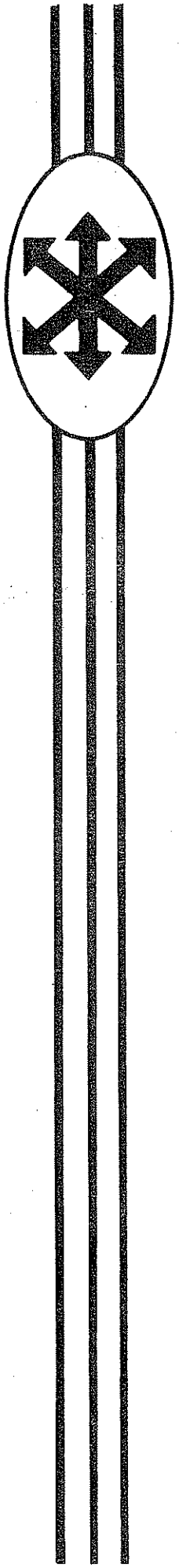

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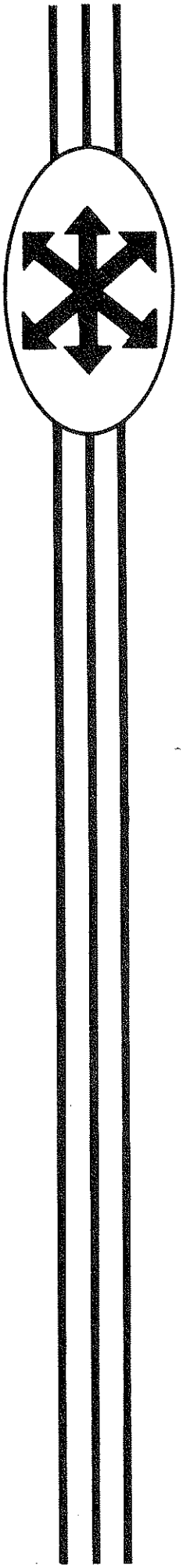

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Abstract

This paper develops a model of the U.S. sheep industry with monthly data for 1964-1980. Consumption of lamb has decreased rapidly since 1970. Findings suggest that consumers are highly sensitive to changes in lamb prices relative to prices for beef and pork.

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A Monthly Econometric Model of the U.S. Sheep Industry

The U.S. sheep industry has experienced a dramatic decline over the past two decades. Per capita consumption of lamb and mutton in the U.S. dropped from 4.70 pounds in 1962 to only 1.42 pounds by 1980. Federally inspected slaughter of lambs decreased from 13.76 million head to 4.97 million head during the same time period (USDA 1981). If a simple linear trend in production and consumption were to continue unabated, there would be no sheep industry in the U.S. by 1986.

This paper develops an econometric model of the U.S. sheep industry, with a particular emphasis on the changes in the industry that have taken place during the past two decades. The model is useful in explaining why the industry has declined rapidly since 1970. Compared with the beef and hog sectors, sheep and lambs have been largely overlooked by agricultural economists. This has probably been because the sector is small compared with beef and hogs. One of the few studies conducted by agricultural economists on the U.S. sheep industry dealt primarily with imports and was published in 1971 (Carman and Maetzold). This study used data only through 1967, before much of the sharp drop in per capita consumption took place. Imports of mutton and lamb meat from Australia and New Zealand were of concern to the domestic industry for a short period of time.

A study conducted by Freebairn in 1973 estimated supply and inventory functions for the sheep industry of New South Wales.

Functions were developed and estimated for lamb production, the supply of mutton, wool production, and inventory relationships for adult sheep and lamb mothers. The farm level price of lamb was hypothesized to be a function of average export price of lamb; average price of wool; consumer income; and quantities of beef, veal, lamb, and mutton.

Ward and Detten examined the changing demand for lamb and wool. They speculated that if there exists a single downward sloping demand for lamb, beef consumption must have increased relative to lamb. A second possibility is that several demand curves exist. This indicates that something other than relative prices has shifted the preference structure for lamb and beef.

Assumptions which have been made by Hayenga and Hackleender; Langmeier and Thompson; Meyers and Havlicek; Davis; Henson and others in modeling the beef, poultry, or hog industries are not necessarily the same for the sheep industry. First, it is hypothesized that since per capita consumption of sheep and lamb is very low relative to other meats, retail prices need not be considered simultaneously determined with retail prices for beef, pork or chicken. Although changes in other retail meat prices may influence lamb prices, the converse is probably not true. Lamb prices could double or halve without a significant impact on prices or consumption of other meats.

A similar situation is hypothesized to exist on the production side. A major problem with beef, pork and poultry sectors is that feed grain prices must be considered simultaneously. The total amount of grain consumed by the sheep

sector is not a significant amount of total feed grain production and hence production and grain prices are not assumed to be simultaneous.

Another characteristic of the sheep industry is the seasonality of production and consumption. Unlike other farm animals, most breeds of sheep will not breed during the warm summer months, and nighttime temperatures need to drop below 55 degrees for significant numbers of lambs to be conceived. As a result, the breeding season for sheep is usually the fall and early winter months. Although in the southeast lambs may occasionally be born in late December or early January, early February is more common. These lambs may be grass and grain fed and marketed at 70-90 pound weights in April and May, particularly for the "spring lamb" trade in the northeast. In the northern plains, severe winters often delay the breeding season and lambing is common from mid March to late April. This allows lambs to take full advantage of the short pasture season common to range areas. These lambs are normally fed and marketed at slightly heavier weights throughout the late summer and fall. These lambs enter the "fall lamb" trade with consumption centered around the winter holiday season.

The Model

Owing to biology, production is subject to wide month-to-month swings and consumption is centered around holidays occurring in certain months. Thus, a model of the sheep industry should account for these fluctuations. Hence, the econometric model of the industry is formulated on monthly, rather than

quarterly or annual data. The model consists of six equations, representing (1) the retail price for lamb by consumers, (2) the farm price for live lambs, (3) per capita consumption (demand) for lamb, (4) the farm price of wool, (5) federally inspected slaughter of lambs, and (6) total production of sheep and lambs.

Retail Lamb Prices

Substitution between alternative meats by consumers is undoubtedly highly dependent on relative prices, as evidenced by prior research. George and King estimated cross price elasticities between beef and lamb at .59, between pork and lamb at .80 and between chicken and lamb at .23. Moreover, real disposable income would also be expected to be an important price determinant.

The model specification for the retail lamb price equation includes nominal prices of substitute meats as well as real disposable income. Consumers are assumed to make purchase decisions not based on real prices, but rather based on nominal relative prices for the various meats. Thus, the equation is:

$$MRLMB = f(MDI72, MRHOG, MRCOW, MRBRL) \quad (1)$$

where:

MRLMB = the retail price of lamb in cents per pound
MDI72 = total real disposable income (1972=100)
MRHOG = the retail price of pork in cents per pound
MRCOW = the retail price of beef in cents per pound
MRBRL = the retail price of broilers in cents per pound

Per Capita Consumption

Production and consumption of lamb peaked in the early 1960s, but dropped rapidly during the 1970s. During the past few years, production and consumption seem to have stabilized somewhat, but at a very low level. Reasons for the sharp decline in consumption during the 1970s are not entirely clear. Over the decade price increases for lamb were actually greater than for beef and pork and may have had an impact on lamb consumption. Choice lamb, in January 1970, was retailing for 104.8 cents per pound, but by December 1980, the retail price was 252.7 cents per pound, an increase of some 141 percent. Comparable figures for beef are 100.2 and 237.6, a 137 percent increase. For pork, the figures are 81.4 and 139.5, a 71 percent increase. The consumer price index (CPI) for the same time period increased 128 percent. Clearly, the relationship between pork and lamb prices changed markedly over the decade, and lamb prices increased more rapidly than the CPI. This would be of particular importance if, in the absence of religious restrictions, pork is viewed by consumers as the substitute for lamb, as George and King's elasticity estimates suggest. The beef/pork price ratio has also shifted, and beef has also recently experienced sizeable reductions in per capita consumption.

Speculation with respect to other reasons as to why lamb consumption has declined centers around changes in tastes and preferences. Lamb consumption is no doubt highest in sections of the country dominated by ethnic groups from southeastern Europe and the middle east, in which lamb traditionally was a large part of the diet and there may be religious restrictions against the

eating of pork. As generations pass and these ethnic groups are dispersed and intermarry into the general population, consumption may decline further. Threshold demand levels may also exist below which retailers do not justify space in the meat counter. The drop in lamb consumption starting in the late '60s coincided with a period marked by increased lamb imports from Australia and New Zealand. Frozen, imported lamb at that time sold at the grocery store for perhaps 25 cents less per pound than domestically produced lamb. But this lamb often had a more pungent (stronger) flavor than the domestically produced lamb. If a consumer's first introduction to the meat during this period was through the purchase of low-cost, imported lamb, the stereotype is reinforced that lamb is a meat with a peculiar flavor that would not be suitable as a part of the regular diet of the average consumer.

In addition, lamb has suffered from some of the same problems as turkeys in that families without ethnic origins in southeastern Europe and the middle east may seldom serve lamb or serve it only on holidays, family gatherings and other special occasions if at all. This keeps total consumption down relative to beef, pork and chicken.

Recent emphasis in this country on improved health and diet, along with reduced consumption of animal fats, may have also contributed to the decline in lamb consumption. Grocery stores often report a general lack of consumer interest in cheaper cuts other than the loin chops and legs that would be served on special occasions. Hence, little, if any, display case space is

often allocated to these cuts.

The drop in per capita consumption may thus be due in large measure to changes in the tastes and preferences of consumers for lamb, as noted by Ward and Detten. A per capita consumption function is estimated that includes the prices of substitute meats. The decline in per capita consumption postulated to be due largely to non-measurable changes in tastes and preferences has not been linear (Figure 1). Hence, the per capita consumption function is estimated to be polynomial with respect to the time variable.

The function is:

$$MDLMBR = f(MRLMB^*, MRHOG, MRBRL, MRCOW, D2, \ldots, D12, T, T2, T3) \quad (2)$$

where:

MDLMBR = monthly per capita consumption of lamb
MRLMB* = predicted price of lamb from Equation (1)
MRHOG,MRBRL,MRCOW are as previously defined
D2,...,D12 = monthly dummies with January omitted
T,T2,T3 = time, time squared and time cubed

Even though tastes and preferences cannot be introduced as an explicit variable in the model, the parameters of the time variables should provide an indication of the nature of the overall trends in per capita consumption.

The Farm Price of Lambs

Average prices for lambs received by farmers are assumed to be a function of the index of feed grain prices lagged two months (when feeding might normally begin), cold storage holdings, and the monthly dummies. Feed grain use in lamb production no doubt varies greatly from farm to farm and from one region of the

country to another. Most of the lambs produced for the spring lamb trade are probably fed concentrate to assure that the lambs are finished for market at the earliest possible date and bring the highest prices. Farm prices for lambs are also assumed to be related to total cold storage holdings in the prior month. If cold storage holdings are low in the prior month, supplies are depleted, and higher current prices may prevail; and conversely, large prior month holdings may be associated with low lamb prices. A series of dummy variables takes into account the month-to-month fluctuations in lamb prices due to production and consumption cycles.

The equation is:

$$MPLMB = f(LMPF2, LMHL, D2, \ldots, D12). \qquad (3)$$

where:

MPLMB = the farm price of lambs
LMPF2 = the feed price index lagged two periods
LMHL = cold storage holdings of lamb lagged one period
D2,...,D12 = monthly dummies with January omitted

Wool Prices

Over the years domestic sheep producers have been faced with increased competition from foreign wool producers for a number of reasons. Mills have tended to favor foreign over domestically produced wool. First, much of the domestically produced wool comes from sheep bred primarily for their ability to produce a speedy rate of gain in the lamb, not for fleece quality. While this wool usually is comparatively fine (which is considered desirable for many uses), staple length is often much shorter and the quality is lower than that from sheep where the emphasis is on fleece quality. Over time, the sale of wool has become a

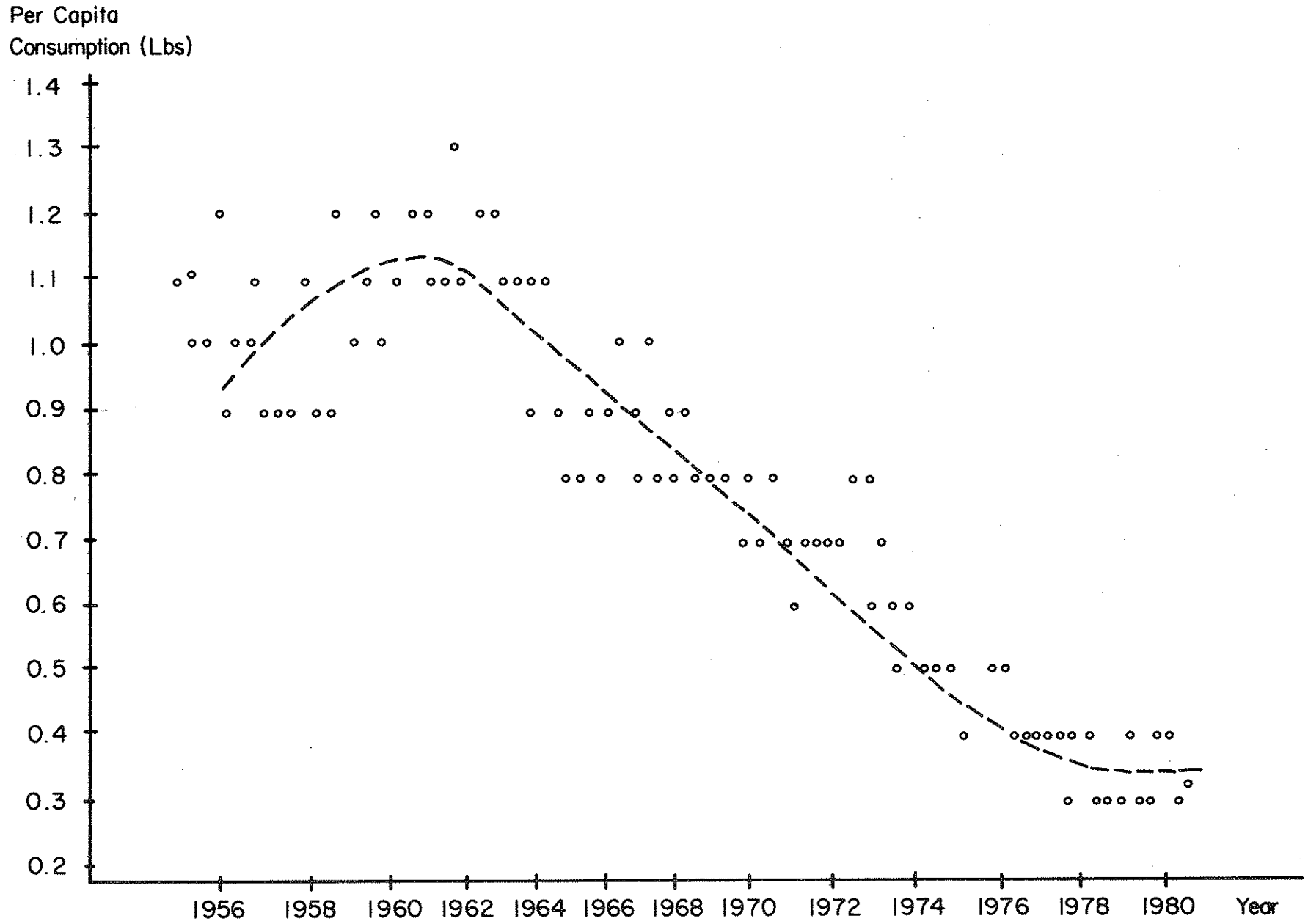
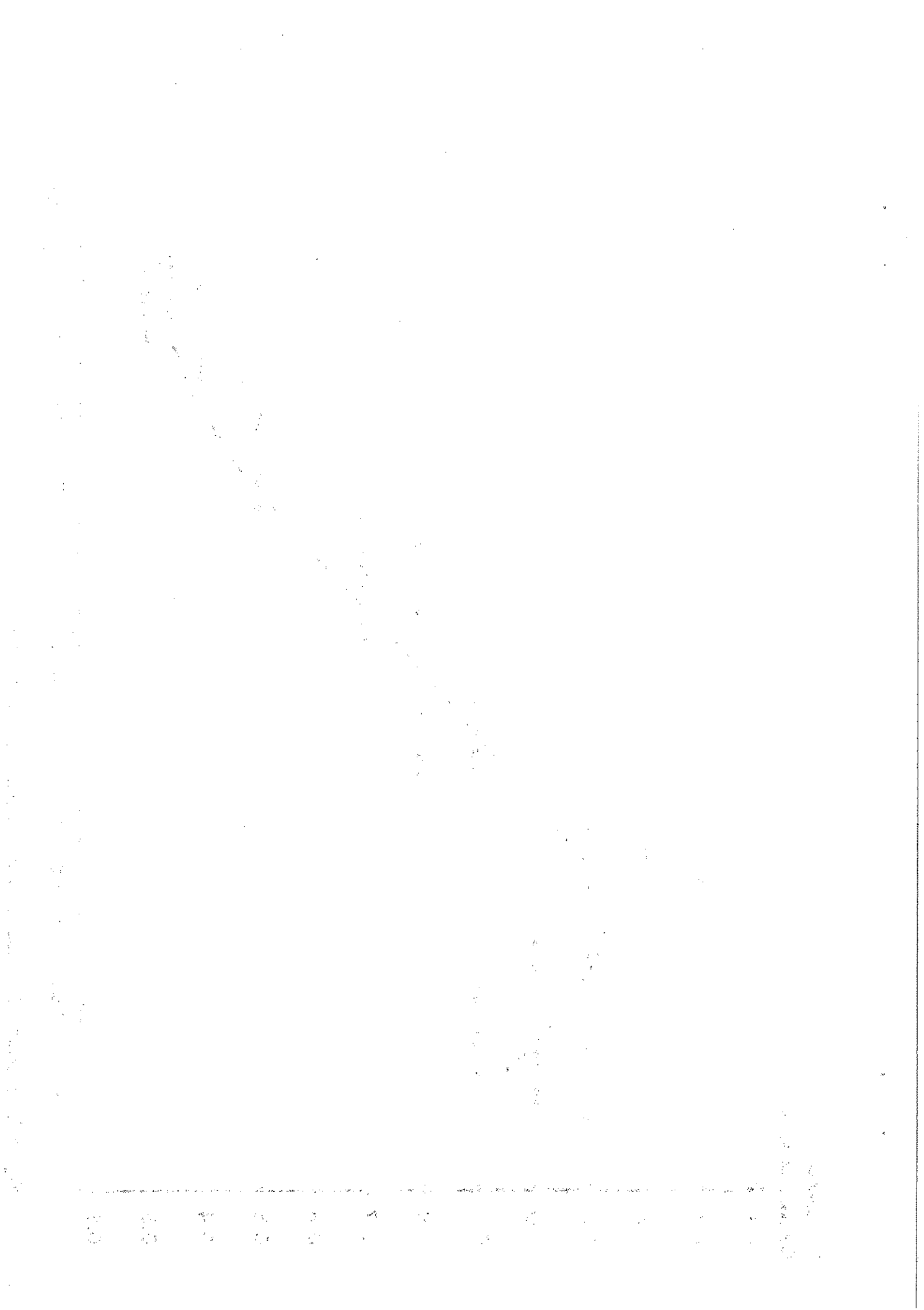


Figure 1. Quarterly Per Capita Lamb Consumption, 1955-1980.



declining share of total revenue from sheep production.

Moreover, domestic fleeces are sometimes thought to be of inferior quality for other reasons. Wool contaminated with black hairs from the face or legs of a Suffolk or Hampshire is obviously a problem. If grain is fed to sheep, some it it may be retained in the wool with the potential for lower fleece quality. Fibers other than wool in the fleece create real problems. A fleece can be ruined by tying with other than paper twine. The most recent problem concerns plastic baling twine. If these twine are not properly disposed of, plastic fibers will again appear in the fleece. These fibers present particular problems as they do not dye. Entire lots of cloth have been rendered unusable because of one or two contaminated fleece. The typical U.S. farm conditions for raising sheep probably do not lend themselves to the uniform production of top quality wool as readily is the case in certain foreign countries. As a result of this lack of uniform quality, some mills reject domestic wool entirely. Others are willing to purchase domestic wool but only at a discount, to take into account any variation in staple length and the potential for contaminants that would render the wool unsuitable for cloth.

The popularity of double knit and other polyester clothing in the late '60s and early '70s was at that time thought to signal a permanent decline in the use of wool fiber. But in recent years there has been a return to clothing made from wool. The wool-polyester blends were found to combine the feel and appearance of wool with the non-wrinkling, easy-care qualities of

polyester. Cotton has experienced a similar decline and resurgence in popularity.

The model specification for the domestic wool price is:

$$MPWOOL = f(MPPIFOW, MPCOT, MPPOLY) \quad (4)$$

where:

MPWOOL = the farm price of domestic wool (cents/lb)
MPPIFOW = the producer price index for foreign wool (1967=100)
MPCOT = farm price for cotton (cents/lb.)
MPPOLY = producer price for polyester (cents/lb)

Federally Inspected Lamb Slaughter

Owing to the need for adequate supplies of fresh lamb for holidays and other special occasions, as well as the spring-fall seasonality of lamb production, slaughter of lambs varies markedly from month to month. A series of dummy variables was used to take into account this month-to-month variation. Slaughter levels are assumed to be linked to both the farm price of lambs and the price of lambs at the retail level. Arguments can be made for either a positive or a negative sign on the farm price variable. Farmers might ship lambs to market in the face of high current prices. Alternately, high current prices may be a signal to hold ewe lambs for breeding, thus reducing slaughter. Similar arguments can be made with respect to retail prices. High retail prices should be a signal to packers for additional slaughter. However, high retail prices also indicate shortages of lamb at the retail level, which suggests that current slaughter levels might be low. The producer price index for meats provides

an indicator of slaughter costs.

The equation is:

$$MSLLMFI = f(MRLMB^*, MPLMB^*, MPPIMTS, D2, \ldots, D12) \quad (5)$$

where:

MSLLMFI = federally inspected lamb slaughter
MRLMB* = predicted retail lamb prices from equation (1)
MPLMB* = predicted farm price for lamb from equation (3)
MPPIMTS = the monthly producer price index for meats
D2,...,D12 = monthly dummies with January omitted

Total Production of Sheep and Lambs

Total production of sheep and lambs is assumed to be linked to prices in the prior year, as well as to feed prices lagged two months, at the start of the feeding period. A time trend variable captures the loss of forage and pasture land and a move by farmers away from labor intensive enterprises. Monthly dummies represent the seasonality of production.

The model specification for total production was:

$$MQSLMSH = f(LMPF2, LSSP, T, D2, \ldots, D12) \quad (6)$$

where:

MQSLMSH = commercial production of lambs and sheep in millions of pounds
LMPF2 = the feed price index lagged two months
LSSP = farm price for lambs lagged one year
T = a linear time trend
D2,...,D12 = monthly dummies with January omitted

Econometric and Data Considerations

All data used for estimation were standard sources, as compiled by the USDA. The complete model was estimated with

monthly data for the years 1964-1980. With the exception of the retail lamb price in the equation depicting per capita consumption, and farm and retail price data in the slaughter equation, all variables appearing on the right hand side of each equation were treated as exogenous. The retail lamb price used in the per capita consumption equation was the predicted value from the retail price equation. Farm and retail prices in the slaughter equation were predicted values from the farm and retail price equations.

The model was first estimated via OLS (two stage least squares in the case of equations 2 and 5). A final GLS-3SLS pass was then used to derive the reported coefficient estimates. Such an approach also takes into account linkages among equations not explicit to the specification.

Empirical Results

Asymptotic t ratios for GLS-3SLS estimates considered important in verifying the arguments laid out in this paper were usually found to be greater than two. The GLS-3SLS results are reported here, and asymptotic t ratios are shown in parentheses.

Retail Lamb Prices

The estimated equation was:

$$\underset{\quad}{\text{MRLMB}} = \underset{(-11.06)}{-84.15} + \underset{(10.20)}{.46\text{MDI72}} + \underset{(7.21)}{.47\text{MRHOG}} + \underset{(12.04)}{.48\text{MRCOW}} - \underset{(-1.01)}{.17\text{MRBRL}}$$

Retail lamb prices move in the same direction as disposable income, beef and pork prices but opposite to retail broiler prices. The broiler price coefficient was approximately the same size as its standard error, suggesting that consumption of

chicken and lamb are not related. The magnitude and significance of coefficients in this equation suggest that beef, not pork, is the best substitute for lamb at the retail level. This would be consistent with religious restrictions with respect to pork consumption for much of the population that consumes signficant amounts of lamb, but varies with George and King's assertion that pork is substituted for lamb more frequently than beef.

Per Capita Consumption

The estimated equation for per capita lamb consumption was:

$$\begin{aligned} MDLMBR = {} & -19.57 \underset{(2.56)}{} - .0035MRLMB^{*} \underset{(-0.98)}{} + .0021MRHOG \underset{(0.97)}{} + .0026MRCOW \underset{(0.91)}{} \\ & - .0043MRBRL \underset{(-1.74)}{} + .089T \underset{(2.72)}{} - .00013T2 \underset{(-2.81)}{} + .000000062T3 \underset{(2.88)}{} \\ & - .06D2 \underset{(-3.84)}{} + .003D3 \underset{(0.23)}{} - .001D4 \underset{(-0.09)}{} - .025D5 \underset{(-1.78)}{} - .021D6 \underset{(-1.47)}{} - .020D7 \underset{(-1.35)}{} \\ & - .029D8 \underset{(-2.04)}{} + .003D9 \underset{(0.21)}{} - .019D10 \underset{(-1.29)}{} - .064D11 \underset{(-4.44)}{} - 0.055D12 \underset{(-3.82)}{} \end{aligned}$$

All three of the coefficients on the polynomial trend variables had asymptotic t ratios of greater than two. Both the signs and signficance of these coefficients would suggest that in recent months, per capita consumption of lamb has stabilized, albeit at a very low level.

Given that retail price data for lamb, beef, pork and chicken all have strong trend components, it is not surprising that the standard errors for these variables were large. However, estimated coefficients for each of these variables provide an indication of own and cross price elasticities for each meat.

Coefficients on dummy variables support the argument that lamb consumption is highest during the spring, particularly March and April, but a similar pattern was not found for the November

and December holiday season when ham and turkey are popular.

Table 1 provides estimated own and cross price elasticities of demand based on coefficient estimates taken from the equation. Since the estimated demand function is linear, and per capita consumption is declining, elasticities are calculated at the sample mean as well as for selected years. With per capita consumption as low as it is, only a small drop (or increase) is needed to result in a large change in percentage terms. This is reflected in the rather large own price elasticities which for December of 1980 was estimated at -8.953. The own price elasticity calculated at the sample mean was -2.137.

Table 1. Elasticities of Demand for Lamb at the Retail Level, Selected Years, and at Sample Mean.

Price	Year			
	1964-Jan.	1972-Dec.	1980-Dec.	At Sample Mean
Own Price	-.507	-2.164	-8.953	-2.137
Beef	+.418	+1.593	+6.461	+1.518
Pork	+.224	+.906	+3.168	+.879
Broilers	-.323	-.886	-3.290	-.952

These values are surprisingly large, and hint that consumer resistance to high lamb prices may have been an important reason why consumption of lamb dropped off so rapidly during the '70s. This is of particular importance in light of the fact that lamb prices increased at a faster pace than beef, pork or chicken.

Both the beef and lamb industries have experienced sharp declines in per capita consumption, and large increases in price. Since production has decreased in both industries, the causal relationships are difficult to isolate.

The cross price elasticities between beef and lamb were found to be positive and rather large. Current per capita consumption levels represent only two or three meals of lamb per year. If lamb prices rise relative to beef, more consumers are likely to choose the beef. A reduction in consumption of lamb of even an average of one meal per family per year represents a major loss of revenue to the industry. Conversely, if the industry could convince families to eat one more meal of lamb a year, sizeable growth in the industry would be possible. These findings suggest that the relative prices between lamb and beef are critical for industry growth.

Not surprisingly, the cross price elasticity between lamb and pork was found to be somewhat less than between lamb and beef. Many consumers no doubt perceive a pork chop as a close substitute for a lamb chop. But Jewish and Moslem religious restrictions against the eating of pork would tend to reduce the cross elasticity.

The cross price elasticity between chicken and lamb was negative not positive. This suggests that lamb and chicken are not perceived by consumers to be substitutes at all. Red meats appear to be the substitutes for other red meats.

Farm Price of Lambs

$$\underset{}{MPLMB} = \underset{(1.41)}{5.73} + \underset{(20.22)}{.27LMPF2} \; \underset{(-2.26)}{-.36LMHL}$$

-1.12D2 -1.44D3 -1.63D4 -0.05D5
(-0.43) (-0.55) (-0.63) (-0.02)

-0.69D6 -2.00D7 -2.25D38 -2.77D9
(-0.27) (-0.77) (-0.86) (-1.07)

-3.72D10 -3.32D11 -2.13D12
(-1.43) (-1.28) (-0.82)

Estimated coefficients were largely as anticipated. The feed grain price index lagged 2 months had a surprisingly strong positive impact on farm prices for lambs, particularly considering that a large share of the lamb crop is not fed a great deal of grain. Perhaps the feed grain price index provides an overall indicator of the cost of producing lambs.

The lagged cold storage holdings variable (LMHL) behaved as anticipated. Cold storage holdings represent the amount of lamb that could potentially be placed on the retail market. As these holdings decline, buyers would bid up the farm price for lambs to replace inventory holdings.

Price of Wool

The estimated equation was:

MPWOOL = -5.23 + .33MPPIFOW - .25MPCOT +.29MPPOLY
(-3.22) (29.58) (-5.58) (12.92)

The domestic farm price of wool and the foreign wool price index (MPPIFOW) move strongly together. This suggests that domestic prices for wool at the farm level are really determined in world markets, and if foreign wool prices are high, domestic wool prices will also be high.

The price of wool (MPWOOL) and the price of polyester (MPPOLY) also move together. This may reflect the complementary

nature of wool and polyester in the blended fabrics. The relationship between cotton and wool prices was found to be negative. This again may reflect the fact that cotton and wool are seldom used as a blend. For a few uses, cotton fabric may perhaps be perceived by consumers as a substitute for wool.

Federally Inspected Slaughter of Lambs

The estimated equation for federally inspected slaughter of lambs is:

$$\begin{aligned} MSLLMFI = {} & 1.06 - .0546MRLMB^{*} - .00419MPLMB^{*} \\ & (48.23) \quad (-12.15) \quad (-6.17) \\ & +.00365MPPIMTS - .117D2 - .0033D3 - .053D4 \\ & (7.51) \quad (-5.28) \quad (-1.48) \quad (-2.43) \\ & -.087D5 - .095D6 - .085D7 - 0.68D8 \\ & (-3.90) \quad (-4.33) \quad (-3.85) \quad (-3.08) \\ & -.012D9 - .0006D10 - .097D11 - .088D12 \\ & (-0.58) \quad (-0.03) \quad (-4.38) \quad (-3.99) \end{aligned}$$

The coefficient on both the retail and farm price had a negative sign. This supports the argument that the response by sheep breeders to high current lamb prices is to withhold ewe lambs from the market, thus reducing current slaughter. The negative sign on retail prices sugests that high retail prices are associated with short supplies at the slaughter house. The coefficient on the producer price index on meats (MPPIMTS), a proxy for the cost of slaughter, was found to be positive, not negative, and quite significant. This may suggest that packers increase margins when volume goes down, and that current slaughter costs have little, if any, short run impact on the number of animals that are slaughtered.

Total Production of Sheep and Lambs

The estimated equation for the total production of sheep and

lambs was:

$$\begin{aligned} MQSLMSH = {} & 155.42 - .0678LMPF2 + .124LSSP \\ & (31.44) \quad (-6.91) \qquad (4.53) \\ & -.15T - 5.85D2 - .10D3 - 1.74D4 \\ & (-17.56) \quad (-5.23) \quad (-0.08) \quad (-1.55) \\ & -4.12D5 - 5.14D6 - 4.62D7 - 3.21D8 \\ & (-3.68) \quad (-4.60) \quad (-4.13) \quad (-2.87) \\ & +.013D9 + 2.06D10 - 4.21D11 - 3.54D12 \\ & (0.013) \quad (1.83) \quad (-3.76) \quad (-3.16) \end{aligned}$$

Production was found to be negatively related to feed prices lagged two months (LMPF2). The sign on farm prices for lambs lagged one year (LSSP) was positive as expected. The time trend variable was strongly negative. The dummies capture the cyclical production, with production highest during April and October, and lowest during June and July.

The Future of the Industry

Results from this study suggest that the retail demand elasticity for lamb is quite elastic when calculated at the sample mean. This is a substantial change from the estimates made by George and King more than a decade ago. Hence, efforts by the industry to promote the sale of lamb at the retail level by sheep producer organizations, if successful, could substantially increase revenue to the industry. American families would need to increase lamb consumption by only one or two meals a year to greatly aid the industry.

Future levels of lamb consumption in the U.S. would appear to be heavily dependent on lamb prices relative to prices for other

meats, particularly beef. If lamb prices do not increase relative to beef prices for comparable cuts, a potential exists for a stabilization or perhaps even growth in per capita consumption.

The substantial changes in production and consumption levels of lamb have not been fully explained. Production was declining while lamb prices increased faster than the CPI or competing meats. Obviously, rising retail prices do not guarantee increased profitability for the producer, and the profitability of the sheep enterprise must be measured relative to other enterprises. But it is not likely that sheep producer's profits were declining during this period. The future of the industry appears to hinge on keeping sheep production in sufficient volume so that retail lamb prices do not exceed, or perhaps are slightly less than, retail prices for comparable cuts of beef.

References

Carman, Hoy F., and James A. Maetzold. "The Regional Impact of Lamb Imports on Equilibrium Returns to Domestic Producers, 1967." Am. J. Agr. Econ. 53 (1971): 92-100.

Davis, Joe T. "An Econometric Analysis of the Quarterly Demand and Supply Relationships for Feeder Cattle in the United States." Unpublished Ph.D. Dissertation. University of Tennessee, 1974.

Freebairn, J.W. "Some Estimates of Supply and Inventory Response Functions for the Cattle and Sheep Sectors of New South Wales." Review of Marketing and Agricultural Economics 41 (1973):43-90.

George, P.S. and G.A. King. "Consumer Demand for Food Commodities in the United States with Projections for 1980." Univ. of California Division of Agricultural Sciences. Giannini Foundation Monograph Number 26. March 1971.

Hayenga, M.L. and D. Hackleender. "Monthly Supply-Demand Relationship for Fed Cattle and Hogs." Am. J. of Agr. Econ. 52 (1970):535-544.

Henson, William L. Short Run Supply and Demand Relationship in the Broiler Industry. Pennsylvania State University A.E. & R. S. Report 160, April 1982.

Langmeier, L. and R.G. Thompson. "Demand, Supply and Price Relationships for the Beef Sector, Post-World War II Period." Am. J. Agr. Econ., 49 (1967): 169-183.

Meyers, L.H. and J. Havlicek. "Some Theoretical Aspects of Short-Term Hog Supply." Am. J. Agr. Econ., 60(1978): 117-125.

USDA, Livestock and Meat Statistics, (Supplements for 1980 thru 1973) Economic Research Service, Statistical Bulletin No. 522, Washington, D.C.

USDA, Livestock and Meat Statistics, (Supplements for 1964 through 1972), E.R.S. Statistical Bulletin No. 333, Washington, D.C.

Ward, Clement E. and Mark T. Detten. "The Changing Demand for Lamb and Wool." Staff Paper 8202, Oklahoma State University Dept. of Agricultural Economics, January 1982.