Comparing estimates of market and non-market values for products of a given land base

COMPARING ESTIMATES OF MARKET AND NON-MARKET VALUES FOR PRODUCTS OF A GIVEN LAND BASE

by

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ABSTRACT

Given that demand and value estimates for outdoor recreation activities have been made for all regions in Arizona, this study examines how to estimate empirically comparable values of an alternative market-priced land-use product from the same land resource base. Cattle grazing for beef calf production was selected as the alternative use for this conceptual examination and empirical case study.

A theoretical framework is constructed for product comparability with respect to whom the social benefits accrue. A statistical demand curve for beef is estimated from which statewide changes in consumer surplus values are generated.

The statewide changes in consumer surplus values are disaggregated into estimates for Arizona Game and Fish Department Regions and estimates per square mile. The consumer surplus values for beef are compared to consumer surplus values for outdoor recreation activities. Producer surplus values are estimated for cattle production but are not relevant for outdoor recreation.

The results show high consumer surplus values for outdoor recreation in areas close to large population centers where demand is great. The values for outdoor recreation are equal to or larger than cattle production values in these areas but smaller than for cattle production in all other areas.

CHAPTER 1

INTRODUCTION

Efficient administration of public and private land requires knowledge of the relevant values of the products attainable from this natural resource. There are possible product combinations which are unrelated or complementary in resource use; in this case, produce values are additive and little problem arises in resource administration. The problem of allocation or administration arises in the case where the resource uses are competitive, in that more of the product of one use can be achieved only at the sacrifice of some of the product of another use.

Given that physical and biological tradeoffs can be specified, the efficient multiple-product solution of what combination of products to produce in what quantities may be specified if the relevant product prices and production costs are known.

Economic values can be determined for many land-use activities such as farming, ranching, timber, and mining by observing the prices of their products as they are sold in the market. But not all land-use products are sold in competitive markets. Some products, such as outdoor recreation, escape the pricing mechanism, making the estimation of relevant prices and economic values difficult. Even where the demand for such non-market commodities can be estimated, there is a conceptual problem of just how these prices and values derived from the non-priced

good may be compared to the prices and values estimated for the market-priced uses of the natural resource base.

Given that recent demand and value estimates for outdoor recreation activities have been made for all areas of Arizona (Martin, Gum, and Smith, 1974), the purpose of this study is to examine how to compare and to estimate empirically comparable values of an alternative market-priced, land-use product from the same land resource base. Cattle grazing for beef calf production is selected as the alternative use for this conceptual examination and empirical case study.

Justification

The State of Arizona is comprised of 82.5 percent public lands (including Indian Reservation land) versus 17.6 percent private lands (see Table 1). Federal and state agencies which control the use of Arizona's public lands include: U. S. Forest Service, Bureau of Land Management, National Park Service, Bureau of Indian Affairs, and Arizona State Land Department.

Traditionally, public land management has emphasized sound conservation practices rather than quantity of outputs. Fire control, insect and disease control, and planting were performed because they were thought to be good conservation practices, not necessarily because they were sound investments (Whaley, 1970). But, with increased demand for all products of the land resource, the conservation rationale is no longer adequate by itself for justifying the kinds of expenditures required. Extensive management for forage and timber may gradually be replaced by intensive management for outdoor recreation, landscape

Table 1. Distribution of Arizona Land Ownership by County, 1974.[a]

County	Federal Owned	Indian Reservation	State Owned	Privately Owned	Total Acreage
	1000 acres				
Apache	646	4,552	695	1,258	7,151
Cochise	959	0	1,363	1,682	4,004
Coconino	4,907	4,402	1,034	1,544	1,887
Gila	1,794	1,149	30	67	3,040
Graham	1,215	991	504	204	2,950
Greenlee	988	0	143	68	1,199
Maricopa	3,750	252	465	1,438	5,905
Mohave	5,692	574	437	1,783	8,486
Navajo	621	4,197	343	1,182	6,343
Pima	1,806	2,480	921	707	5,914
Pinal	700	599	1,354	789	3,442
Santa Cruz	436	0	62	299	797
Yavapai	2,688	4	1,215	1,215	5,179
Yuma	5,431	227	234	499	6,391
Total	31,633	19,427	8,857	12,771	72,688
% of Total	43.5	26.7	12.2	17.6	100.0

[a]Source: Valley National Bank of Arizona (1975).

esthetics, water and wildlife, in addition to intensive timber and forage management. Rational change can only be achieved if more is known about the public's assessment of the alternative values of these products.

Research Objectives

The general problem to be studied is how may the prices and values derived for the non-priced good, outdoor recreation, be compared to the prices and values estimated for the market-priced good, beef calf production, on a given land resource base. Specific objectives are to:

1. Construct a theoretical framework for product comparability. Concern will focus on to whom the net social benefits accrue.
2. Estimate a statistical demand function for Arizona beef calf production from which a statewide consumer surplus value may be developed.
3. Disaggregate the statewide consumer surplus value into representative shares for each Arizona Game and Fish Department Region.
4. Compare the estimates developed in (3) above, with recreational values already available from Martin et al. (1974).
5. Analyze the relationships of the empirical estimates to theory and discuss how theory affects the interpretation of the estimates.

CHAPTER 2

CONCEPTUAL FRAMEWORK

The primary purpose of this chapter is to introduce and discuss the theoretical constructs used in obtaining valid estimates of benefits accruing to consumers from the utilization of Arizona lands for two products, cattle grazing and outdoor recreation. The use of theory, by definition, is to employ abstract deductive reasoning so that conclusions are drawn from sets of initial assumptions. The constructs introduced here will provide guides for the empirical studies of the next chapter. The empirical studies, in turn, will provide tests of the usefulness of the assumptions and conclusions of theories.

Economic Demand

Economic demand is defined as a schedule of the amounts of goods or services which consumers are able and willing to purchase in a given market at a given array of prices in a given time period. The word "able" refers to the ability of a consumer to purchase a particular good and is a function of income and wealth. "Willingness" refers to the consumer being prepared to purchase and is determined by individual preferences. The "given array of prices" means that there are alternative prices which allow choice between quantities of the good or service at these different prices. The "given time period" emphasizes the fact that the time frame of reference is important to the definition and must

be clearly stated. Thus, the demand schedule is specific to a particular time and place. The place may be as specific as a particular city or state, or as general as the United States. Similarly, the particular time may refer to the demand per day, per week, or per year.

The basic principle of demand is that the quantity demanded varies inversely with the per unit price; at a relatively low price more quantity will be demanded than at a higher price. On a graph with the vertical axis referring to per unit price and the horizontal axis referring to total quantity demanded, a curve depicting a demand schedule slopes downward and to the right. The demand curve depicts a maximum concept. For any given quantity, a consumer would not be willing to pay more than the corresponding price on the demand schedule, though he would be willing to pay less to obtain the same quantity.

Consumers of a commodity assign an economic value to the commodity. The value is what they are willing to give up in order to enjoy possession of a good or service. Furthermore, consumers of any economic good must receive satisfaction (utility) that is at least equal to the price that they are willing to incur, otherwise they would not be acting rationally in incurring the expense.

The Model of Demand for and Value of Outdoor Recreation

Recreation demand is a modification of conventional consumer demand. The basic notion of the relationship between price and quantity remains unchanged. Clawson (1959) states that the demand for outdoor recreation should measure a willingness of users to pay measurable or definable sums of money for specified volumes of outdoor recreation.

The quantity or volume demanded for recreation is usually in terms of use. Use of recreation sites can be measured in such units as visits, trips, or user days. The concept of use of a recreation site is only part of what Clawson (1959) calls the recreation experience. The whole experience includes anticipation and preparation for the trip, travel to the site, the on-site experience, travel back from the site, and recollection of the experience. Clawson maintains that one part cannot be separated from the others and that economists measure what people do in terms of the total recreation experience consumed and costs involved.

The major difference between demand for recreation and ordinary market-priced consumer demand is that of defining prices. In the conventional type of demand, the price of the commodity is established by a functioning market mechanism wherein the equilibrium price occurs at the point where supply is equated with demand. In contrast, most forms of outdoor recreation have no conventional market mechanism. Alternative quantities of recreation are not offered for sale at alternative prices. Consumer prices are either totally absent or set by administrative fiat.

Wennergren (1967) examined the problem of pricing outdoor recreation and showed that, although outdoor recreation developed as a non-market good, it is not a free good. There are time and money costs associated with the consumption of recreation which regulate the quantity of outdoor recreation taken. These money costs can be used as surrogate or substitute prices in determining demand functions for outdoor recreation with time costs acting as demand shifters.

The recreator must face two cost-related decisions. First, the recreator faces the long-run decision requiring the purchase of certain items of a fixed nature which may be used for more than one trip and in more than one time period. These items can include: camping equipment, a recreational vehicle, and certain sporting equipment. These long-run costs are referred to as fixed or sunk costs. Once incurred, these sunk costs do not affect the decision to participate in a specific recreational activity.

The second costs decision is of a short-run nature. Within a given period of time, the individual must decide what form of recreation in which he will participate and at what site. There are associated costs for transportation, lodging, time, food costs, and any additional on-site costs that would not have been incurred had the trip not been made. These short-run decision costs are considered variable costs and are the pertinent costs for the surrogate prices described by Wennergren (1967).

The use of variable costs as the surrogate price is analogous to the short-run decisions made by a business firm. Economic analysis shows that, in the short-run, the marginal costs (additional costs) are a function only of variable costs and that the marginal costs are the decision variables. The short-run decision of how much to produce is not affected by the fixed costs. In the same way, only the variable costs are pertinent in estimating the short-run demand for recreation (Martin et al., 1974).

In the process of relating variable costs to a schedule of volume, a demand curve can be formulated. Hotelling (1949), in an early study of the demand for outdoor recreation, defined concentric zones around a recreation site such that the costs of travel from each zone to the site are equal. These costs, related to the number of visitors, could then be used to estimate points on a demand curve.

Clawson and Knetsch (1966) use Hotelling's concept in developing the demand for any outdoor recreation experience. The authors state that the estimation of demand must proceed in two two steps. First, a statistical demand curve is estimated for the total recreation experience. The data are taken directly from tabulation of consumer behavior.

The second step in the analysis is that of developing a demand curve for the resource site itself. This demand curve is derived from the demand curve for the recreation experience based on the assumption that the resource users would react to changes in costs at the site ("added costs") in the same manner to which they react to costs for recreation experience as a whole. In developing the demand curve for the resource, the total projected number of visits is calculated at each posited increased interval of cost. The resulting demand curve is in terms of added costs and total quantities of visitation. The consumer is expressing preference through his willingness to pay for the particular outdoor recreation activity at a given site.

The study of Martin et al. (1974) developed demand estimates for given outdoor recreation activities in Arizona Game and Fish Department management regions. General categories for the activities included

hunting, fishing, and general outdoor recreation. The dependent variable for their estimated demand function was always number of trips for a particular activity to a specific region. This definition of activity implies that the demand generated for recreation is for a consumer good with consumer surplus values accruing solely to the final consumer.

Consumer Surplus

Marshall (1947) is credited with the development of the concept of consumer surplus in economic theory. Simply defined, the consumer surplus measures the surplus satisfaction that a consumer receives from a commodity above the price that he actually paid for that commodity. The central idea behind consumer surplus is that the consumer has in his mind a price that he would be willing to pay rather than to go without a certain commodity. The price that the person is willing to pay rather than to go without must be greater than or equal to the price he actually does pay. Since price is a measure of satisfaction, the difference in price that the individual is willing to pay and the price he does pay is a measure of surplus satisfaction.

However, outdoor recreation lacks a price of acquisition set by market forces. The supply cost of outdoor recreation activities is not faced by the consumer since, in most cases, it is a function of the public sector or government. A conceptualization of the demand curve generated by the consumer is shown in Figure 1, where the consumption level is Qr at an added cost of zero. The consumer has expressed a willingness to pay defined by demand curve DD. Thus, he realizes a surplus benefit equal to the total area within the demand curve. The

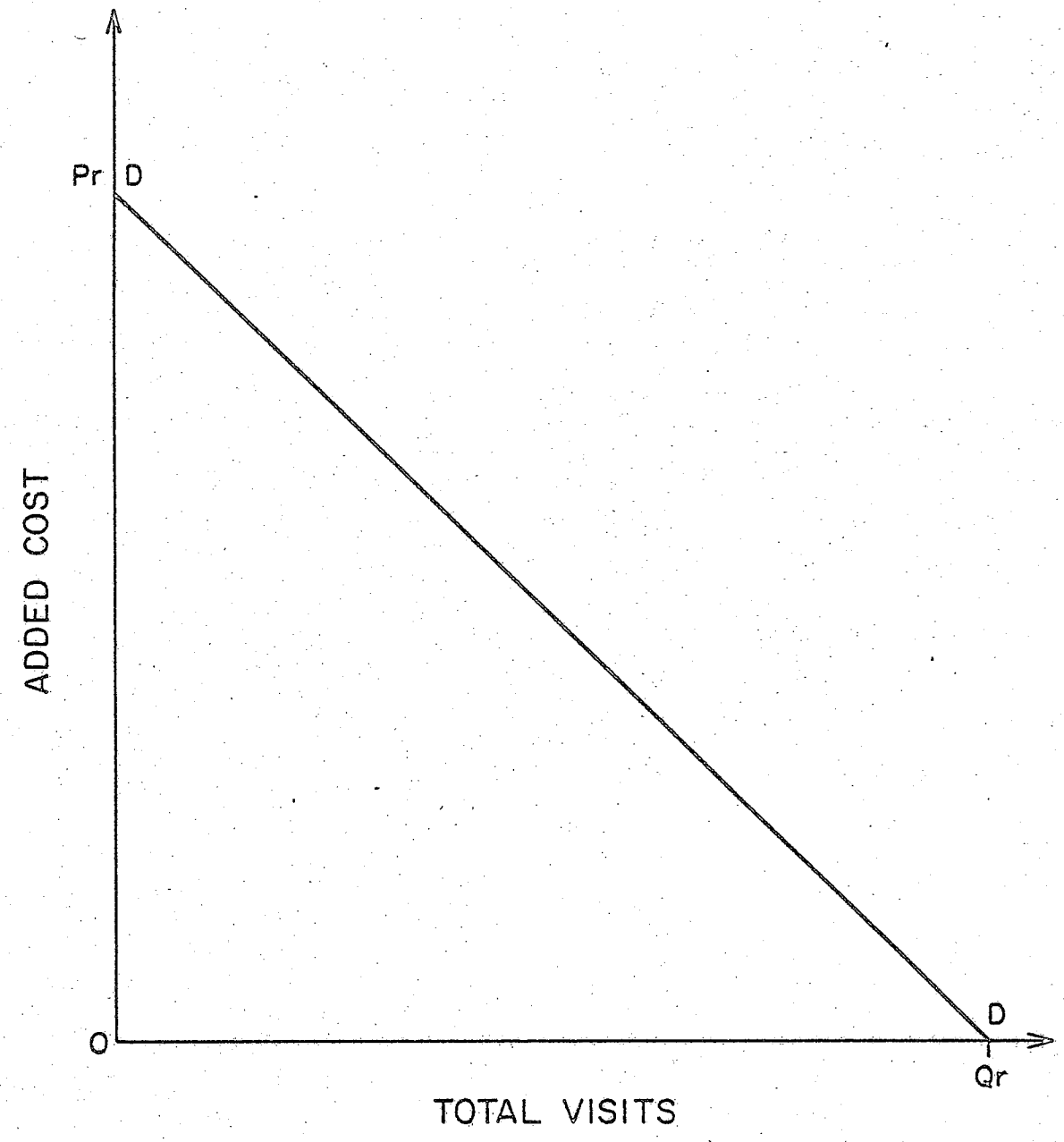

Figure 1. Demand for Outdoor Recreation (Hypothetical).

consumer surplus value in this case is a monetary measure of the maximum value of the resource net of acquisition costs.

For a market-priced good, the consumer pays the price determined by the market forces of demand and supply. Figure 2 represents the price (Pm) and quantity (Qm) in the market at equilibrium (e). At this point, there are no sellers making price concessions to attract buyers, nor are there waiting lines of buyers trying to buy quantities that are not available. The consumer here realizes a surplus value equal to area A since he would be willing to pay more when lesser quantities are offered.

The producers in the market receive a price Pm for each good sold and sells the quantity Qm. Thus, the total revenues are represented by the area OPmeQm. The area C is the cost of producing the good; the value of resources (human and physical) used in the production process. The area B is what Marshall (1947) refers to as producers' surplus and is defined as a measure of the resource-owner's gain from having the opportunity of placing his production factors in the chosen occupation at the existing factor price, given the prices his factors would earn in all other occupations. This measure is regarded as the counterpart of consumer surplus which measures the opportunity of buying a particular good at the existing price, where all other prices are given.

The Model of the Change in Consumer Surplus for Beef

The consumers of beef pay a price determined in the market by the intersection of supply and demand. In Figure 3 the total U. S. market situation for beef is shown as the intersection of the supply curve, S_1,

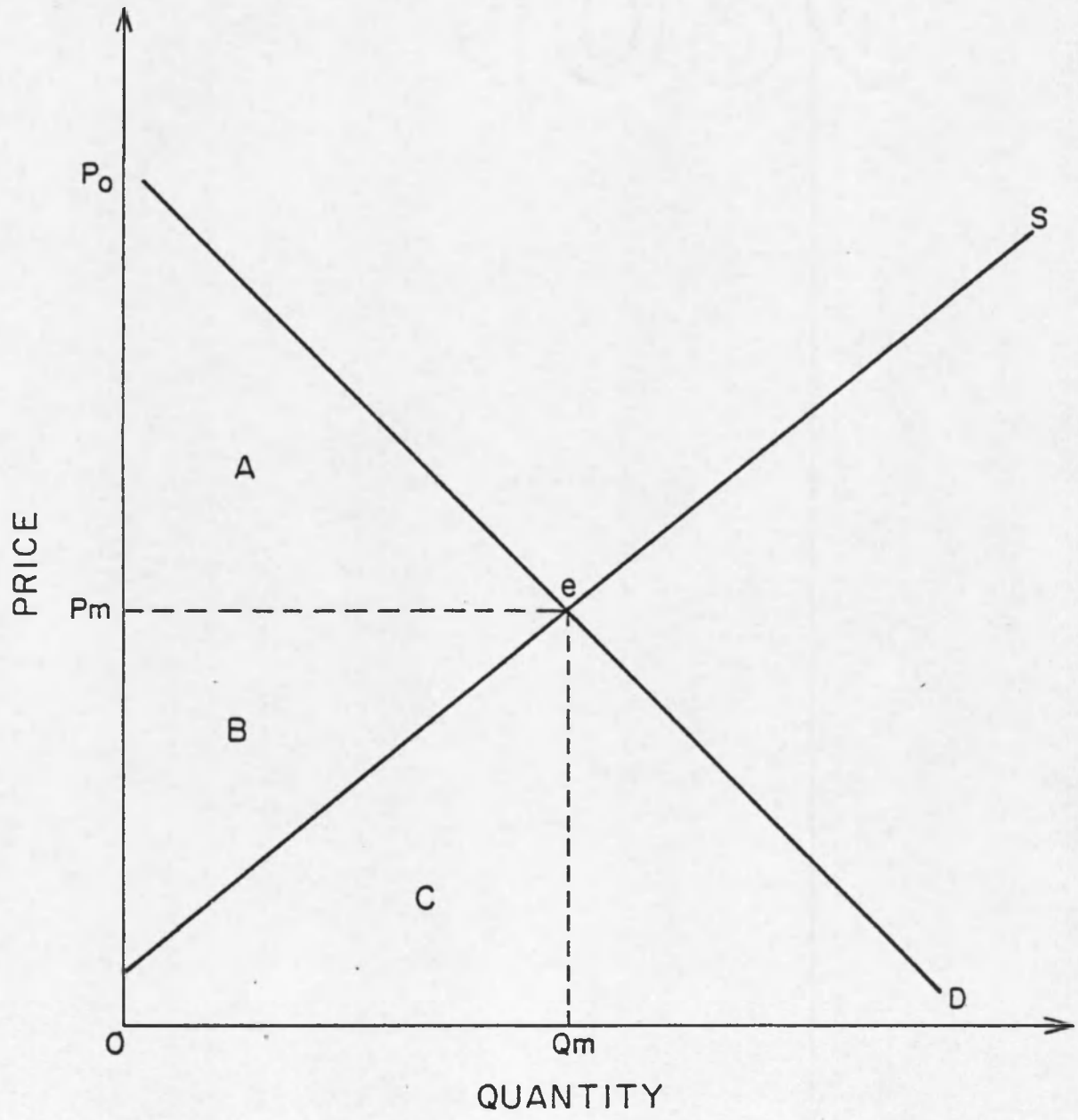

Figure 2. Illustration of Consumer Surplus, Producer Surplus, and Value of Resources of Production (Hypothetical).

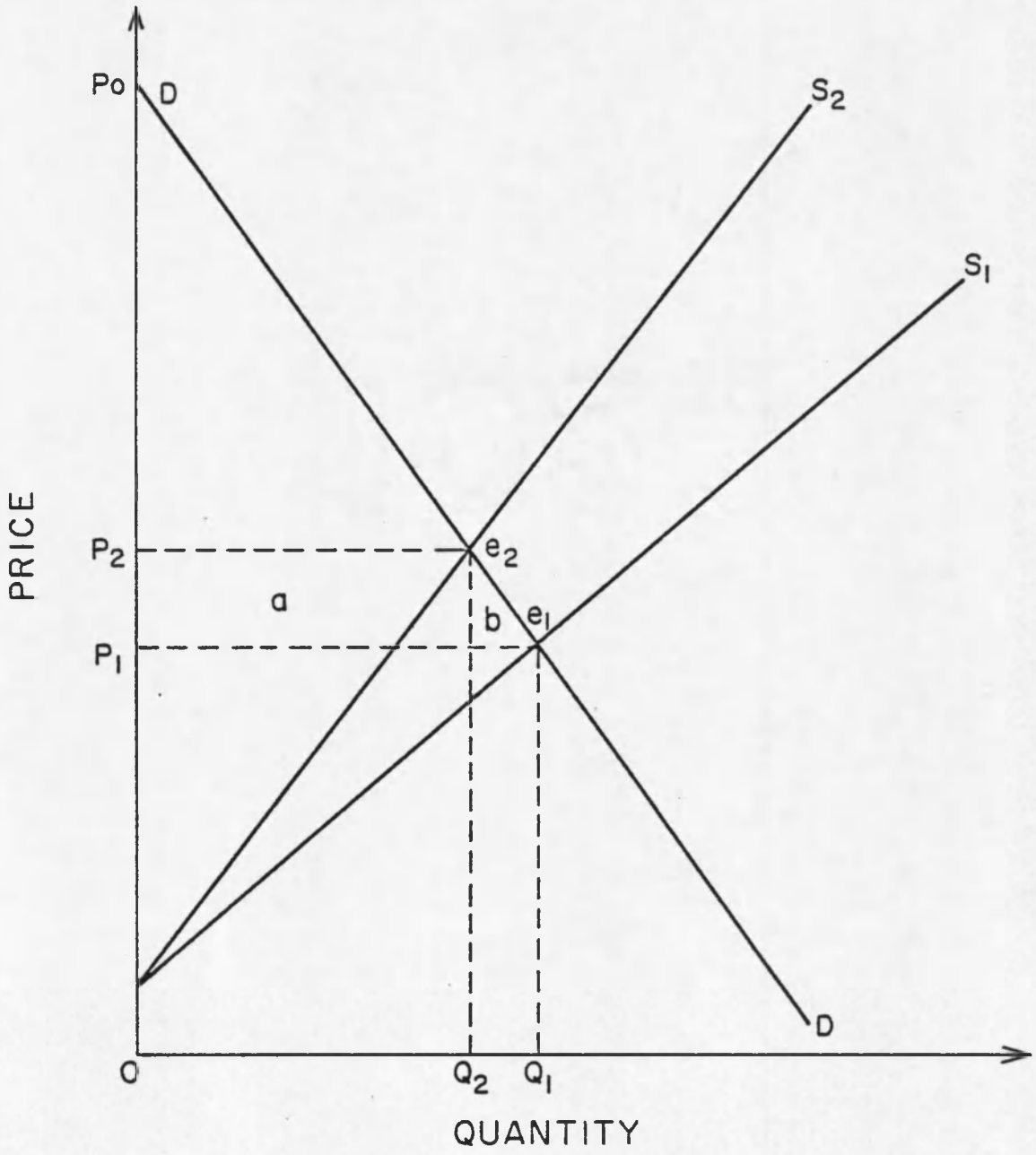

Figure 3. Change in Consumer Surplus (Hypothetical).

and the demand curve, DD. The consumer pays price P_1 for the quantity offered, Q_1. His consumer surplus is the area $P_1P_0e_1$.

If the land used in the production of beef calves in Arizona, a small portion of the total U. S. production area, were in another activity, the supply curve would shift to the left (S_2). This shift is due to a reduction in the resources available for the production of beef. The new supply curve would intersect the demand curve for beef at point e_2 since the posited reduction is equal to Q_1 minus Q_2. The price would rise to P_2 in accordance with the slope of the demand curve at this segment. At this new equilibrium point, the consumer surplus is the area $P_2P_0e_2$. The consumer would realize a loss of consumer surplus equal to the area a, change in total expenditures, plus the area b. The interpretation of the change in consumer surplus measure, in this case a reduction in quantity offered, is simply the maximum amount of value (in money) the group of consumers as whole would forego in response to a reduction in Arizona beef calf production. Stated positively, the change in consumer surplus value is the value to the consumers of the land in its present use.

Product Comparability

The products, outdoor recreation and beef calves, produced on the land base, Arizona, are marketed in under very different circumstances. Outdoor recreation displays a high degree of public good characteristics since it is a non-market good. Calf production is a market good with private good characteristics. The question is posed of how these market differences would affect the distribution of net social benefits from

land use in each production activity if the benefits are to be compared. Examination of the offer of the good to the consumer is the basis used for product demand comparability.

Estimation of outdoor recreation values presuppose that the good is a final good offered to the consumer and it is offered to all of the consuming public. The fact that outdoor recreation is a final good demanded for consumption simply distinguishes it from an intermediate good which is demanded for production processes.

The characteristic of unlimited offer for outdoor recreation is assumed since all recreators, including those from other states, are not denied participation in recreation activities in Arizona. But out-of-state recreators usually opt not to participate in Arizona's recreation activities due to competing substitute products (outdoor recreation in their locality) offered at a lower "price," where "price" is a proxy for the time and variable costs incurred to participate in outdoor recreational activities. That is to say, all U. S. consumers are equally offered outdoor recreation opportunities in spatially differentiated localities, but, for the most part, are excluded from use of distant recreation facilities because of similar, low-priced substitutes in their locale. To summarize, Arizona recreation is a final consumer product offered to everyone, but actual buyers are limited because the recreation opportunity is fixed in space.

Beef calf production on the Arizona land resource is not for final consumption. The calf only becomes a product for final consumption after being fed and converted to beef. Thus, in order to achieve closer

product comparability, the Arizona calf crop is evaluated in terms of its possible retail beef product. It is assumed that all saleable beef calves will yield as a choice steer of the average slaughter weights as reported in "Livestock and Meat Statistics" (U. S. Department of Agriculture, 1975).

By assuming that Arizona calves become a part of the total U. S. beef supply, the characteristic of unlimited offer for beef is also assumed. Beef is a homogeneous product offered in a competitive market to many buyers. The demand for beef is estimated using average prices of beef to determine total U. S. production. The benefits are homogeneously shared by all beef consumers. Thus, while both demand for recreation and demand for beef are final demands, the demand for beef is generated by the total U. S. populus, and most of the demand for Arizona recreation is generated by Arizona residents.[1] While the consumer surpluses generated by Arizona recreation and beef production may be compared, the distribution of the surplus among the population obviously differs.

The Change in Price of Beef Resulting from a Reduction in Arizona Beef

The total possible Arizona retail beef yield represents only 0.67 percent of total U. S. retail beef production (see Table 4, p. 26). A posited one hundred percent reduction in Arizona beef production would be such a small change that it is assumed that the demand curve is linear

1. Whereas the conceptual model presented here does include non-resident demand for outdoor recreation activities, it must be recognized that the empirical estimates of outdoor recreation demand presented by Martin et al. (1974) do not.

over the small segment describing the price-quality change. To measure the change in price resulting from a change in quantity, price flexibility is used. Price flexibility measures the percentage change in price in response to a given percentage change in quantity; the direction of causation is from quantity to price.

The price flexibility coefficient (Pf) is defined as:

$$Pf = \frac{\%\Delta P}{\%\Delta Q} = \frac{\frac{\Delta P}{P}}{\frac{\Delta Q}{Q}}$$

Thus,

$$Pf \cdot \%\Delta Q = \frac{\%\Delta P}{\%\Delta Q} \cdot \%\Delta Q = \%\Delta P$$

where

$\%\Delta P$ = percentage change in price,

$\%\Delta Q$ = percentage change in quantity,

ΔP = change in price,

ΔQ = change in quantity,

P = original price, and

Q = original quantity.

Past estimates for price flexibility (as summarized by Ginn, 1977) of retail beef include: Schultz (1938), Pf = -2.44; Working (1954), Pf = -0.89; Fox (1953), Pf = -1.06; and Brandow (1961), Pf = -1.15. The differing values could be a function of either different model specification and/or the change in the demand for beef over time.

Two estimates of price flexibility of demand for retail beef are used in this study: Pf = -1.55 (derived from George and King, 1971), and Pf = -1.71 (derived from a demand curve estimated by the author).

For both estimates, it is assumed that price flexibility is simply the inverse of price elasticity demand. Houck (1965) discusses problems which arise from such an assumption. Where the derivative dP/dQ from $P = f_1(Q)$ is the reciprocal of dQ/dP from $Q = f_2(P)$. But demand functions are more complex than this; if different variables are held constant, it can no longer be assumed that the partial derivative, $\partial P_i/\partial Q_i$, of the equation $Q = f_3(P_i, P_j, Y)$ is the reciprocal of $\partial Q_i/\partial P_i$. However, Houck goes on to say, if the cross effects of other products are zero (essentially no substitutes), then the reciprocal of the price elasticity is a good estimate of the flexibility. Conversely, if significant cross effects exist, then the reciprocal of the price elasticity is greater than true price flexibility. Mathematically,

$$|Pf_{ii}| \leq \left|\frac{1}{E_{ii}}\right|$$

where E_{ii} is the price elasticity of demand, and Pf_{ii} is the price flexibility of demand. Thus, the estimated price flexibility of demand for beef and subsequently the estimated change in consumer surplus from a reduction of Arizona beef are maximum values.

Estimation of the Change in Consumer Surplus for Beef

Calculation of the change in consumer surplus resulting from the elimination of the Arizona beef calf crop is done as follows. First,

there are data for the production of retail beef in the U. S. and Arizona. The production level in Arizona represents the change in production (ΔQ). The percentage change in production is then the change in production, divided by total U. S. production (TP), or:

$$\Delta Q/TP = \%\Delta Q$$

Next, application of the price flexibility coefficient to find the percentage change in the price level is in the form:

$$Pf \circ \%\Delta Q = \%\Delta P$$

where the factor one minus the percentage change in price (% P) times the existing price level (P) yields the new price level (P') which would be generated by elimination of the Arizona beef calf crop, given existing demand conditions.

The change in consumer surplus formula in general form is:

$$|TE - TE'| + |\Delta Q| \circ |\Delta P|/2 = \Delta \text{ in Consumer Surplus}$$

where

$TE = P \circ Q$ = total expenditures for retail beef in the U. S. in 1970;

$TE' = P' \circ Q'$ = estimated total expenditures for retail beef in the U. S. if there were no Arizona beef crop;

$|\Delta Q| = |Q - Q'|$ = absolute change in quantity; and

$|\Delta P| = |P - P'|$ = absolute change in price.

Thus, given a reduction in quantity, the change in consumer surplus will decrease existing consumer surplus since Pf is less than zero.

The Derivation of Consumer Surplus Values for Arizona Game and Fish Department Regions

The change in consumer surplus generated by the previous analysis represents a one hundred percent reduction in Arizona's production of retail beef entering the U. S. retail beef market. The value added by each Arizona Fish and Game Department Region to the total statewide consumer surplus value for beef calf production is calculated by: 1) approximation of the percentage of each county within specific Arizona Game and Fish Department Regions, 2) use of county estimates for saleable beef calf crops by number of head (Arizona Agricultural Statistics, 1971, 1972, 1973, 1974, 1975) and percentage of the county within the Fish and Game Region to calculate number of calves produced in the Region, 3) estimation of the percentage of the statewide total calf crop in each Region, and 4) derivation of the consumer surplus values for each Region from the statewide consumer surplus.

CHAPTER 3

EMPIRICAL ANALYSIS

Estimation of the Demand Function for Beef

The estimation of the demand function for beef is by ordinary least-squares regression. The data are from "Livestock and Meat Statistics" (U. S. Department of Agriculture, 1975). The regression equation is based on quarterly data within the range of first quarter 1970 to fourth quarter 1975.

Retail quantity of beef produced is the dependent variable (Y). Independent variables which proved significant are retail price of beef (X_1) and personal disposable income (X_2). Other variables not testing significant in this model included the price of retail pork, price of feed corn, and the consumer price index. The functional form of the equation is a double-logarithmic transformation as shown below:

$$\log Y = a \log + b_1 \log X_1 + b_2 \log X_2$$

The effect of price (X_1) upon quantity consumed has a negative coefficient (b_1), as expected, which, in the case of a double-logarithmic functional form, reads directly as the price elasticity of demand, -0.58409. The corresponding calculated "t" statistic (-2.8928) is significant at the 99% level (tabulated "t" is 2.819). The coefficient of determination has a corrected value of .514.

The coefficient for the income variable reads directly as income elasticity of demand, which measures the percentage change in the amount of a commodity purchased per unit of time resulting from a given percentage change in a consumer's income. The value of the income elasticity, 0.77665, is positive indicating that beef is a normal rather than an inferior good. The elasticity is less than one, showing that beef is a necessary good rather than a luxury good. This estimator of income elasticity is significant with a calculated "t" statistic value of 3.9931, surpassing the tabulated value of "t" at the 99% level (2.819).

When inverted, the estimated price elasticity of demand for beef (-0.5841) yields a price flexibility coefficient of -1.7120. The interpretation of this coefficient is that a one percent change in quantity demand results in a -1.7120 percent change in price.

In addition to the author's estimation of price flexibility for beef, an estimate was derived from George and King (1971) from the study, Consumer Demand for Food Commodities in the United States with Projections for 1980. Their estimate for price elasticity of demand for beef is -0.6438, yielding a price flexibility coefficient of -1.5533.

Quantity Change in U. S. Retail Beef Production Resulting from a Total Reduction of the Arizona Beef Calf Crop

Table 2 presents the conversion of average liveweight per steer to retail beef yield. The average conversion for liveweight to retail weight was 2.25 to 1. Table 3 presents U. S. total cattle slaughtered and the estimated Arizona beef calf crop. The average retail weight

Table 2. Conversion of Average Liveweight per Steer to Retail Beef Yield.

Year	Average Liveweight[a] per Steer Salughtered	Average Retail[b] Weight per Steer
	lbs	
1970	1,035	460
1971	1,028	457
1972	1,038	461
1973	1,043	464
1974	1,039	462
1975	996	443

[a]Source: U. S. Department of Agriculture (1975).
[b]The average conversion ratio for liveweight to retail weight was 2.25 to 1. Source: Uracek (1967).

Table 3. U. S. Total Cattle Slaughtered and the Estimated Arizona Beef Calf Crop.

Year	Total U. S. Cattle[a] Slaughtered	Estimated Arizona[b] Beef Calf Crop
	---------- 1000 Head ----------	
1970	35,354	236
1971	35,894	233
1972	36,082	223
1973	34,029	220
1974	37,327	191
1975	41,464	223

[a]Slaughter in federally inspected and other slaughter plants; includes farm slaughter. Source: U. S. Department of Agriculture (1975).
[b]Source: Archer (1976, p. 12).

(Table 2) multiplied by the cattle slaughtered and calf crop estimates (Table 3) yields total U. S. retail beef and Arizona retail beef production by pounds, as found in Table 4. The percentage change in quantity is calculated as Arizona retail beef production divided by total U. S. retail beef production.

Table 4. Quantity Change from Reduction of Possible Yield of Arizona Beef Calf Crop on U. S. Total Retail Beef Produced.

Year	Total U. S. Retail Beef[a]	Arizona Retail Beef Production	Total U. S. Retail Beef Minus Arizona Share	Percentage Change from Deletion of Arizona Beef
	---------- Million Pounds ----------			
1970	16,262.84	108.56	16,154.28	.66754
1971	16,403.56	106.48	16,297.08	.64914
1972	16,633.80	102.80	16,531.00	.61804
1973	15,789.46	102.08	15,687.38	.64651
1974	17,245.07	88.24	17,156.83	.51170
1975	18,368.55	98.79	18,269.76	.53781

[a]Source: U. S. Department of Agriculture (1975).

The data for the Arizona beef calf crop are from a study by Archer (1976), which lists the estimated Arizona calf supply, death loss, and number of dairy calves. The saleable beef calf crop is total calf supply minus dairy calves and death loss.

Change in Price Resulting from Change in Quantity

The change in the price of beef resulting from a change in the quantity of retail beef offered on the market is presented in Tables 5 and 6 by years. Table 5 gives price changes calculated from the author's estimate of price flexibility (-1.71) and Table 6 gives price changes using the price flexibility estimate derived from George and King (1971) (-1.55).

The estimate for price flexibility of retail beef times the percentage change in quantity (Table 4) yields the percentage change in the price of beef. The percentage change in price is positive since the percentage change in quantity and price flexibility estimates are both negative.

Change in Consumer Surplus, State Total

Table 7 presents the change in consumer surplus resulting from a complete elimination of Arizona beef calf production. Two series of estimates are given, one where price flexibility of demand is -1.55 and another where price flexibility is -1.71. The estimates are by years; differences between years reflect the changing retail prices of beef as well as the change in U. S. beef production as compared to Arizona's share of U. S. retail beef production.

The consumer surplus estimates derived from the two differing price flexibilities do not increase or decrease in corresponding proportions. This difference is because of the relative responsiveness described by the price flexibility estimates. The George and King (1971)

Table 5. Change in Price, by Years (Price Flexibility Estimate Is -1.71).

Year	Actual Average[a] Price Retail Beef ($/lbs)	Percentage Change	Adjusted Average Price Retail Beef
1970	.986	1.143	.997
1971	1.043	1.111	1.055
1972	1.138	1.058	1.150
1973	1.355	1.107	1.370
1974	1.388	.876	1.400
1975	1.460	.921	1.473

[a]Source: U. S. Department of Agriculture (1975).

Table 6. Change in Price, by Years (Price Flexibility Estimate Is -1.55).[a]

Year	Actual Average[b] Price Retail Beef ($/lbs)	Percentage Change	Adjusted Average Price Retail Beef
1970	.986	1.037	.996
1971	1.043	1.008	1.053
1972	1.138	.960	1.150
1973	1.355	1.004	1.370
1974	1.388	.795	1.400
1975	1.460	.835	1.472

[a]Source: George and King (1971).
[b]Source: U. S. Department of Agriculture (1975).

Table 7. Change in Consumer Surplus, State Total, by Years.

Year	Pf = -1.55	Pf = -1.71
	----- Millions of Dollars ----	
1970	55.04	71.26
1971	60.65	85.15
1972	63.77	82.33
1973	76.33	98.35
1974	66.74	83.93
1975	79.24	93.91

estimate (-1.55) creates a less flexible price which is consistent with a more elastic demand. The flexibility coefficient estimated by the author (-1.71) is more price flexible; that is, it implies a more inelastic demand. Thus, for a price flexibility of -1.55, total revenues increase for 1972 over the 1971 estimate by approximately three million dollars, even though the Arizona share of the beef market declined (see Table 4). The author's price flexibility coefficient, which is more price flexible, allows for a decrease from 1971 to 1972 of approximately three million dollars. The difference in the response of the total revenues to each price flexibility estimate for this period is because of a reduction in the Arizona share of cattle produced in relation to total U. S. production.

The retail price of beef (see Table 6) has risen significantly in recent years, having the effect of generally raising the change in consumer surplus estimates. The actual average retail beef price experienced the largest change from the previous year in 1973, approximately twenty-two cents per pound.

Beef Calf Production by Arizona Department of Game and Fish Region

Figure 4 shows the Arizona Department of Game and Fish Regions. The beef calf production for each region, presented in Table 8, is estimated by 1) approximation of the percentage of each county within specific Arizona Game and Fish Regions, and 2) use of county estimates for beef calves sold by number of head (Arizona Agricultural Statistics,

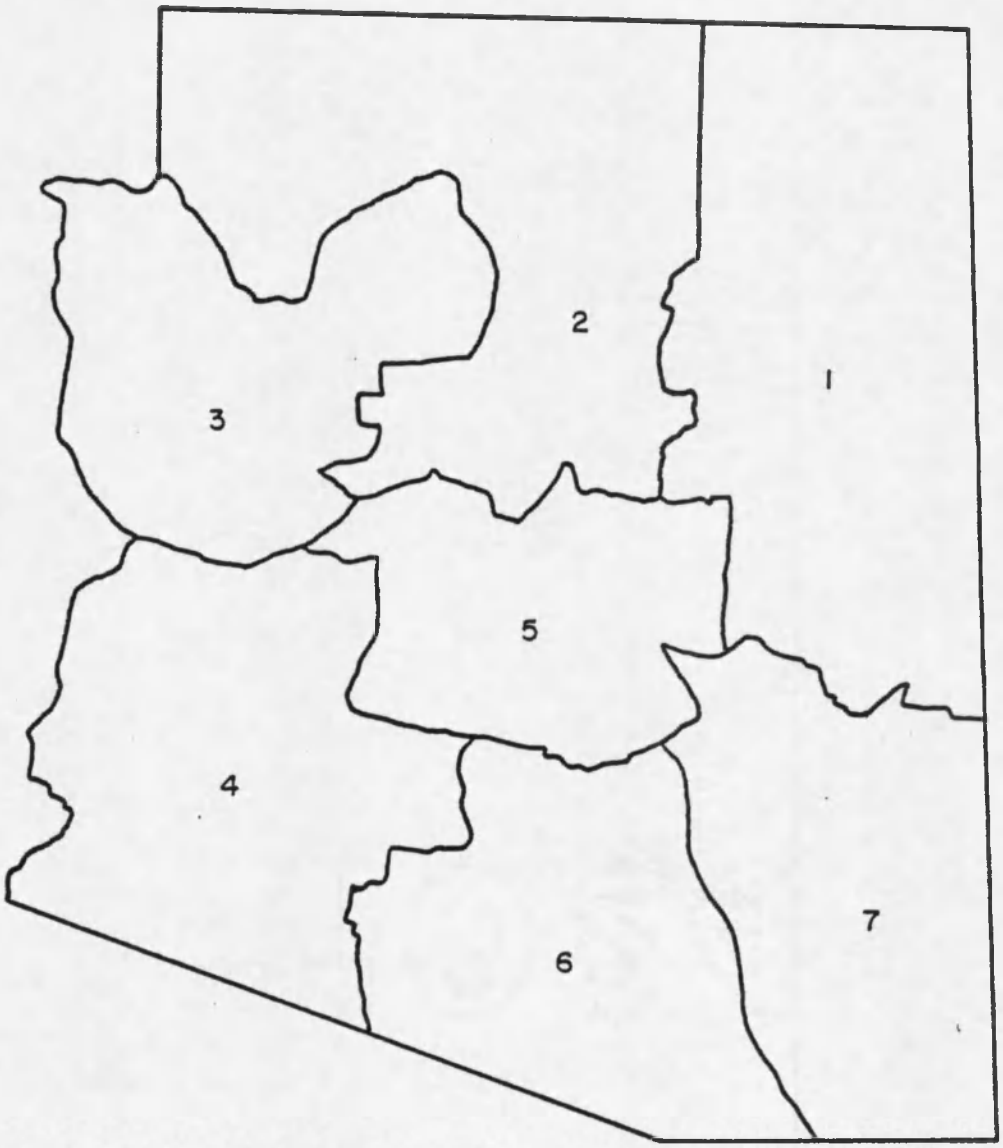

Figure 4. Arizona Game and Fish Regions. -- Source: Martin et al. (1974).

Table 8. Estimated Beef Calf Production by Arizona Game and Fish Regions, 1970.

Region	Beef Calf[a] Production (1000 head)	Percentage of Total
1	52.39	22.2
2	47.43	20.1
3	15.81	6.7
4	14.16	6.0
5	25.96	11.0
6	49.56	21.0
7	30.68	13.0
Totals	236.00	100.0

[a]Source: Arizona Agricultural Statistics (1971).

1971). Also presented in Table 8 is the percentage of state total of calf production within each region.

Comparison of Consumer Surplus Values Generated, Arizona Beef Production and Outdoor Recreation, by Arizona Department of Game and Fish Regions

Estimated values of consumer surplus generated by Arizona beef production and outdoor recreation for 1970 are presented in Table 9 for each of the seven Game and Fish Regions (see Figure 4). The relative size of the change in consumer surplus from Arizona cattle reduction overwhelms the consumer surplus estimates from hunting in all areas except Region 5. The second largest regional estimate for hunting is in Region 6. These two regions encompass the most densely populated areas in Arizona; Region 5 contains the Phoenix metropolitan area and Region 6 contains Tucson.

The consumer surplus values for all recreation activities (hunting, fishing, and general outdoor recreation) in all regions are much larger than the values for cattle production. Due to the volume of activity in all outdoor recreation, one would expect the consumer benefits to be large in comparison to the single activity of beef production.

The largest consumer surplus value for all activities of outdoor recreation is in Region 2. The recreation category in this region with the highest value is general outdoor recreation (hiking, camping, etc.), which represents 82 percent of the total 68.37 million dollars. Region 5 has the second largest value for all activities, with warm water fishing

Table 9. Comparison of Consumer Surplus Values Generated, Arizona Beef Production and Outdoor Recreation[a], by Arizona Department of Game and Fish Regions, 1970.

Region	Change in Consumer Surplus from Reduction in Beef Production		Consumer Surplus Value	
	Pf = -1.55	Pf = -1.71	All Hunting Activities	All Outdoor Recreation Activities
	Millions of Dollars			
1	12.21	15.81	2.87	55.98
2	11.06	14.32	6.83	68.37
3	3.68	4.77	.64	13.77
4	3.30	4.27	2.21	7.82
5	6.05	7.83	9.87	60.80
6	11.55	14.96	7.40	23.31
7	7.15	9.26	4.61	13.19
Totals	55.04[b]	71.26[b]	34.48[b]	243.24[b]

[a]Consumer surplus estimate for all hunting includes the activities: deer hunting, other big game hunting, small game hunting, waterfowl hunting, and general hunting. All outdoor recreation activities include: all hunting, fishing, and general outdoor recreation (Martin et al., 1974).

[b]Regional consumer surplus values do not sum due to rounding error.

and general outdoor recreation representing 35 percent and 47 percent of the total, respectively.

Consumer Surplus Values per Square Mile

This study reveals that the Arizona beef calf crop for 1970, 236 thousand head (see Table 3), generated an estimated high value of 71.26 million dollars (Table 7) in consumer surplus value. This value represents the value to the consumers of beef of Arizona's beef grazing lands in their 1970 use. The statewide estimate for change in consumer surplus from a reduction in Arizona's beef calf production is then broken down into seven estimates representing the share contributed by each of seven Arizona Game and Fish Department Regions for 1970 (Table 9). The regional estimates for beef are compared to values of consumer surplus for outdoor recreation estimated by Martin et al. (1974) (Table 9).

The preceding analysis, however, does not compare the intensity of value per land unit used in the activities of beef calf production and outdoor recreation. Table 10 presents the consumer surplus values for Arizona beef calf production and outdoor recreation per square mile. The calf production estimates are calculated as average calf production per section of grazing land times the average consumer surplus value per calf ($302). Average value per calf is estimated as statewide consumer surplus for beef calf production divided by calf crop for a specific year. The consumer surplus values for calf production are given as a range where the lower values reflect areas where grazing is poor and calf production is lower than in areas which have prime grazing conditions.

Table 10. Consumer Surplus Values of Arizona Beef Calf Production and Outdoor Recreation by Square Mile by Arizona Department of Game and Fish Region.

Region	Consumer Surplus[a] Value of Calf Production (Pf = -1.71)	Consumer Surplus Value[b]	
		All Hunting Activities	All Outdoor Recreation Activities
1	1,510 - 3,020	487	3,022
2	2,023 - 3,020	404	2,611
3	513 - 1,510	75	1,179
4	435 - 492	231	481
5	815 - 966	1,115	5,482
6	1,661 - 1,963	880	1,725
7	1,214 - 1,812	346	797

[a]Values are given in a range reflecting differential grazing conditions of areas within the region. The change in consumer surplus is estimated using Pf = -1.71.
[b]Source: Martin et al. (1974).

Analysis of Table 10 shows very high per-section values for calf production in Regions 1 and 2. These values reflect the high carrying capacity of the rangelands within these regions (32.4 acres per animal unit, Central Plateau estimate) (Dickerman and Martin, 1967). The corresponding consumer surplus value for outdoor recreation in this region is also high, where 37 percent of the value is generated by cold water fishing activities and 54 percent by general rural outdoor recreation activities (picnicking, camping, hiking, swimming, boating, waterskiing, birdwatching, and snowskiing).

Region 5, which contains Phoenix, generates a consumer surplus value for all hunting of $1,115 and for all outdoor recreation of $5,482 per square mile. These values are because of the volume of demand for recreation activities; 31 percent of all trips made for all recreation activities in Arizona for 1970 were made in this area. The corresponding calf production values are low in comparison, reflecting a carrying capacity for grazing of approximately 7 animal units per section per year and an average calf productivity of 2.7 to 3.2 calves per section per year.

Alternative Values of Cattle Ranching

Thus far, the analysis has focused on comparisons of consumer surplus values generated by the two activities, beef calf production and outdoor recreation. The values were derived using similar conceptual framework, consumer surplus, which valued land resources as benefits accrusing to the consumer for land in its present use for a specific year.

Table 11 includes consumer surplus values of calf production for six different areas and annual average market value of cattle-producing land per square mile. The six areas are shown in Figure 5. The areas were selected on the basis of similar land characteristics for grazing. The differences in value between areas given for grazing in Table 11 reflect the value of the land resource in cattle production; in the areas where grazing conditions are poorer, returns are lower than in areas which have prime grazing conditions.[1]

The annual average value of all lands for ranching is the annual equivalent (at 6 percent interest) of the average sale price of all ranches, including deeded land as well as the rights to public land permits, as developed by Martin and Jefferies (1966) and reported in Dickerman and Martin (1967). Whole ranches were selling for the average price per square mile (1 section or 640 acres) shown in Table 11.

The consumer surplus values of beef calf production reflect the value productivity of the land to the final consumers. The average market values reflect the demand for cattle ranches by individual investors in addition to those consumer surplus values accruing to the final consumer of beef.

Economic reasoning dictates that the cattle producer would conceptually use land to the point where his marginal cost of producing cattle (which describes the supply curve for Arizona beef cattle) equals the price for the cattle he receives. Figure 2 hypothetically illustrates

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1. The market value estimates also include the value of the cattle ranch to the owner as consumption and speculation goods (see Smith and Martin, 1972).

Table 11. Alternative Values per Square of Mile of Cattle Ranching in Arizona for Six Different Cattle-Producing Areas, 1970.

Ranching Area[a]	Consumer Surplus Values of Beef Calf Production[b]	Annual Average Market Value of All Lands[c]	Total Economic Benefits to Society
	---------- Dollars per Square Mile ----------		
Western Desert (Region 4)	492	140	632
Arizona Strip (Region 2)	1,558	290	1,848
Southern Desert (Region 6)	1,540	352	1,892
Central Mountain (Region 5)	815	355	1,170
Central Plateau (Region 1) (Region 2)	3,029	424	3,453
Southeastern Desert (Region 7)	1,781	558	2,339

[a]These ranching areas roughly compare to Arizona Department of Game and Fish Regions as listed. See Figure 5.

[b]Calculated as average consumer surplus generated per calf times estimated calf production per section. Consumer surplus estimated from $Pf = -1.71$.

[c]Average value of all lands (Martin and Jefferies, 1966; Dickerman and Martin, 1967). Average values are also shown in Martin et al. (1974).

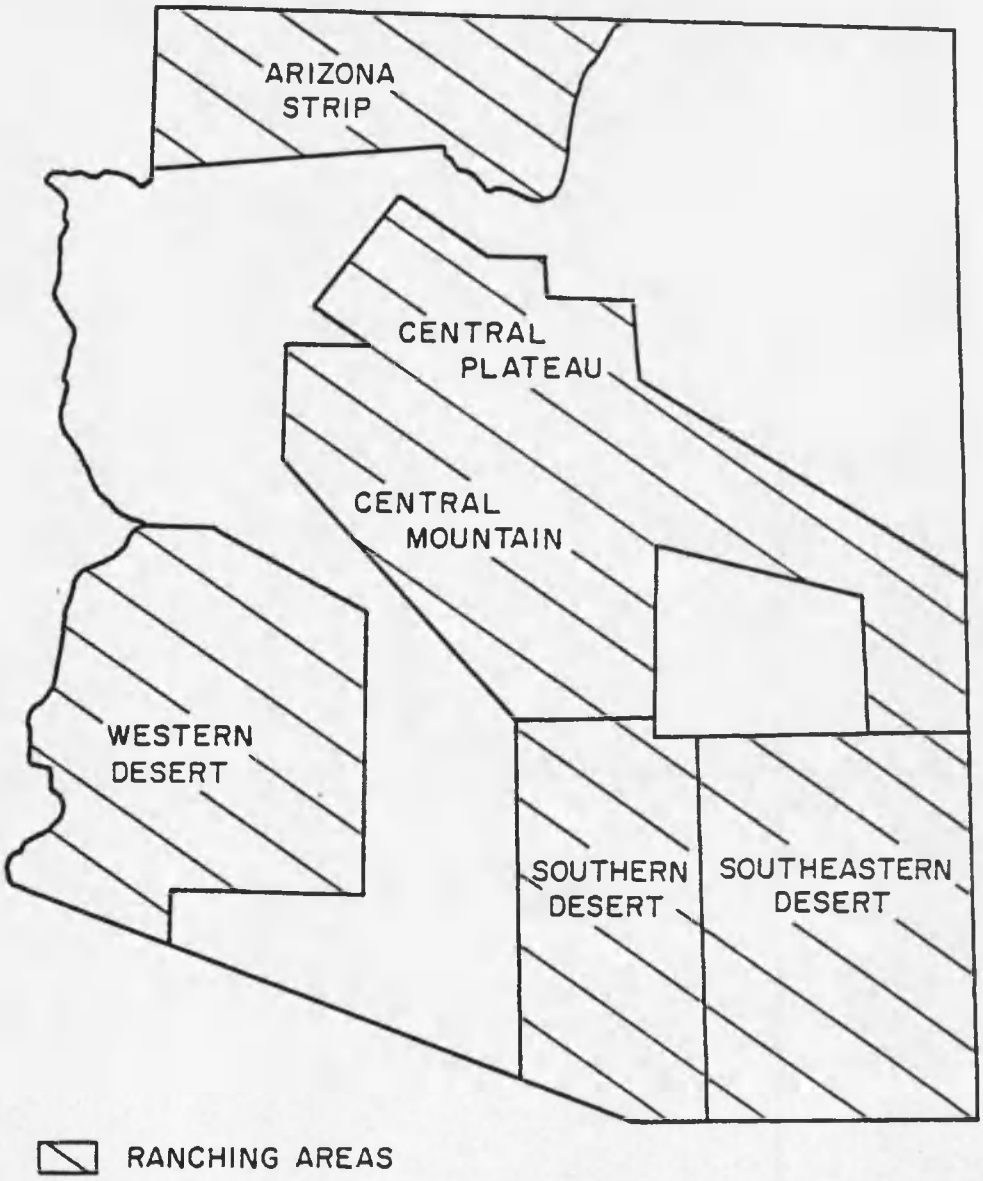

Figure 5. Ranching Areas in Arizona. -- Source: Dickerman and Martin (1967).

this concept. The area above the supply curve (OS) and below the price line (Pm) represents the economic rents (profits) accruing to the cattle producer for each unit of land in production. The area contained below the supply curve (OS) and to the left of quantity (Qm) is the value of the resources (human and physical) used in the production processes. The cattle producer would not produce more quantity than Qm since to do so he would incur a loss; the next unit of cattle produced would have a value of productive resources higher than the price which he receives for the cattle. Thus, the area above the supply curve (aggregated producer marginal cost curve) and below the price is an accurate estimate of the value of the land to cattle producers. Since average value is the value of the land to the cattle producers, it is the Marshallian producer surplus as described previously in Chapter 2.

In reality, the supply curve of ranch land also includes speculative costs as well as land costs related simply to "land fundamentalism," that is, value of the land to the ranch investor as a consumptive good (Smith and Martin, 1972). Given that these two values may also be viewed as products in addition to the product value of beef, they contribute to the value of producer surplus. Thus, the total annualized sale value of the ranch land is the measure of producer surplus.

The summation of the producer surplus and the consumer surplus in Table 11 is the total economic benefits to society per square mile for land in cattle production. The producer surplus accrues only to the cattle producers in the form of profits above variable costs, where the

consumer surplus accrues to all beef consumers, including the cattle producers.

The demand for outdoor recreation activities (see Figure 1) has no marginal cost associated with it since it is a zero marginal cost good. Thus, the consumer surplus estimate for outdoor recreation activities is the total economic benefits to society for land in that activity.

CHAPTER 4

RELATIONSHIP OF THE EMPIRICAL ESTIMATES TO THEORY

Ability and Willingness to Pay

The products in this study, outdoor recreation and beef calf production, possess different market characteristics. Outdoor recreation is not priced in the market; it has an administered price in most cases set by government fiat. Usually the price is zero or very low. Beef calf production generates market goods and is subject to the price mechanism of the market.

The comparative evaluation of the two products used consumer demand theory as the theoretical framework. The values are in terms of benefits accruing to the consumer from products generated on a specific land resource in a given use. The benefits are a measure of surplus satisfaction that a consumer receives from a commodity above the price that he actually paid for that commodity. This consumer surplus is conceptualized as the area under the consumer's demand curve (the relation of alternative quantities that would be purchased at alternative market prices at a given point in time) above the price of acquisition.

The principle of economic demand is that consumers are able and willing to pay to enjoy possession of a good or service. Ability to pay is a function of income and wealth. Willingness to pay refers to the consumer being prepared to purchase and is determined by individual

preferences. Much of the criticism of welfare analysis for any good is based on these demand principles.

The implementation of policy to change existing cattle production lands to outdoor recreation lands should consider not only the consumer's preferences, as expressed in willingness-to-pay terms, but also distributional considerations (the consumer's ability to pay). Consumer demand theory differentiates between the substitution and income effects of a price change, while the price of one good (such as beef) changes with respect to other goods.

The income effect with respect to a given demand curve for a normal good is such that an increase in price decreases the consumer's real income or purchasing power. Thus, the consumer tends to cut his consumption of all goods to some extent where lower consumption signifies a lower level of satisfaction or welfare.

The substitution effect causes the consumer to substitute relatively lower-priced goods for the relatively higher-priced good when its price goes up. Usually, the substitution effect is by far the stronger of the two effects, since a moderate increase in the price of any one commodity purchased does not substantially decrease the consumer's real income.

Figure 6 illustrates the income and substitution effects. Indifference curves between two products, X and Y, are shown; their prices are px_1 and py_1, respectively. Point A, containing x_1 of X and y_1 of Y, maximizes the consumer's satisfaction. Suppose the price of X rises to px_2. Now, less X can be consumed with the given income, I_1. Now

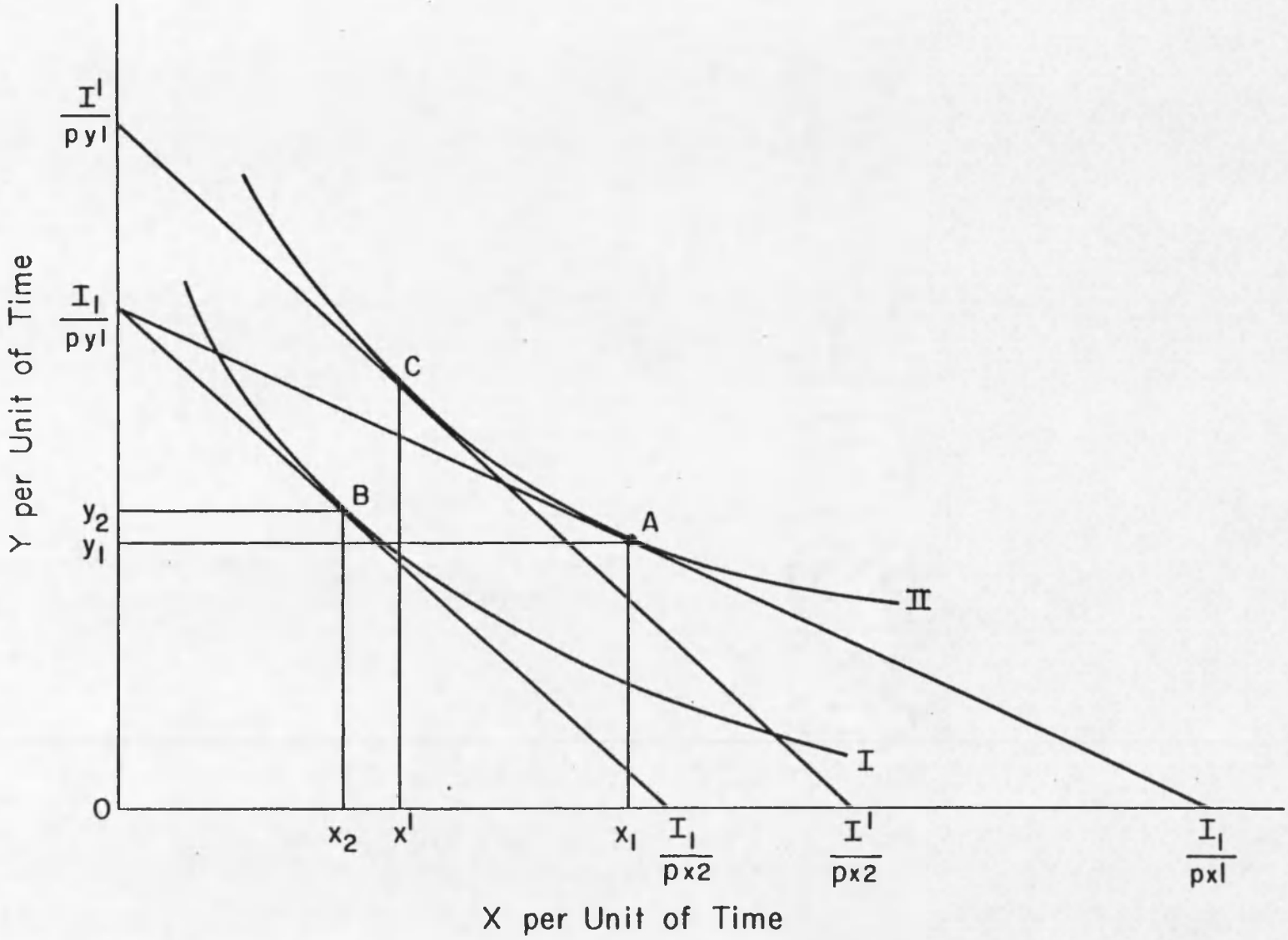

Figure 6. Income and Substitution Effects.

point B, containing x_2 of X and y_2 of Y, maximizes consumer satisfaction. Thus, the consumer's real income has been decreased by an increase in the price of X. This decrease is represented by the fact that the combination of goods, point B, is on a lower difference curve.

In order to isolate the substitution effect and determine its magnitude, the consumer's income is increased enough to compensate him for his loss in purchasing power. The additional purchasing power of the compensating increase in income will move the line of attainable combinations to the right, parallel to itself and tangent to the original indifference curve at point C. Point C yields the same satisfaction to the consumer as did point A, even though less of commodity X is consumed on this new income line since it has a now relatively higher price. The income effect of the increase in the price of X has been eliminated by the compensating variation in the consumer's income; hence, the movement from A to C, or the decrease in X taken from x_1 to x', is the substitution effect.

The income effect can be determined by taking the compensating variation in income away from the consumer. The line of attainable combinations shifts to the left, and the highest indifference curve to which it is tangent is indifference curve I. Combination B is the point of maximum satisfaction. The movement from C to B is the income effect and reduces the quantity of X taken from x' to x_2. The relative value of the substitution effect is usually much larger than the value of the income effect. A consumer who purchases a great many goods will not ordinarily experience a large drop in real income when the price of one

of the goods rises. Thus, the compensating variation in the case of a small price change of one commodity is usually insignificant.

However, if the income effect is significant, a substitution effects demand curve, or compensated (Hicksian) demand curve, is necessary to protray the consumer surplus value in willingness-to-pay terms. The substitution effects demand curve is where all income effects are compensated and a change in price does not alter the consumer's level of satisfaction. The pure substitution demand curve lies to the right of the uncompensated (or Marshallian) demand curve for a price increase for a good with positive income elasticity. For a price decrease and a positive income elasticity, the compensated demand curve will lie to the left of the Marshallian demand curve. The opposite will occur if the income elasticity is negative. The smaller the income effect the less difference there will be between the compensated and uncompensated demand curves.

Martin et al. (1974) included income of the recreators interviewed as a variable in their demand equation. The term was found to be insignificant; therefore, no income effect is presumed. This situation occurs because recreation expenses normally are only a small portion of the consumer's income. Cesario (1976) discusses this point, stating that, since it may be assumed that the total amount of money spent on the kinds of consumption being talked about here (outdoor recreation expenditures) probably represents only a small portion of the total expenditures of any individual consumer or household, income effects can probably be safely ignored.

This same line of reasoning applied to the demand for retail beef implies little bias in the analysis presented. The coefficient of the income variable used in the demand equation for beef was 0.29 for the George and King (1971) estimate (Pf = -1.55) and 0.78 for the author's estimate (Pf = -1.71). Whereas both of the income elasticities are significant, George and King (1971) note that expenditures for beef represent only 2.6 percent of a household's total expenditures.

If there is little bias from income effects, then the consumer's willingness to pay is adequately portrayed for both products. If it can be further assumed that changes in the price of beef will not substantilly alter prices elsewhere, the benefit values generated in this study are the total values to the consumer of land resources in their use for a given year.

Factors Influencing Price Flexibility Coefficients

The estimate of price flexibility of demand for beef was used to determine what the price response for retail beef would be to a given change in the Arizona beef calf crop. The magnitude of the price flexibility coefficient, thus, affects how total expenditures change in response to a quantity decrease. A price flexibility coefficient greater than one in absolute value (termed price flexible) describes a one percent change in quantity, effecting a greater than one percent change in price, analogous to inelastic price elasticity of demand. For a price inflexible coefficient, the absolute value is less than one and a one percent change in quantity leads to a less than one percent change in price, analogous to an elastic price elasticity of demand.

The major factors influencing the size of the price flexibility estimate are: 1) the availability of good substitutes for the commodity, 2) the number of uses to which the commodity can be put, 3) the price of the commodity relative to consumer's income, 4) whether the price established is toward the upper end of the demand curve or toward the lower end of the curve (Leftwich, 1966). The first point is usually considered the most important.

For a good such as beef where few other substitutes are available, considering the American consumer's preference for beef over other meats, the price flexibility coefficient tends to be price flexible. In other words, the consumer would be willing to pay most any price to maintain the same quantity demanded. A change in consumer tastes and preferences toward beef would be reflected by a changed price flexibility coefficient. For example, if many substitutes for beef were acceptable to consumers, the price flexibility coefficient would be more price inflexible, describing a flatter portion of the demand curve. The inflexible price flexibility coefficient would change price less than one percent from a given one percent change in quantity; thus, the change in consumer surplus would be relatively small.

The price of beef and total expenditure of a household for beef are small relative to the household income, but a sizeable increase in the price of beef would make it economically less useful and curtail quantity consumed. With less quantity consumed, the price would rise and the intersection of price and quantity would be established more toward the upper end of the demand curve in a more price inflexible region. The

effect of the more inflexible price flexibility coefficient would be then to decrease the change in consumer surplus generated by a given change in quantity.

Thus, policymakers contemplating changes in land usage, as in this case from cattle grazing lands to outdoor recreation lands in Arizona, should be concerned with the price flexibility estimates. If the price flexibility is very flexible ($Pf > |1|$) and the relative share of Arizona beef is increasing, the loss of consumer surplus benefits will be very high. On the other hand, if the Arizona share of beef is decreasing, the impact on the consumer surplus will be smaller and alternative land uses could be implemented.

Conclusion

This study describes a means to generate comparable values of a land resource used in two independent production activities. The activities are assumed independent since the product-product relationship or transformation function for the attainable products from the resource remain unsolved. The method, therefore, does not prescribe the optimum combination of products to produce, but rather describes the values of the activities in an "as is" situation to the consumers of the activities.

The empirical estimates are comparisons of values for beef cattle production and outdoor recreation activities. The results show relatively high values for outdoor recreation activities close to heavy population centers where the demand is great. The cattle values are greatest in regions of extensive cattle production. For example, the per square mile consumer surplus values in Region 5 (see Table 10), which contains

Phoenix, are $815-966 for cattle production compared to recreation values of $1,115 for all hunting activities and $5,482 for all outdoor recreation activities. The per square mile values for Region 7, the southeastern area of Arizona where the productivity of the rangeland for cattle production is high and the nearby population density is low, are $1,214-1,812 for cattle production compared to $346 for all hunting and $797 for all recreation activities.

When producer surplus values for beef production are added to the consumer surplus values, the lands appear even more valuable for cattle production relative to outdoor recreation (see Table 11). However, from a distributional point of view, producer surplus values only accrue to a limited number of people, and possibly should not be given equal weight.

The values of land use in the production of two products have been estimated. However, the land base produces other products, such as timber and water. Thus, before extensive change of land use is considered, all comparative product values should be explored. This study provides a reasonable framework to do so.

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