existence, private forage market prices are inappropriate for determining a fair market value for federal forage under both first and second best pricing assumptions. A case study is used to empirically estimate the existence of market interdependence.

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What should be the price of domestic livestock forage produced and consumed on federal lands? The Federal Land Policy and Management Act of 1976 requires that users of federal land resources pay a "fair market value" (FMV) for these resources unless otherwise prescribed by statute. One widely applied operational definition of FMV is the price at which a private good or service provided by the federal government would be exchanged under competitive conditions (Obermiller and McCarl). Using this definition, a comparable market approach extrapolates a FMV for federal forage resources from forage prices established in private markets under competitive conditions.

Two major problems have been associated with the comparable market approach: 1) dissimilar goods and use rights provided by federal compared with private grazing leases; and 2) interdependence between federal and private markets. The first problem has been substantiated through documentation of higher, nonfee livestock grazing costs on Bureau of Land Management (BLM) and Forest Service (FS) administered lands (Torrell, Godfrey, and Nielsen; Obermiller and Lambert; Nielsen and Workman; Roberts). Ramifications of these cost differentials have influenced federal grazing fee recommendations to Congress (USDI/USDA 1977, 1986).

Market interdependence, however, has been virtually ignored as a research topic in federal grazing fee literature (Obermiller). Despite being identified as the most damaging theoretical criticism

of the comparable market approach (Quigley and Taylor), the empirical effects of federal forage pricing and quantity allocations on private forage market prices and quantities have not been previously investigated. The objective of this research is to investigate the implications of and empirically test for the existence of market interdependence in a manner that can be applied to federal land livestock grazing under BLM and FS management.

What Does Forage Market Interdependence Imply?

Market interdependence is defined as the influence that quantity allocations and/or pricing of private goods provided by the public sector have on observed quantity and price in private markets. The existence of interdependence creates nonzero cross elasticities between publicly provided resource quantities and/or prices and private market characteristics. For federal forage pricing, these nonzero cross elasticities have negative implications for social welfare improvements under both first and second best pricing by federal agencies.

Given the above operational definition, FMV policy can be interpreted as a first best pricing directive. With the comparable market approach, private forage market prices are assumed to reflect marginal cost pricing of forage under competitive market conditions and would serve as an approximation of marginal cost for federal forage. First best pricing of federal forage resources is an example of a piecemeal pricing approach to fulfill conditions of Pareto optimality in one sector of the economy without regard to other sectors (Boadway and Bruce). Piecemeal pricing, however, is

an inappropriate means to maximize social welfare under market interdependence because nonzero cross-price elasticities violate the sufficient conditions for welfare maximization[1] (Boadway and Harris).

When FMV policy is interpreted as a second best pricing directive[2], social welfare is maximized if federal forage is priced at grazing permit holder use value (Collins). However, when the comparable market approach is used to appraise federal forage use values, the existence of interdependence results in a violation of an implicit assumption of appraisal theory. Value appraisal techniques implicitedly assume that when an appraised resource (federal forage) is offered for exchange in the marketplace, it has no or at least minimal influence on the observed exchange value (private forage prices) from which its use value (FMV of federal forage) is estimated. Under market interdepedence, the nonzero cross elasticities which exist between federal and private markets would violate this implicit assumption. Thus, the existence of forage market interdependence would seriously compromise the application of comparable market approaches for use value appraisal of federal forage resources.

The Case Study: Malheur National Wildlife Refuge (MNWR)

The MNWR is located in Harney County, Oregon. Established in 1908 as a preserve and breeding ground for native birds, livestock grazing is an authorized management tool to remove excess forage growth from flood irrigated pastures. Most livestock grazing use occurs in the form of rake-bunch grazing where forage is harvested

on irrigated pastures in late summer, bunched in piles, and grazed from October through January.

Much like BLM and FS grazing programs, the privilege to graze livestock on the MNWR is allocated by permit. Grazing and haying permits are assigned to individual ranchers on a continuous basis. Grazing fee per animal unit month (AUM)[3] and permit quantities are set independently of one another by the MNWR administration.

Permitted grazing use on the MNWR varied between 110 and 120 thousand AUMs during the 1960s and early 1970s (roughly 25 and 30 percent of November to March cattle forage requirements in the county). In 1973, a change in MNWR management led to an official policy of reducing livestock grazing permits. When this policy ended in 1981, permitted use had been reduced by roughly 70 percent from the 1973 level. This substantial reduction provided an ideal case study to test for market interdependence between federal and private forage markets[4].

The connection between MNWR and private forage markets is postulated to stem from management adjustments taken by MNWR grazing permit holders (permittees) in response to MNWR forage quantity changes. Based on a survey of permittees[5], the alfalfa hay market in Harney County was the primary private forage market impacted by MNWR grazing program changes. Survey respondents developed over 1,000 acres of alfalfa hayland and annually purchased an additional 1,650 tons of alfalfa hay in response to MNWR forage reductions.

Methods

Two influences of MNWR forage reductions are hypothesized for the Harney County alfalfa hay market: 1) increases in development of alfalfa hay acreage either by the permittees themselves to replace lost forage or by other hay producers in anticipation of hay prices increases; and 2) real price increases created by permittee hay purchases to replace reductions in MNWR forage. To estimate the magnitude of federal/private forage market interdependence, a system of simultaneous equations is formulated:

$$HAA_t = f(EOAA_t;\ \Sigma_{n=1}^{2} RF_{t-n};\ D1), \qquad (1)$$

$$H_t = f(HA_t;\ T_t*HA_t;\ W_t), \qquad (2)$$

$$HP_t = f(ORHP_t;\ H_t;\ C_t;\ RF_{t-1}), \qquad (3)$$

where:

HAA_t = changes in Harney County alfalfa hay acreage between the past year and current year (t);
$EOAA_t$ = changes in Eastern Oregon alfalfa hay acreage, excluding Harney County, between the past year and current year (t);
RF_t = changes in MNWR forage quantity from the previous year's total, summation of 2 lagged years in (4) and by one year in (6)[6];
D1 = dummy variable for Malheur and Harney Lakes flood impact for flooding which began in 1982 and hayland remained submerged through 1988;
H_t = quantity of alfalfa hay produced in Harney County;
HA_t = Harney County alfalfa hay acres;
W_t = weather variable to reflect annual changes in climatic conditions, average temperature during the growing season (April through August) is used due to irrigation meeting water needs;
T_t*HA_t = multiplicative variable of time trend times Harney County alfalfa hay acres;
HP_t = alfalfa hay prices in Harney County, adjusted to 1986 values by the Gross National Product deflator;

$ORHP_t$ = alfalfa hay prices for the state of Oregon, exclusive of Harney County, adjusted to 1986 values by the Gross National Product deflator;
H_t = quantity of alfalfa hay produced in Harney County;
C_t = number of cattle (cows and calves) in Harney County as of January 1.

Equation (1) is used to explain changes in production capacity in the Harney County hay market (HAA). EOAA serves as a proxy variable for to account for changing alfalfa hay price expectations and economic growth assuming these are uniform across Eastern Oregon. Production capacity (HA) is then linked to hay production (H) in (2). The variable T*HA is used to reflect increasing technology on per acre yield of alfalfa hay (Oury).

In equation (3), H acts as an independent variable to explain HP[7]. The ORHP variable represents a proxy variable for economic impacts on alfalfa hay prices outside of Harney County. With alfalfa hay being a livestock production input, C is used to account for shifts in final product demand (Myer and Yanagida).

From the hypothesized influences of MNWR forage reductions, RF variables are postulated to have negative coefficients in (1) and (3). The existence of federal/private forage market interdependence is established by two statistical inferences from RF coefficients: 1) a significant difference from zero with a one-tailed Student's t-test; and 2) a significant structural change associated with the forage reduction policy based on a linear restriction F-statistic. Statistical significance for both tests would reject a null hypothesis of no market interdependence between the MNWR grazing program and the Harney County alfalfa hay market.

RF variables are postulated to be negatively correlated with HAA and HP only after the 1973 implementation of a MNWR policy to permanently reduce livestock forage. Refuge forage quantity changes prior to 1973 are hypothesized to have no influence on the private hay market due to the temporary nature of these quantity fluctuations. To separate pre and post 1973 influences, estimation of RF coefficients is done with RF variables in block-diagonal form (Johnston).

Linear relationships are assumed among variables based on well established hypothesis testing techniques for regression coefficients in small samples (Judge et al.). If error terms are uncorrelated between equations (1)-(3), then this system of equations is a recursive and can be estimated with ordinary least squares (OLS) on each equation. Breusch-Pagan Lagrangian Multiplier and likelihood ratio tests are used to test for a diagonal error term covariance matrix.

Data sources included MNWR records, the Office of Economic Information at Oregon State University, and Burns, OR weather station. The time series data set spanned from 1958 to 1986.

Statistical Evidence of Forage Market Interdependence

OLS estimation of variable coefficients for each equation are shown in Table 1. Both Breusch-Pagan Lagrangian Multiplier test ($\chi^2_3 = 1.449$) and the likelihood ratio test ($\chi^2_3 = 1.772$) did not reject the null hypothesis of a diagonal error term covariance matrix. Thus, OLS estimation of each equation is appropriate.

Table 1. OLS Estimation of Regression Coefficients for Equations (1)-(3), 1960-1986.

Equation						
(1)	HAA = 0.312	+ 0.023 EOAA	+ 0.027 $RF_{1960-73}$	- 0.069 $RF_{1974-86}$	- 6.334 D1	
	(0.260)[1]	(0.022)	(0.026)	(0.019)**	(1.157)**	
	N = 27	Adjusted R^2 = 0.573		$F_{4,22}$ = 9.712		
(2)	H = 53.373	+ 3.920 HA	- 0.005 [T*HA]	- 1.337 W		
	(33.260)	(0.553)**	(0.015)	(0.559)*		
	N = 27	Adjusted R^2 = 0.978		$F_{3,23}$ = 386.266		
(3)	HP = 23.218	+ 0.863 ORHP	- 0.197 H	- 0.046 C	+ 0.056 $RF_{1960-73}$	- 0.389 $RF_{1974-86}$
	(15.337)	(0.087)**	(0.066)**	(0.178)	(0.160)	(0.211)*
	N = 27	Adjusted R^2 = 0.857		$F_{5,21}$ = 32.107		

[1] Standard error of estimated regression coefficient.
* Regression coefficient is statistically different from zero at 5 percent level, one-tail test for $RF_{1974-86}$.
** Regression coefficient is statistically different from zero at 1 percent level, one-tail test for $RF_{1974-86}$.

Table 2. Re-estimation of Regression Coefficients Due to Violations of OLS Assumptions.

Equation (2)		Violation: First order Autocorrelation Violation: Multicollinearity	Correction: Cochrane-Orcutt Iterative Process, rho=0.426 Correction: Drop [T*HA] variable	
	H = 25.047 (30.969)[1]	+ 3.761 HA (0.175)**	- 0.821 W (0.518)	
		N = 27	Adjusted R^2 = 0.981	$F_{2,24}$ = 258.552
Equation (3)		Violation: Multicollinearity	Correction: Drop C variable	
	HP = 19.769 (7.381)*	+ 0.852 ORHP (0.075)	- 0.207 H (0.051)**	+ 0.059 $RF_{1960-73}$ (0.156)	- 0.391 $RF_{1974-86}$ (0.206)*
		N = 27	Adjusted R^2 = 0.863	$F_{4,22}$ = 41.894

[1] Standard error of estimated regression coefficient
* Regression coefficient is statistically different from zero at 5 percent level, one-tail test for $RF_{1974-86}$.
** Regression coefficient is statistically different from zero at 1 percent level, one-tail test for $RF_{1974-86}$.

Strong statistical support for market interdependence between the MNWR grazing program and the Harney County alfalfa hay market is evident in Table 1. $RF_{1974-86}$ coefficients are negative and statistically different from zero in both (1) and (3). Prior to the reduction policy, $RF_{1960-73}$ coefficients are, as expected, not statistically different from zero.

For structural change, RF coefficients in (1) have a statistically significant F-statistic ($F_{1,23}$ = 6.970) at a five percent level. Based on this result, the estimated coefficient for $RF_{1974-86}$ is statistically different from $RF_{1960-73}$. Thus, both statistical inferences from RF coefficients in (1) reject the null hypothesis and are highly supportive of the MNWR grazing program having an influence on production capacity changes (HAA) in the private alfalfa hay market. $RF_{1974-86}$ coefficient estimates imply that for each 1,000 AUM reduction in MNWR forage Harney County alfalfa hay acreage increases by 138 acres (lagged over two years).

In (3), a F-statistic for structural change in RF coefficients is not statistically significant ($F_{1,22}$ = 0.957). The two statistical inferences from RF coefficients in (3) did not reject the null hypothesis, but did show partial support for the MNWR grazing program having a direct effect on prices in the Harney County alfalfa hay market based on the $RF_{1974-86}$ coefficient being statistically different from zero.

In testing for violations of OLS assumptions, there are no major problems in (1). In (2), a Durbin-Watson statistic of 1.283 revealed positive first-order autocorrelation of error terms, and

multicollinearity is a problem based on a condition index from principle components analysis of 183.7, much larger than the problem level suggested by Johnston. For (3), multicollinearity is present among independent variables (condition index of 21.8). The corrections for OLS violations in Table 2 do not change statistical inferences of market interdependence from Table 1.

Implications for Federal Forage Pricing

Gulley has suggested that the comparable market approach is a constructive way of interpreting FMV only when the federal government's presence in the market is nominal. Given a nominal presence, competitive market forces are allowed to determine value without government influence. However, existence of federal/ private forage market interdependence shows that federal government presence in forage markets cannot be considered nominal.

The existence of market interdependence violates sufficient conditions for piecemeal pricing of federal forage resources and violates an implicit assumption of appraisal under second best pricing. Because of these violations, first or second best pricing of federal grazing fees can not be justified based on improvements in economic welfare. Thus, under market interdependence, formula pricing of federal forage using strictly private market price data becomes a value judgment devoid of economic justification. This value judgement would be that federal grazing permittees should pay what private market lessees pay.

Case study results suggest that market interdependence should be of concern in establishment of federal grazing fees policy. A

federal/private market size ratio of 1.13 was present prior to the MNWR reduction policy. For BLM and FS grazing programs, there are 268 million acres of BLM/FS leases in the western U.S. compared to about 103.5 million acres of non-federal leased grazing land (Tittman and Brownell). Even with greater forage productivity of private land, this size ratio for BLM/FS grazing programs and private land grazing leases strongly implies existence of market interdependence given that interdependence is found in Harney County with a federal/private ratio equal to 1.13.

Given existence of federal/private forage market interdependence, there is an alternative valuation technique for federal forage whose assumptions are not violated by market interdependence. Obermiller suggests utilizing a ranch operation budgeting approach to determine net returns to permit ownership. By using this technique, only data from federal forage markets are employed to value forage, thereby eliminating use of private forage market data.

1. Sufficient conditions under a dual formulation require zero cross-price elasticities of uncompensated demand and supply functions between distorted (federal forage) and undistorted (private forage) markets. This research examines federal and private forage market cross elasticities for quantity and price with primal formulations.

2. For example, the grazing fee formula designated by Congress in 1978 to represent FMV incorporated grazing permit holders' ability to pay into fee determination.

3. On the MNWR, an AUM is the quantity of forage required to support a cow/calf pair for one month.

4. A lack of statewide BLM or FS policies on forage quantity allocations prevented meaningful testing for the existence of market interdependence between private grazing land lease markets and BLM plus FS grazing programs (Collins).

5. This survey covered management responses by about half of the ranch operations using MNWR forage during 1972 (Collins).

6. The lagged influence of RF on HAA and HP is the result of most permittee operations tending to delay alfalfa hay purchases and/or acreage development in favor of other management actions (such as cutbacks in cattle numbers or a drawdown of existing hay stocks). Experimental techniques for estimating different model formulations were used to specify the number of lags for RF in each equation. This experimental approach to econometric modeling is described in Koutsoyiannis.

7. H is assumed to be predetermined in the short-run, i.e. hay production does not change in response to prices during the growing season (Myer and Yanagida). From this assumption, H becomes a measure of stock rather than demand and HP can be estimated as a function of H (Heiden).

References

Boadway, R. W. and N. Bruce. Welfare Economics. New York: Basil Blackwell, 1984.

Boadway, R. W. and R. G. Harris. "A Characterization of Piece-Meal Second Best Policy." J. Public Economics. 8(1977):169-90.

Collins, A. R. The Public Forage Pricing Implications of Public/Private Market Interdependence. Unpublished PhD dissertation, Oregon State University, Corvallis, OR, 1989.

Gully, D. A. "The Fair Market Value of Federal Coal." West Virginia Law Review. 86(1983-84):741-771.

Heiden, D. "Price Determination Processes for Agricultural Sector Models." Amer. J. Agr. Econ. 59(1977):126-32.

Johnston, J. Econometric Methods. Third Edition. New York: McGraw-Hill, 1984.

Judge, G. G., R. C. Hill, W. E. Griffiths, H. Lutkepohl, and T. C. Lee. Introduction to the Theory and Practice of Econometrics. New York: John Wiley & Sons, 1982.

Koutsoyiannis, A. Theory of Econometrics. Second Edition. Great Britian: Harper & Row Publishers, Inc., 1977.

Myer, G. L. and J. F. Yanagida. "Combining Annual Econometric Forecasts with Quarterly ARIMA Forecasts: A Heuristic Approach." W. J. Agr. Econ. 9(1984):200-206.

National Oceanic and Atmoshperic Administration. Climatological Data, Oregon Monthly and Annual Summaries. National Climatic Data Center, Ashville, NC, 1960-1987.

Nielsen, D. B. and J. P. Workman. The Importance of Renewable Grazing Resources on Federal Lands in the 11 Western States. Utah Agr. Exp. Sta. Circ. 155, 1971.

Obermiller, F. W. Economic Theories. Federal Grazing Fees: What is Fair Market Value? J. H. Smits, editor. Washington, D.C.: Public Lands Committee, National Cattlemen's Association, 1984, p. 27-46.

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

Obermiller, F. W. and B. A. McCarl. In Search of Reason: Issues and Alternatives in the Federal Grazing Fee Debate. Unpublished paper presented at symposium on grazing fees for public rangelands, AAEA and WAEA joint annual meeting, Logan, UT, 1982.

Oregon State University Extension Service. Unpublished data on alfalfa hay acreage and production. Office of Economic Information, Department of Agricultural and Resource Economics, Corvallis, OR.

Oury, B. 1965. "Allowing for Weather in Crop Production Model Building." J. Farm Econ. 47(1965):270-283.

Quigley, T. K. and R. G. Taylor. Econometric Estimation of Range Forage Demand. Range Economics Symposium and Workshop. F. G. Wagstaff, Editor. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station General Technical Report Int-149, p. 38-43, 1983.

Roberts, N. K. "Discovering Grazing Values." J. of Range Manage. 20(1967):369-75.

Tittman, P. B. and C. E. Brownell. Appraisal Report and Estimating Fair Market Rental Value of Public Rangelands in the Western United States Administered by USDA - Forest Service and USDI Bureau of Land Management. Report prepared for the BLM and FS, Washington, D.C., 1984.

Torell, L. A., E. B. Godfrey, and D. B. Nielsen. "Forage Utilization Cost Differentials in a Ranch Operation: A Case Study." J. of Range Manage. 39(1986):34-39.

U.S. Department of the Interior and U.S. Department of Agriculture. Grazing Fee Review and Evaluation Final Report 1979-85. Report of the Secretaries of Agriculture and the Interior, Washington, D.C., 1986.

U.S. Department of the Interior and U.S. Department of Agriculture. Study of Fees for Grazing Livestock on Federal Lands. Washington, D.C., 1977.