A PRICE FORECASTING MODEL AND DECISION MAKING TOOL TO ASSIST IN MARKETING SLAUGHTER LAMBS

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SLAUGHTER LAMBS

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CHAPTER I

THE RESEARCH PROBLEM

Background

Sheep and lamb numbers in the United States declined every year from 1960 (over 30 million head) to 1979 (over 12 million head) (25). In addition, per capita consumption of lamb also declined, from 4.8 lbs. in 1960 to 1.5 lbs. in 1980 (27). Although sheep and wool production has not been a major farming enterprise in the United States, a renewed interest in sheep and lamb production was evidenced by an increase in sheep and lamb inventory each year from 1979 through 1981. In 1982, sheep and lamb inventory declined eight percent, to 11.9 million head nationally, in part because producer net returns deteriorated over the past several months (27).

Although sheep and lamb numbers decreased in 1982, Oklahoma was one of four states which increased total sheep and lamb numbers. With respect to the prices received by sheep and lamb producers in Oklahoma relative to national averages, Oklahoma producers were better off in 1981 than in 1980. In 1980, Oklahoma producers received $1.60 per cwt. less compared to the national average, while in 1981 Oklahoma producers received $1.40 per cwt. more than the national average of $54.90/cwt. (21, 22).

Oklahoma wool prices have been consistently below national average wool prices (21, 22). Although state wool prices were up in 1981 by 4 cents per pound (from 73 cents per pound), the national average was up 6.4 cents per pound (from 88.1 cents per pound). Both higher prices and increased production contributed to higher total wool value for the state in 1981.

Lamb Marketing in Oklahoma

Because the production of lamb in Oklahoma is small compared with other areas of the country, there are relatively few marketing alternatives for lambs. Alternatives include computer marketing, tele-auctions, public auctions, forward contract-pricing and private treaty (31, 32). Most of these markets (e.g. computer auctions, tele-actions and public auctions) conduct only one sale per week. Forward contracting and private treaty may occur anytime, but most producers make such decisions on a weekly basis. Hence, most lamb producers make marketing decisions on a weekly basis.

Problem Statement

Since 1979, prices for sheep and lambs have decreased while costs of production have increased. The index of prices paid by farmers in the United States for production items with farm origin (feed and feeder livestock) has increased from 114 to 145 (1977=100) (21, 22). Prices received for lambs declined from $66.70/cwt. to $54.90 /cwt. during the same period (27). This combination of higher costs and lower product prices has resulted in lower net returns for producers. It is clear that sheep producers must combine their skills as an

animal scientist, agronomist, and economist to receive as high a return as possible for their products. Increasing costs, decreasing per capita consumption, and lower prices mean that sheep producers must make better production and marketing decisions in their operations to survive and prosper.

One approach for producers is to increase their marketing skills. However, little research has been directed in this area. Since the production of sheep is low compared to beef, pork, and poultry, relatively little economic information is published about sheep and lamb marketing. Also, with the limited information available there are very few available tools to aid lamb producers make marketing decisions.

Sheep production has several seasonal influences which need to be evaluated to understand the marketing of lamb more thoroughly. Seasonal patterns which need to be studied include the price movements in both the wholesale and live markets, changes in total lamb production, weight discounts, and consumer demand. This seasonality in the sheep industry has its roots in both the supply of lambs and the demand for lamb.

On the demand side, there are seasonal patterns in the consumption of lamb. Consumption patterns are influenced by certain religious and ethnic groups and various holidays throughout the year. For example, as the Easter season approaches, the consumption of lamb increases. Conversely, during the Thanksgiving, Christmas and summer seasons, the demand for lamb gives way to beef, pork and poultry. Per capita lamb consumption is higher among certain religious and ethnic groups relative to other United States residents.

The seasonality on the supply side originates from the ewe herself (15). In their natural state, sheep are seasonal breeders with lambs coming at the time of the year most favorable for survival of the young. More specifically, ewe conception rates are highest in the fall (e.g. September and October), providing for winter lambing and lowest in the summer (e.g July and August), yielding lambs in the fall. Conception rates for summer lambing or spring breeding (e.g. December and January) are slightly below that for winter lambing.

The supply of lambs and demand for lambs arising from the seasonal characteristics of each, combine to form several problems. The flow of lamb into the marketing channels is inconsistent. Consequently, seasonal price patterns have developed. Seasonal price patterns are viewed by the producer to be significant enough to warrant altering marketing practices or strategies and holding lambs to heavier weights in the spring when lamb prices are at their peak. This creates an oversupply of "heavy" lambs and the extra weight is discounted by the wholesale and retail markets. The retail market can move only a certain number of heavier lamb carcasses and when there are too many, price declines. For example, "heavy lambs" are those which weigh in excess of 110 pounds when there is an oversupply of these carcasses on the market.

Another problem unique to the sheep industry, includes the lack of a tool to shift the risk of seasonal, as well as, unexpected price changes to someone who is willing to accept these risks (e.g. a speculator). Because there are no futures markets for lambs, producers must bear all of the price risk in the market. However, on the cost side of the profit equation there are avenues which provide

producers with the opportunity to hedge against price increases for the major feed ingredients such as corn, grain sorghum and wheat.

Finally, there is a need for a management tool or decision aid to evaluate expected price and cost changes. This marketing tool should consider such factors as weight discounts, pelt credits, ram discounts, old crop discounts and tail discounts and cost factors associated with grain and feed efficiency. This tool must be flexible enough to fit each producer's individual situation, be easy for the producer to understand and use, and, above all, the tool must be as accurate as possible.

Purpose of Study

The purpose of this study is to develop a marketing tool which can enhance lamb producer returns by enabling producers to market lambs at the most profitable time. Specifically, the objectives are:

1. To study the lamb pricing and price patterns.
2. To develop a price forecasting tool for slaughter lamb prices one week ahead.
3. To develop a tool which will integrate the expected costs and expected revenues to aid lamb producers make more profitable slaughter lamb marketing decisions.
4. To evaluate the marketing tool with respect to alternative marketing strategies.

Limitations

The model and forecasting tool are based on weekly data and analysis. This weekly interval was chosen for two reasons. First, as mentioned previously, there are relatively few market outlets large enough to handle more than one sale per week economically. Therefore,

most producers have only one option each week to sell slaughter lambs. Second, there are limitations set forth by existing data. For example, there are no reliable daily or bi-weekly lamb price and production data available in any USDA or private publications.

Procedure

In January of 1982 personal interviews were conducted with lamb buyers from two of the larger lamb slaughter plants in the southern part of the United States (14, 29). The major emphasis of these interviews was to learn about pricing procedures for both slaughter lambs and wholesale carcasses. Also, tours were conducted on the kill floor and in the freezers to help explain the reasons for discounts on older rams and weight classes.

To describe the seasonal implications of the lamb industry, several seasonal indices were calculated and studied. These indices included wholesale and live prices, total production, live dressed weights and carcass price discounts for "heavy" lambs. Most indices were computed for five and ten year periods.

Next, an econometric model was constructed to forecast live lamb prices and wholesale weight discounts. Weekly data from 1978 through 1981 were used to estimate the models. After the models were estimated, results were used to forecast 1982 prices and weight discounts.

A microcomputer software program was written to help lamb producers in their marketing decision making. Requirements were published data or data specific to producers' sheep and lamb enterprises. The tool was designed to be easily understood and applied while allowing for maximum flexibility.

The tool was applied to weekly data from 1978 through 1982 to study optimal marketing decisions under perfect information about expected prices, and with alternative assumptions about expected costs. Finally, the predicted prices in conjunction with the marketing tool were compared to alternative lamb marketing strategies for 1982 to see if the model significantly increased producer returns.

CHAPTER II

ECONOMIC THEORY AND LITERATURE REVIEW

Theory

The economic theory on which this study was based includes production theory and microeconomic theory of the firm. A marginal cost-marginal revenue approach to lamb marketing was used.

Gould and Ferguson (5) define marginal revenue as the change in total revenue attributable to a one-unit change in output. Marginal revenue (MR) is calculated by dividing the change (Δ) in total revenue (TR) by the change in output (Y). Thus, marginal revenue (MR) is

$$MR = \frac{\Delta TR}{\Delta Y}. \tag{2.1}$$

Marginal revenue may also be described as the difference between the total revenue received in the next period (t) and the total revenue received this period (t-1) or:

$$MR_t = \Delta TR_t = TR_t - TR_{t-1} \tag{2.2}$$

or

$$MR_t = \Delta TR_t = Y_t * P_{yt} - Y_{t-1} * P_{yt-1} \tag{2.3}$$

where P is the price of the product.

The shape of the marginal revenue curve is dependent upon the characteristics of the economic environment in which the firm operates. Two assumptions of the perfectly competitive model are homogeneity and many buyers and sellers in the marketplace. These

provide for all producers marketing the same product at the same price, in any given time period. Under perfect competition, the marginal revenue curve is horizontal and perfectly elastic with respect to price. This curve also represents the individual producer's demand and average revenue curves. This is illustrated in Figure 1.

Under monopolistic conditions, the marginal revenue curve acquires different characteristics. It slopes down and to the right as shown in Figure 2. There is only one buyer in this market and the product is differentiated from any other product in the marketplace.

The marginal revenue curve can be derived from the demand function. Assume the firm demand function is linear, as represented by

$$P = a - bY \tag{2.4}$$

where P, Y, a and b are the price, quantity, intercept and slope, respectively. Then,

$$TR = aY - bY^2 \tag{2.5}$$

and

$$MR = a - 2aY. \tag{2.6}$$

Figure 2 illustrates this relationship. Because of the linear nature of this demand function the slope of the marginal revenue curve is twice as steep as the demand curve and intersects the horizontal (x) axis exactly half way between the origin and the point where the demand curve intersects the x-axis.

Marginal cost (MC) may be derived much the same way. Marginal cost is defined as the addition to total cost (ΔTC) attributable to the addition of the one unit of output (ΔY). Mathematically this is

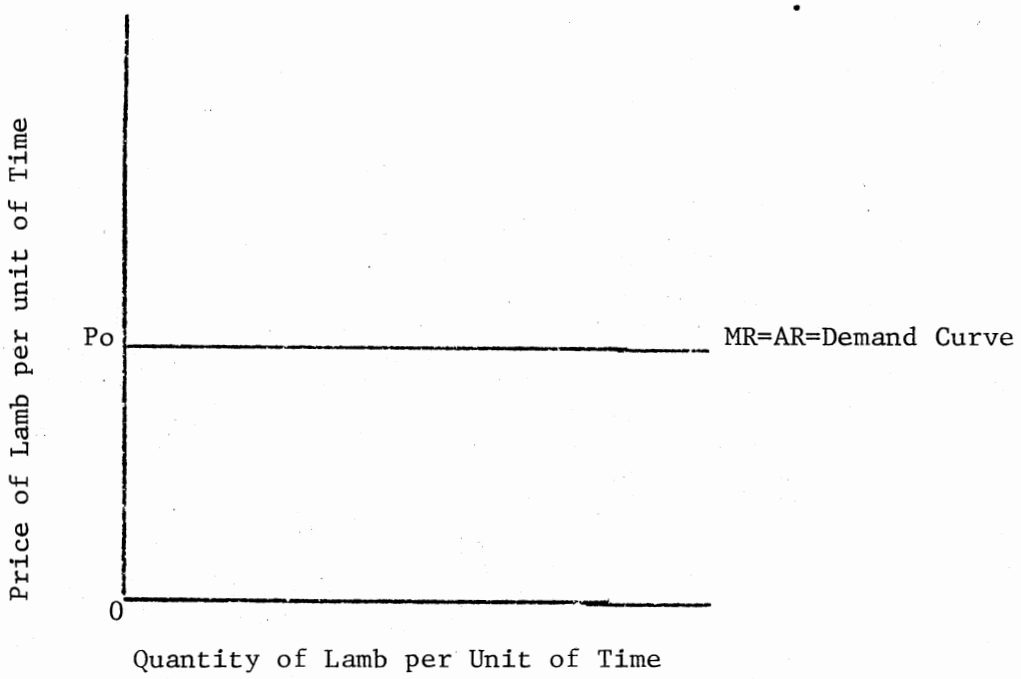

Figure 1. Marginal Revenue Under Pure Competition

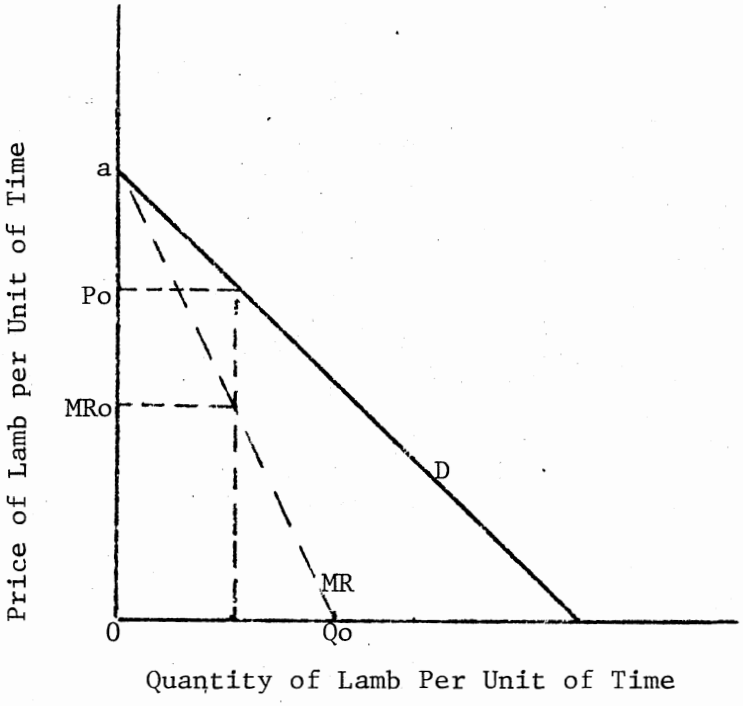

Figure 2. Linear, Demand and Marginal Revenue Costs Under Monopoly Conditions

shown as follows

$$MC = \frac{\Delta TC}{\Delta Y}. \tag{2.7}$$

Marginal cost may also be defined as the total cost (TC) incurred in the next period (t) minus the total cost incurred in the present period (t-1). This is illustrated in the following equations:

$$MC_t = \Delta TC_t = TC_t - TC_{t-1} \tag{2.8}$$

or,

$$MC_t = \Delta TC_t = X_t * P_{xt} - X_{t-1} * P_{x_{t-1}}. \tag{2.9}$$

Derivation of the marginal cost curve is illustrated in Figures 3 and 4. As output increases from A to B (see Figure 3), the producer moves from point Y to Z and total costs increase from TC1 to TC2. Thus,

$$MC = \frac{TC2 - TC1}{OB - OA} = \frac{ZW}{YW}. \tag{2.10}$$

As Y is moved closer to Z, a progressively more accurate measurement of ZW/ZY is obtained. In the limit around point Z the slope of the tangent line is marginal cost. As the tangent line is moved to point V, MC decreases and at point V, MC is minimized. Thereafter, as the production of the product increases the slope (MC) increases as illustrated in Figure 4.

Profit Maximization

Since one of the major purposes of this study was to enhance producer returns, the assumption of profit maximization is appropriate. Mathematically, the profit maximization equation is as follows:

$$\Pi = TR_t - TC_t \tag{2.11}$$

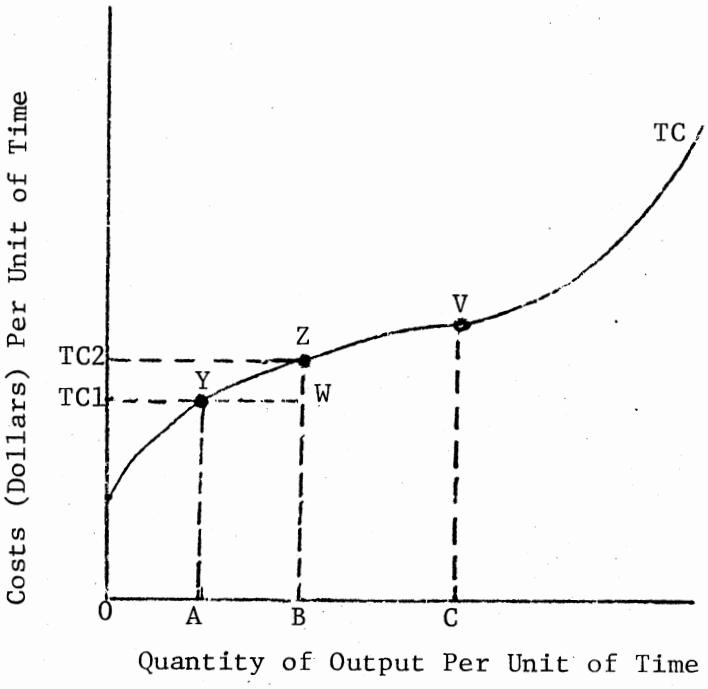

Figure 3. Total Cost Curve

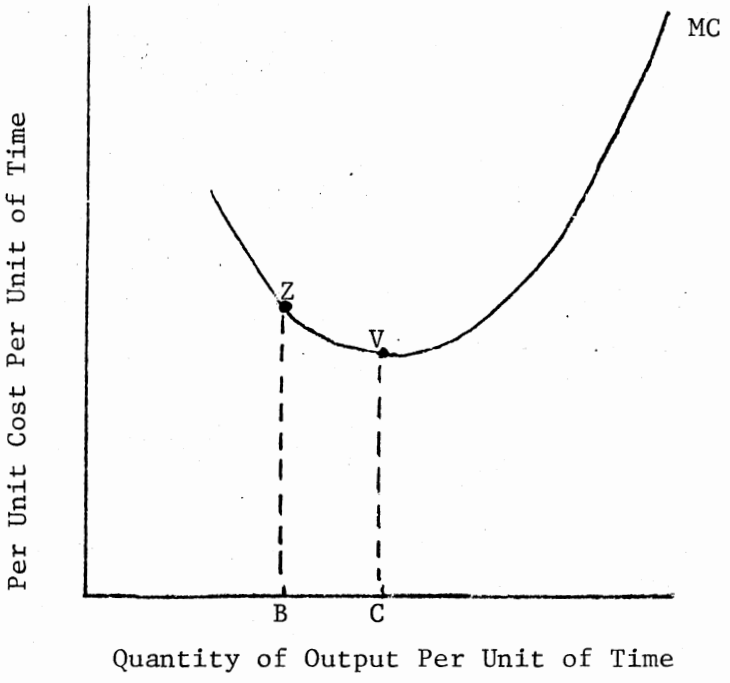

Figure 4. Marginal Cost Curve

or,

$$\frac{\Delta \Pi}{\Delta Y} = \frac{\Delta TR}{\Delta Y} - \frac{\Delta TC}{\Delta Y} = MR - MC. \qquad (2.12)$$

Profit may be calculated two ways, by using total costs or by using marginal costs, shown in equations (2.11) and (2.12). First, consider profit maximization by using total costs. Maximum profits would result when the difference between total costs and total revenues is the greatest (Figure 5). At production level Q, the difference among the two curves is maximized and profit maximization occurs. It should be noted that profit maximization (or loss minimization) does not always occur at maximum revenue output; and may be less than the rate of output for which price is equal to marginal revenue (requirements specified by theory for profit maximization under perfect competition). It is evident that if one were to produce an amount of product greater or less than Q, profits would be less.

With the concept of marginal cost-marginal revenue, precisely the same profit maximization point would be obtained (Figure 6). If a producer were to decrease production from Q_0 to Q_1 ($MR_1 > MC_1$) then the rate at which total revenues increase would be greater than the rate at which total costs increase and the producer would be better off by moving to production level Q_0. Similarly, if production were to increase to Q_2 from Q_0 ($MR_2 < MC_2$), the producer would increase profits by moving back to output Q_0. Profit maximization occurs when marginal cost is exactly equal to marginal revenue or the difference between the two is zero.

Ultimately, either the monopolist or perfect competitor will maximize profit or minimize loss by producing and marketing at a level where the rate which total returns are increasing equals the rate

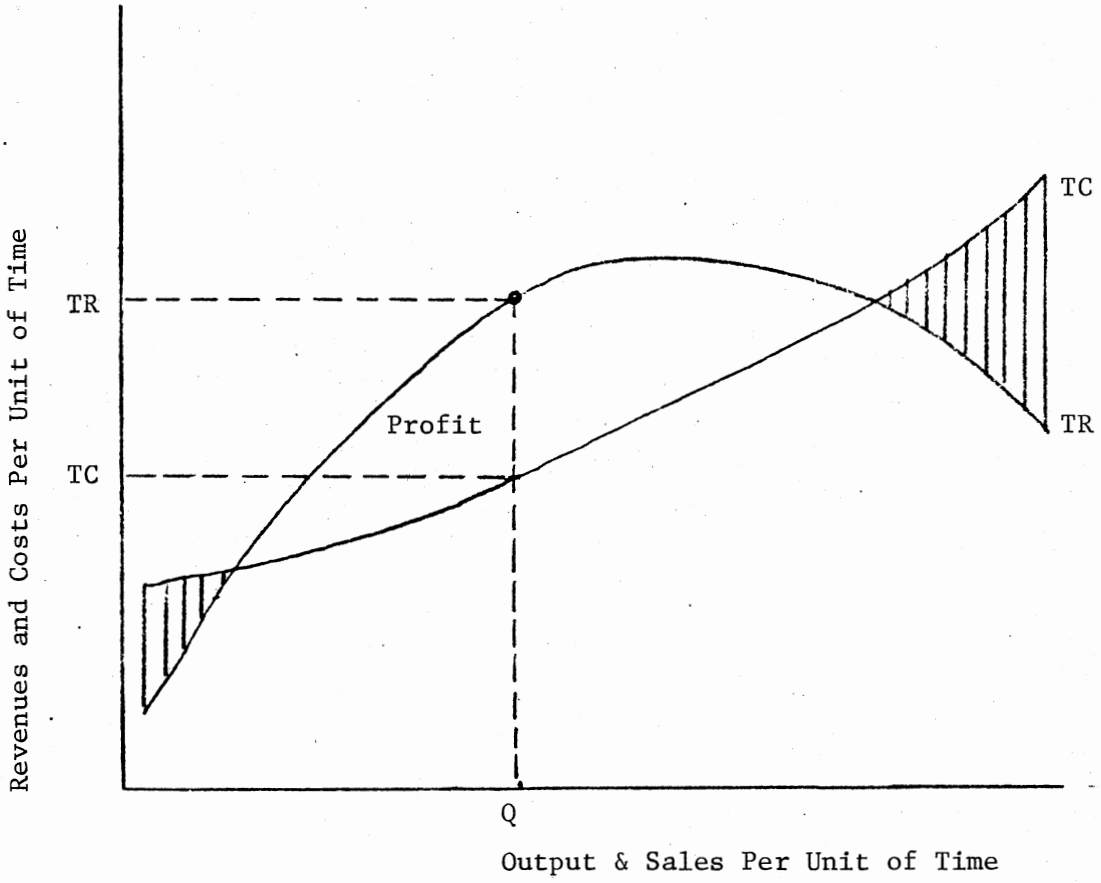

Figure 5. Profit Maximization Using the Total Cost and Revenue Curves

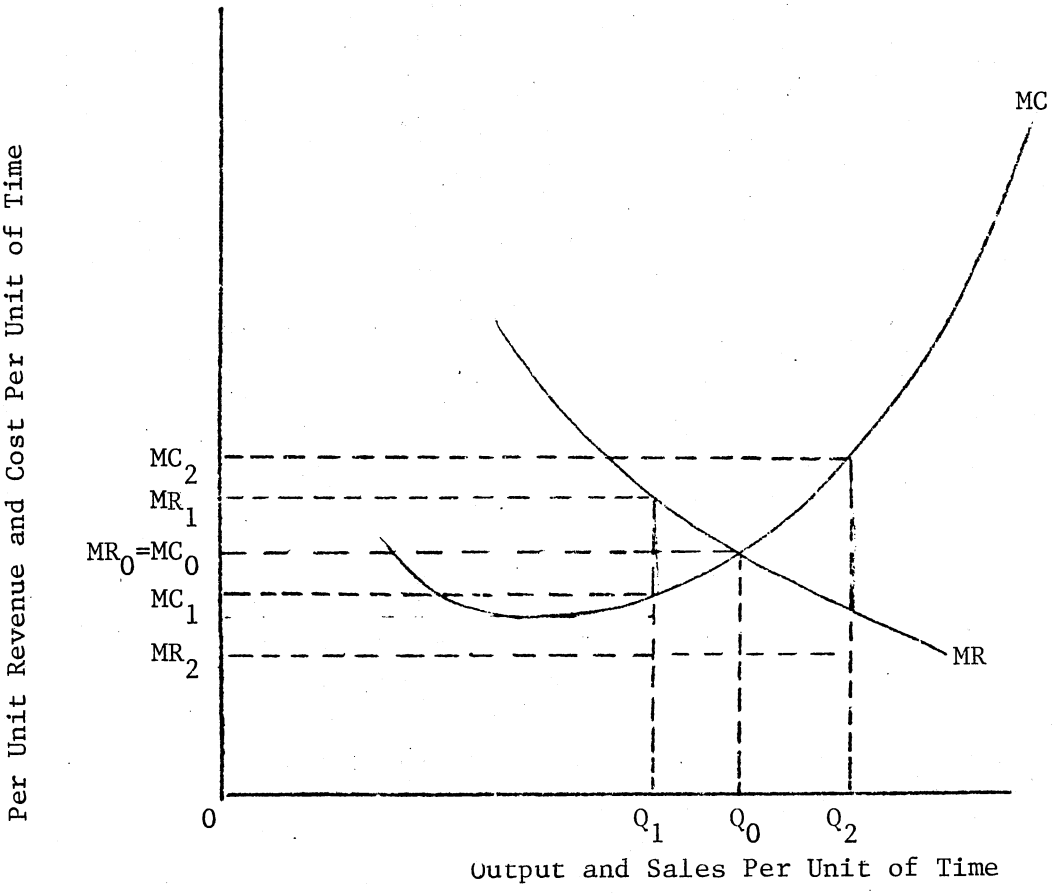

Figure 6. Profit Maximization Using Marginal Cost and Marginal Revenue Curves

which total costs are increasing. Whether a profit or loss results is dependent on the relation between price of the product and the average total cost of the enterprise.

With respect to the sheep industry, determinants of the total revenue function include growth functions, sale weight, lamb prices, pelt prices and by-products prices. The total cost function is made up primarily of input costs and the rate at which they are used. Costs include feed (which depends on feed consumption, conversion and gain), interest, veterinary expenses and other costs. The marginal cost and marginal revenue may be derived directly from these curves by taking the total derivative of each function with respect to Y (the product).

Literature Review

In a computerized search conducted through the university library, many references were found by using the code words: lamb market price, lamb demand analysis and lamb price forecasting, among others. However, these sources were of very limited use as many were from foreign countries or other parts of the United States and did not address the problems being considered in this study. The computerized retrieval systems searched such reference files as AGRICOLA, CRIS/USDA, CAB and CAIN.

Many works contributed to different portions of this study. In a study conducted by Usman and Gee (28), monthly and quarterly data from 1950 through 1975 were used to derive demand equations for retail, wholesale and slaughter lamb prices. Also, farm-retail price spreads, seasonal price indices and price flexabilities were analyzed. In

their derivation of farm level lamb price, variables used include quantity of lamb, beef, and pork, per capita disposable income, a wholesale price index, time, and sine-cosine functions. The quantity of lamb produced was found to have the largest impact on farm level slaughter lamb prices. Usman and Gee also concluded that farm level lamb prices exhibited a distinct seasonal pattern with an average peak in the spring, about May, and a low point in December.

Jordan and Hanke (8) reported on a study which observed several factors affecting lamb sale weights and time on feed. They concluded that as long as feed prices remain low (25 to 35 cents per lb. of gain) and prices remain high in relation to costs of gain, it will be advantageous to feed to heavier weights even in the face of no significant price advance. Also, they reported no significant increases in average daily gain and feed efficiency from 75 to 120 pounds.

Relatively few studies examining average daily gain and feed efficiency for lambs were found in the economic or animal science literature. DeWeese et al. (3), Orskov et al. (12), Orskov et al. (13), Herriman et al. (7), Sents et al. (16), Adams (1) and Shelton and Carpenter (17) found that average daily gains for lambs did not vary significantly with increasing slaughter weight while feed efficiency decreased as slaughter weight increased. Most studies concluded that for each pound of increase in live weight from approximately 75 to 125 pounds, the overall quantity of feed required on a dry matter basis per pound of gain increased in a range from .07 to .08.

One of the original objectives of this study was to develop a set of growth curves for slaughter lambs, since no previous growth curve

studies were found. An effort was made to find feedlot and performance data which would lend itself to this type of analysis (for example, from research experiments at Oklahoma State University and from a Texas feedlot and packer), but insufficient data were available.

Ward (30) outlined the conceptual framework for this study. Two examples were given using assumed prices, weights, average daily gains, dressing percentages, etc. At the end of each example a marketing decision was made based on the expected marginal cost and marginal revenue. Ward concluded that producers must study the marketing decision for each week and each pen of lambs independently.

CHAPTER III

MODEL DEVELOPMENT

Price Discovery

Before developing a price forecasting model, a basic understanding was needed of the pricing process for slaughter lambs and the nature of lamb prices. Price discovery is the process by which buyers and sellers arrive at a specific price for a given lot of produce in a give location (10). There are two stages to this process. Stage one involves evaluating supply and demand forces in the market and estimating a market price. Stage two applies this price to a specific trade or in this case a certain pen of lambs, with consideration for weight discounts, pelt credits, tail discounts, ram discounts, buyer and seller bargaining power, etc. It should be pointed out that this is a non-exact, human process and errors will be made.

In applying this to the lamb industry, each buyer and seller of lambs must evaluate their own supply and demand situation. If a buyer has an undersupply of lambs, he will be willing to pay more for lambs than a buyer who has an optimal supply. Similarly, if a situation arises where a seller has an oversupply of lambs (maybe due to a lack of feed, space limitations or cash flow difficulties) then he will be willing to accept a lower price than one who does not have these limitations.

Discussions with two Texas lamb buyers (14, 29) in January of 1982 resulted in a better understanding of the price discovery process for slaughter lambs and items which should have the greatest importance. They began with the standard profit maximization equation, that profit equals total revenue minus total cost. Then this equation is refined further to arrive at the actual price discovery model shown below:

$$\Pi = (P_{y_1} Y_1 + P_{y_2}) - (P_{x_1} X_1 + P_{x_2}) \tag{3.1}$$

where 'P' is profit per head, Pyl is wholesale price of lamb (cents/pound), Yl is the carcass weight, Py2 is the value of number one grade pelts ($/head), Pxl is the price paid by the packer for the live lamb (cents/pound), Xl is the live weight of the lamb and Px2 is the slaughter costs ($/head). To arrive at the price which a buyer can pay for live lambs, the equation must be rearranged as follows:

$$P_{x_1} = \frac{(P_{y_1} Y_1 + P_{y_2}) - (P_{x_2} + \Pi)}{X_1} . \tag{3.2}$$

The packer must estimate the returns from the carcass and pelt, and must know their slaughter costs and have a profit target to put into the equation. Then it is put on a live weight basis by dividing by the live weight.

The computation of this estimated breakeven price completes stage one of the price discovery process. Stage two is completed when the buyer estimates the price for the conditions of the individual lot of lambs, the supply and demand situation of the sellers and buyers, and the competition among the packers themselves.

The price discovery process may be useful to individual producers. If accurate estimates of the variables in the price

discovery equation can be made, producers may be able to negotiate for the true market value of their lambs.

Development of Seasonal Indices

The basic theory of seasonal variations is simply that the average change of a variable as refined from past measurements will be typical of actual changes which occurred (11). The seasonal index obtained by using the ratio-to-moving-average method may be used to: (1) isolate seasonal patterns, (2) remove the seasonal factor from the data or (3) obtain knowledge of the seasonal pattern as an aid in forecasting. This particular method is useful in that each month is divided by the average of the period of which it is the median. In this respect the ratio-to-moving-average method is more accurate than other methods which divide each time period by a single average for the year.

Previous works mention seasonal pricing, production and demand patterns (4, 28), yet, seasonal live and wholesale price movements have been the only series studied. Indices calculated in this study included: (1) live prices, (2) wholesale price, (3) live weight, (4) dressed weight, (5) federally inspected lamb slaughter, (6) total lamb production and (7) wholesale weight discounts.

Data for the live price and total lamb production seasonal indices, as well as those indices appearing in Appendix A, were found in U.S.D.A.'s Livestock and Meat Statistics: Supplement for 1980 (24). The ratio-to-moving-average method required eleven years of monthly data (one year extra) to compute a 10 year index. Both five and ten year seasonal indices were calculated for all variables in

the analysis, except for the weight discount index where only the five year index was computed due to data limitations.

The data used to calculate the weight discount seasonal index came from five years of the U.S.D.A. publication, Livestock-Meat-Wool Market News: Weekly Summary and Statistics (26). Weekly prices for wholesale carcasses from two weight categories were used. The wholesale price of carcasses weighting 55 to 65 pounds was subtracted from the wholesale price of carcasses weighting 50 to 55 pounds. This difference was summed and averaged for each month from July, 1976 through June, 1982. This method of calculating the weight discount seasonal index also required one extra year of data.

Results of these computations are given in Tables 1, 2 and 3, and results are illustrated in Figures 7, 8 and 9. Live Prices reach a maximum in May and a minimum in October (Table 1 and Figure 7). The peak coincides with the higher consumer demand at Easter and the low may be attributed to the surplus of lambs on the market in the fall. This surplus is due to the seasonal high in lamb numbers (see Appendix A) and a decrease in per capita consumption due to increased consumption of competing meats and poultry such as beef, pork, chicken and turkey at this time of year.

The total production index (federally inspected lamb red meat production) has two peaks, one in the spring and one in the fall. The first peak (see Table 2 or Figure 8) coincides with the seasonal live price peak which conflicts with conventional supply and demand theory. However, as mentioned earlier, there is a strong increase in consumer demand during the Easter season which accounts for high prices even when production is high. The second high point corresponds with the

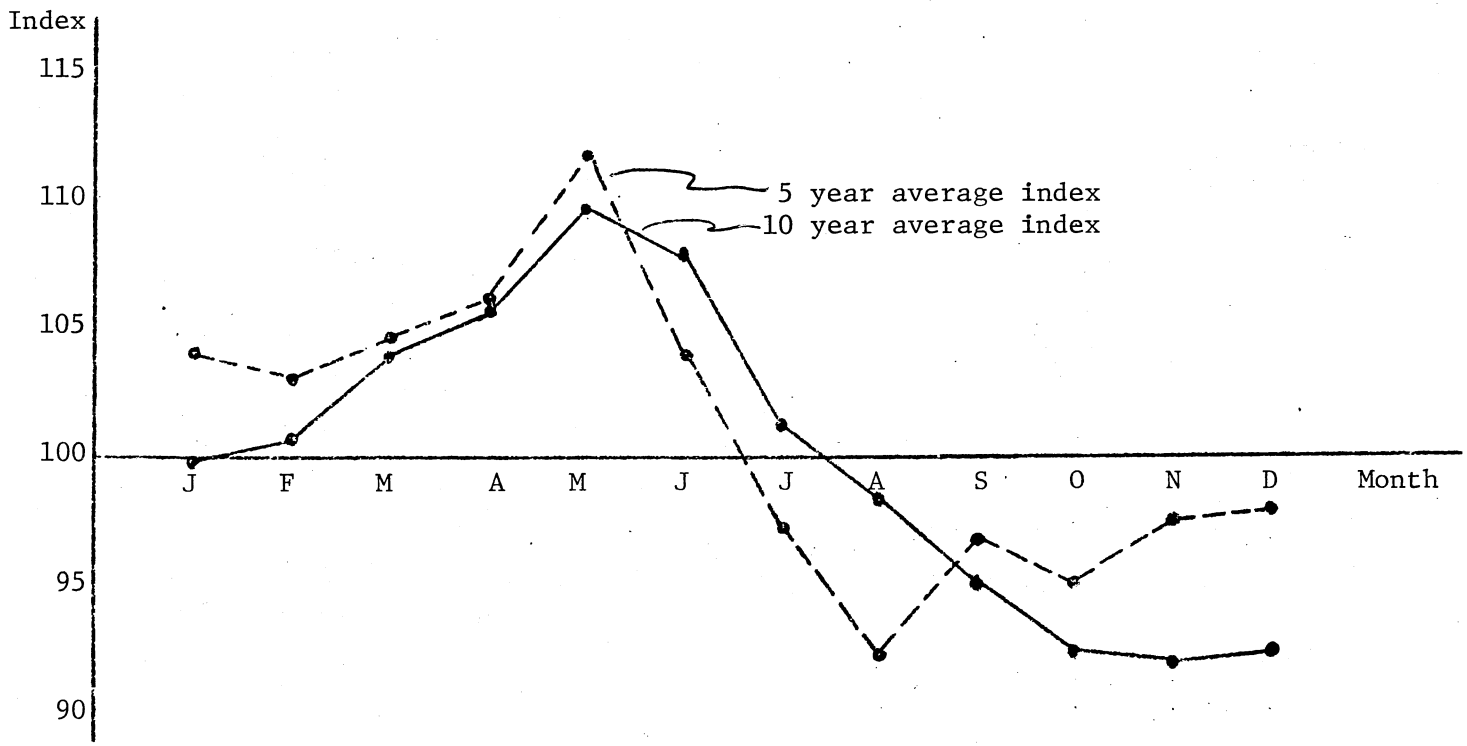

Figure 7. Seasonal Index for Live Lamb Price, Ten Year and Last Five Year Averages (January, 1971 - December, 1980)

Table 1. Seasonal Index for Live Lamb Price, Ten Year and Last Five Year Averages (January, 1971 - December, 1980)

	10-Year Index			Last 5-Year Index		
	Average	Standard Error	Standard Deviation	Average	Standard Error	Standard Deviation
January	99.9	2.0	6.4	104.2	1.2	2.7
February	100.8	2.1	6.7	103.5	2.2	4.9
March	104.3	2.6	8.1	105.0	2.8	6.3
April	106.2	2.0	6.4	106.7	3.6	8.1
May	110.3	3.6	11.3	112.5	6.7	14.9
June	108.3	1.9	6.0	104.3	2.1	4.6
July	101.0	1.9	6.0	96.8	2.3	5.2
August	97.8	3.0	9.4	92.1	3.3	7.4
September	94.7	2.3	7.1	96.1	4.4	9.9
October	92.3	1.9	6.1	94.7	3.1	6.9
November	91.9	1.3	4.2	91.9	1.8	4.1
December	92.3	1.8	5.8	92.2	3.6	8.0

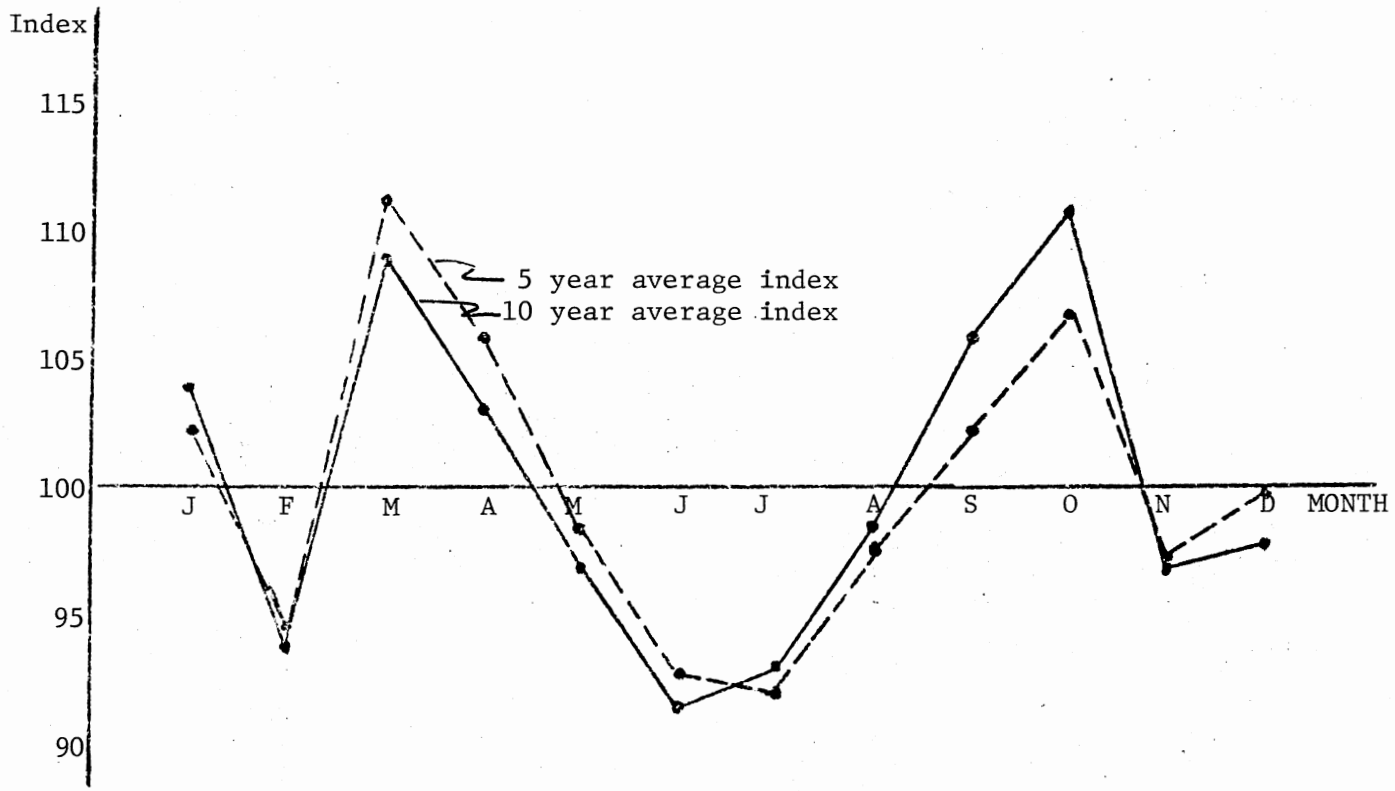

Figure 8. Seasonal Index of Federally Inspected Lamb and Mutton Production, Ten Year and Last Five Year Averages (January, 1971 - December, 1980)

Table 2. Seasonal Index of Federally Inspected Lamb and Mutton Production, Ten Year and Last Five Year Averages (January, 1971 - December, 1980)

	10-Year Index			Last 5-Year Index		
	Average	Standard Error	Standard Deviation	Average	Standard Error	Standard Deviation
January	104.0	1.9	6.1	102.4	3.9	8.7
February	93.5	1.8	5.5	94.0	3.1	6.9
March	109.5	2.2	7.1	112.3	1.5	3.4
April	103.4	2.2	6.8	106.2	2.2	4.9
May	96.8	3.4	10.8	98.0	3.9	8.8
June	90.6	2.3	7.2	91.9	3.4	7.6
July	92.5	1.8	5.6	91.2	1.5	3.3
August	97.9	1.9	5.9	97.4	2.9	6.6
September	106.0	3.0	9.5	102.7	4.2	9.4
October	111.9	2.0	6.2	107.4	1.1	2.4
November	96.6	1.9	5.9	97.1	2.2	4.8
December	97.4	2.1	6.8	99.5	2.6	5.8

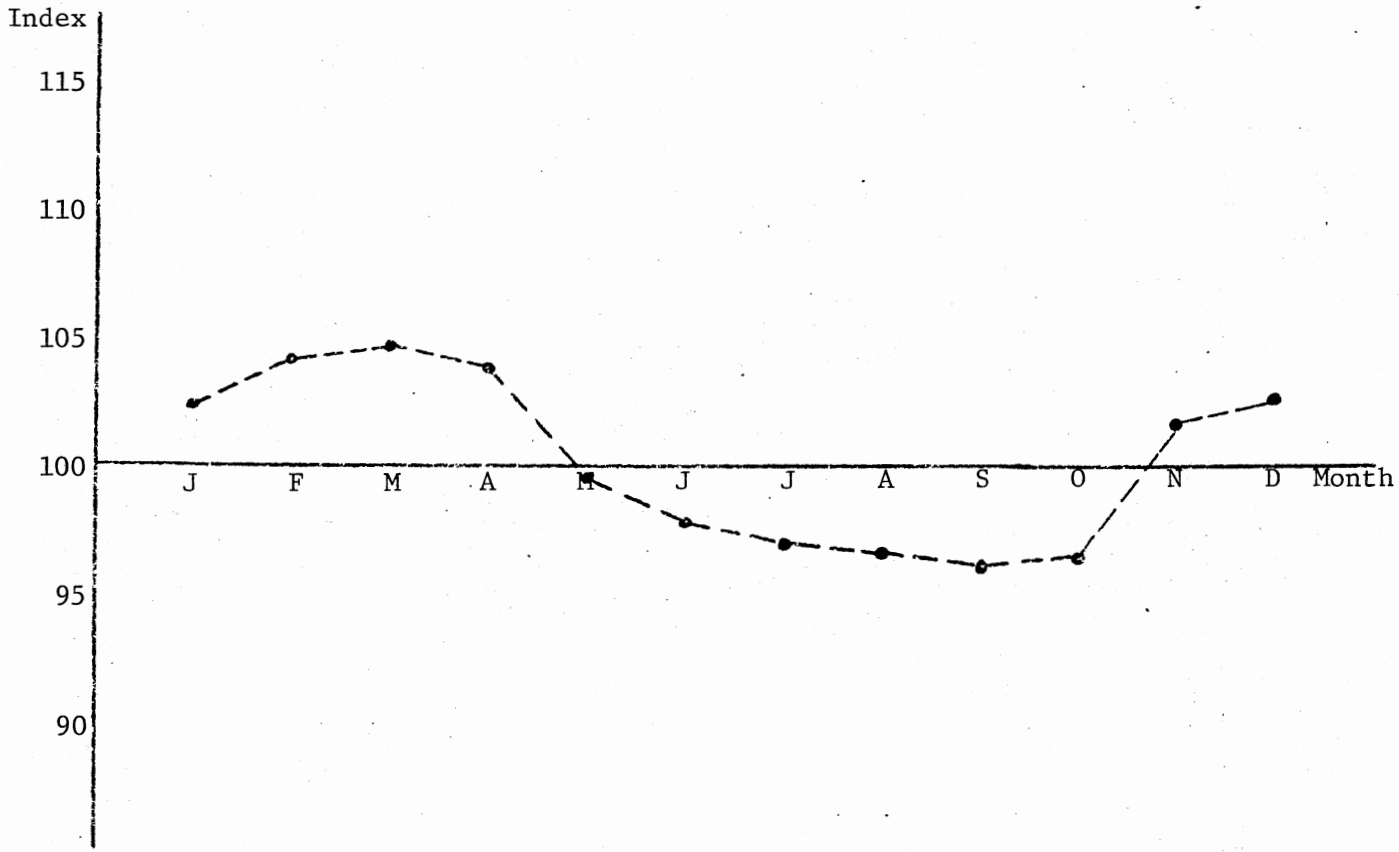

Figure 9. Seasonal Index for Heavy Weight Discount for Lambs, Five Year Average (January, 1977 - December, 1981)

Table 3. Seasonal Index for Heavy Weight Discount for Lambs, Five Year Average (January, 1977 - December, 1981)

	Last 5-Year Index		
	Average	Standard Error	Standard Deviation
January	102.8	2.6	5.8
February	104.6	1.3	3.0
March	104.9	1.2	2.7
April	104.1	2.4	5.3
May	99.0	1.5	3.3
June	97.0	1.3	2.9
July	96.2	1.0	2.2
August	95.9	1.0	2.2
September	95.3	0.9	2.1
October	96.5	0.9	2.1
November	101.6	1.9	4.3
December	102.3	1.8	4.0

seasonal price low as theory would suggest. Also, a comparison of the five-year and ten-year total production indices suggest that producers have shifted production from the fall months when the price is relatively low to the spring when prices are higher. This is illustrated by a higher peak in the spring months observed for the five-year index as opposed to a higher peak in the fall observed for the ten-year average.

Table 3 and Figure 9 show that the seasonal weight discount index has its peak in March with its trough in October. Again, the pattern seems to follow the live price index. It is possible that producers hold lambs to heavier weights in early spring in anticipation of higher seasonal prices. It should be pointed out that this peak in the spring coincides with Easter, a high point in consumer demand. The live and dressed weights are also at a maximum at this time of the year (see Appendix A).

Price Forecasting

Computing a forecasted price from a regression equation is accomplished by obtaining the relevant values of the independent variables, inserting them in the model and computing the dependent variable. If the regression equation in use is correct and the relevant values for the independent variables during the forecast period are obtained, the forecasted price will be accurate. However, obtaining the correct econometric model and appropriate values for the independent variables may be difficult. At best the forecast is a conditional forecast, conditional upon the values of the independent variables used.

While price forecasts may be useful and provide higher returns, there are limitations with this analysis which the user should know (19, 20). First, there are two errors which will always occur. Even if the econometric model is correctly specified and there are no sources of bias, the forecasted price is still only an estimate of the true population (the estimate is subject to sampling error). Second, there will be random factors which will influence the value of the forecasted price.

In addition to the two aforementioned errors which always occur, there are two more potential types of errors. One may be that the econometric model specified may be incorrect. This will cause the regression equation to have serious biases. Furthermore, the structure of the model may change with passage of time. If this occurs then the model will be appropriate for the sample period but not for the forecast period.

Econometric Model for Live Prices

Sources of Data

Weekly data from 1977 through 1981 were used in the development of the price forecasting model. Data were compiled from the Livestock Meat Wool Market News: Weekly Summary and Statistics (26) and included live slaughter lamb prices at San Angelo, No. 1 pelt prices, dressed weight and federally inspected lamb slaughter. San Angelo live prices were chosen because San Angelo was the closest reporting market to Oklahoma and the largest terminal for sheep in the United States. A weekly total pounds of production figure was generated by multiplying dressed weight by total slaughter.

Presentation of the Model

Live price (as opposed to wholesale price) was chosen as the dependent variable primarily because it would seem to have more usefulness to the producer. A model using wholesale prices was estimated, but was not significantly different from the live price model. The lags on live price, total production and the No. 1 pelt price were then fit into a regression equation using ordinary least squares regression, without correcting for autocorrelation. The lagged values of these variables were used because they represent the most recent value producers would have for each variable. Then, a set of dummy variables was added to the equation to account for seasonal price variation. The seasonal indices indicated that the seasonal price peaks in May. Thus, no dummy variable was included for May.

The econometric model which was estimated is as follows:

$$\begin{aligned} PLP = {} & 10.784 + .855LLP - .0004LTP + .205LNO1 - 1.175D1 - .449D2 - \\ & (3.13)^{***} \quad (22.53)^{***} \quad (-1.39) \quad (2.11)^{**} \quad (-1.54) \quad (-.59) \\ & .691D3 + 1.355D4 - 1.413D6 - 1.018D7 - 1.452D8 - .829D9 - \\ & (-.94) \quad (1.77)^{*} \quad (-1.85)^{*} \quad (-1.20) \quad (-1.86) \quad (-1.09) \\ & .954D10 - 1.73D11 - .294D12. \\ & (-1.25) \quad (-2.17)^{**} \quad (-.38) \end{aligned} \tag{3.3}$$

$R^2 = .885$ F-Value = 105.31***
T-Values in Parenthesis

Significance Levels: $(P < 1)=*$ $(P < .05)=**$ $(P < .01)=***$

where PLP, LLP, LTP, LNO1, D1, D2, D3, D4, D6, D7, D8, D9, D10, D11 and D12 are respectively equal to the predicted live price, lagged live price, lagged total prdocution, lagged No. 1 of pelt price and dummy variables for January, February, March, April, June, July, August, September, October, November and December. The R^2 means

that the independent variables explained about 88 percent of the variation in the dependent variable over the time period 1978 through 1981 (208 observations). The F-value is used to determine whether or not the coefficients of the independent variables are equal to zero. The F-value is highly significant and suggests that the coefficients are not equal to zero.

Coefficients on the LLP and LNO1 variables were statistically significant ($P < .05$), while LTP approached significance with a students t-value of -1.39 ($P < .16$). Furthermore, each of the above mentioned independent variables had the theoretically expected sign. Forecasted live price increased as the lagged live price and the lagged number one pelt price increased. Also, as the total production increased the price of lamb decreased as theory would suggest.

Negative relationships were expected from all monthly dummy variables. This is based on the seasonal index of live prices, (previously shown in Figure 7) and omitting the dummy variable for the peak month (May). However, the coefficient on the April dummy variable was positive. All of the other coefficients displayed signs which were expected. An atypical month or months in several years during the study period might explain the positive April dummy variable.

Evaluation of the Forecast Model

As it might be expected, the forecast model did a relatively good job of forecasting when price was constant or changed little from week to week. The model performed worst when there were large changes in the reported live price. Since the lagged live price variable (LLP),

influenced the model to the largest degree (see Equation 3.3), it would be expected that the forecast model would be a week late in predicting these large changes.

Figure 10 illustrates the actual live price and predicted live price plotted for every week in 1982. The forecast error of these two variables is shown in Figure 11. These plots illustrate that during the period when live prices were increasing at a rapid rate (March and April), the econometric model had a higher forecast error than during the time periods when the price was decreasing at a rapid rate (June through August).

The mean of the forecast error for live price was $.26/cwt. (Table 4). Thus, the forecast model predicted slightly higher prices than San Angelo live prices for 1982. The percent forecast error was .46. The standard deviation of the forecast error and standard deviation of the percent forecast error were 1.30 and 2.26, respectively. Although the means of the forecast error and percent forecast error were relatively close to zero, the standard deviations illustrate the variation of the forecast.

Econometric Model for Weight Discounts

Sources of Data

An econometric model for the purpose of forecasting weight discounts was also developed. Data for this model were also gathered from, Livestock Meat Wool Market News: Weekly Summary and Statistics (26). The discounts were derived by subtracting the 55 to 65 pound New York wholesale carcass price from the 50 to 55 pound

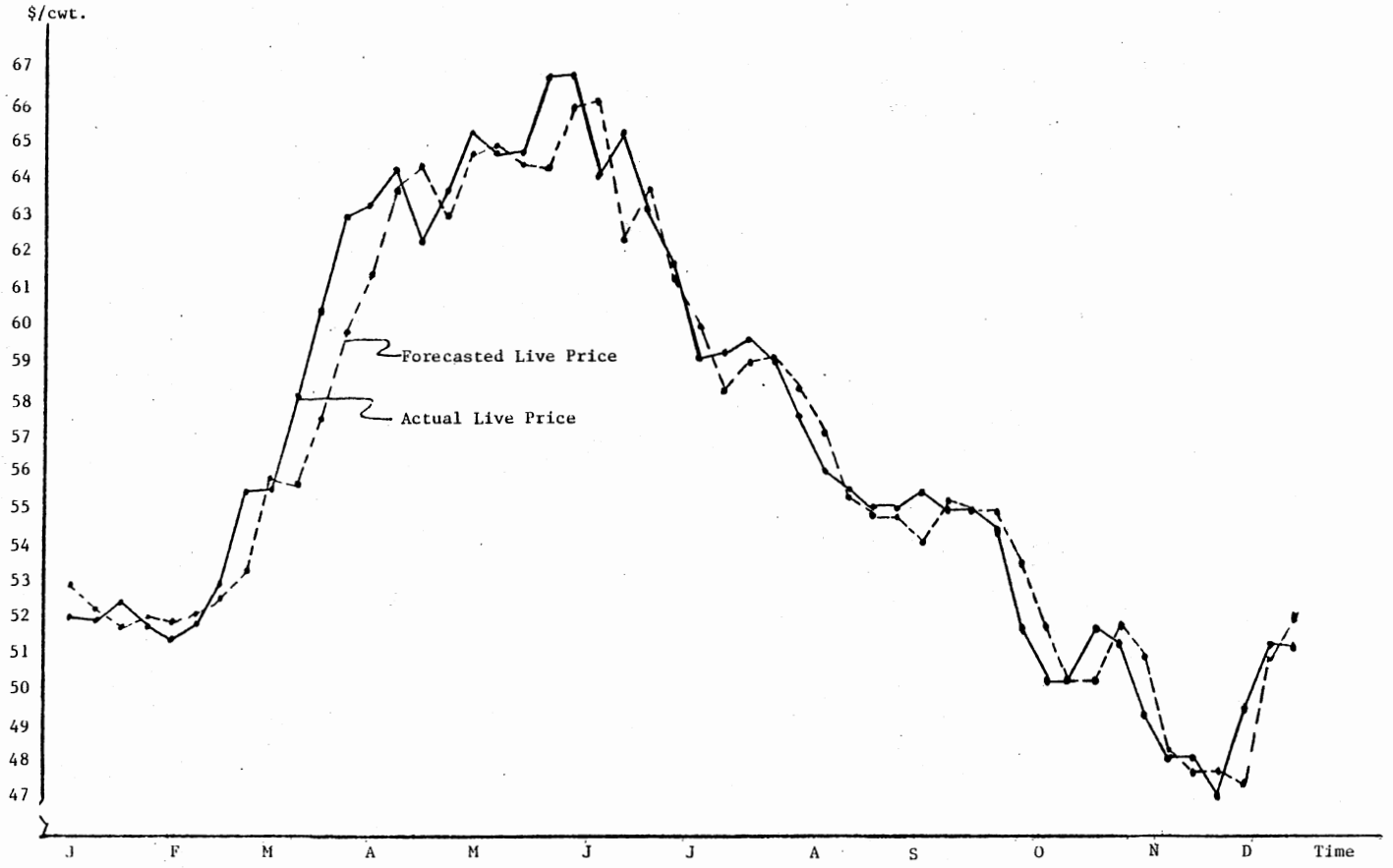

Figure 10. San Angelo Live Slaughter Price and the Forecasted Live Price for 1982

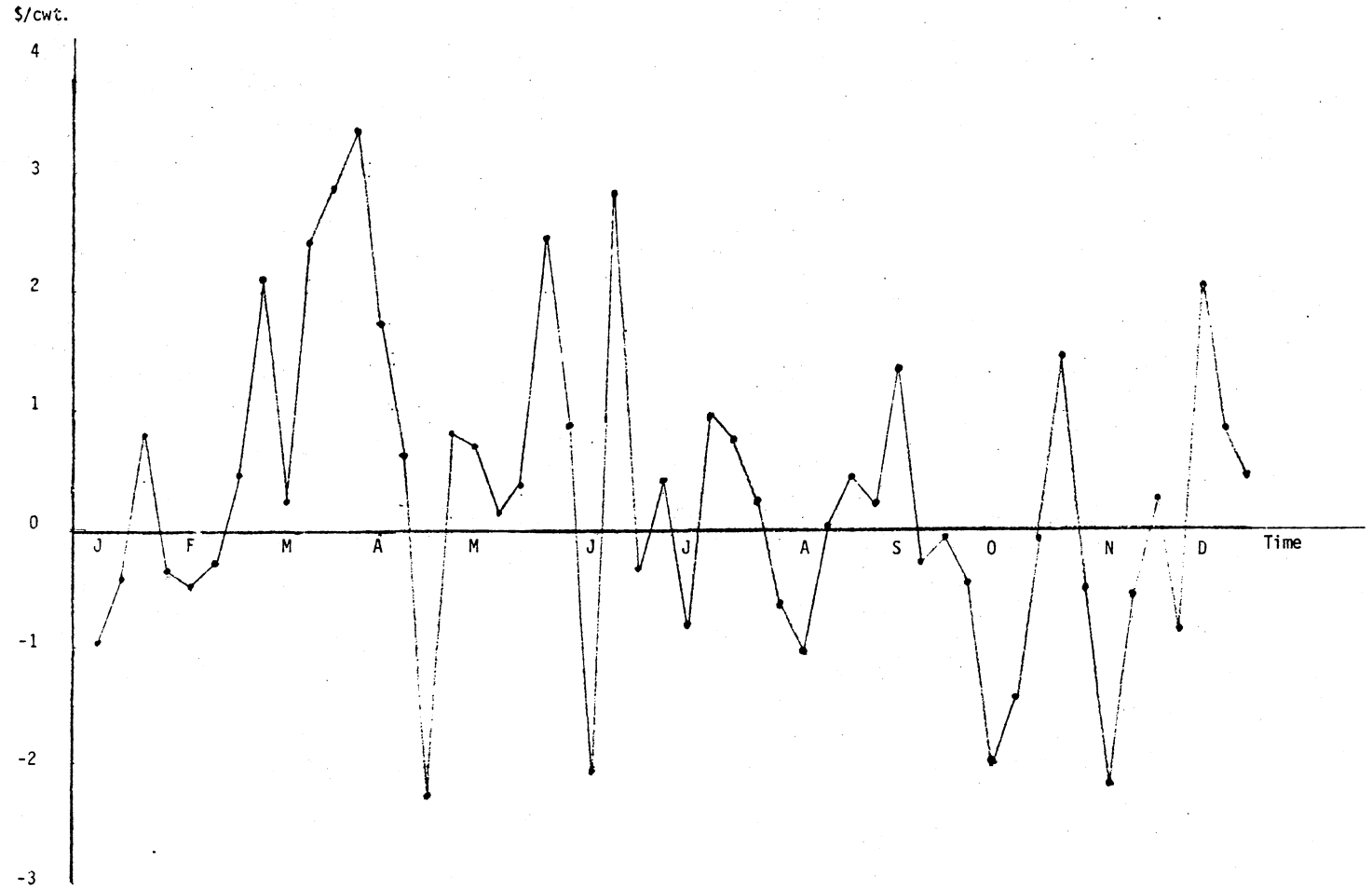

Figure 11. Forecast Error for San Angelo Live Slaughter Price and the Forecasted Live Price for 1982

Table 4. Mean, Standard Deviation and Variance for Forecast Error and Percent Forecast Error Between Actual and Forecasted Live Price Models

	Statistics		
	Mean	Standard Deviation	Variance
Actual Live Price vs. Forcasted Live Price			
Forecast Error ($/cwt.)	.26	1.30	1.69
Percent Forecast Error	.46	2.26	5.10
Actual Weight Discount vs. Forecasted Weight Discount			
Forecast Error ($/cwt.)	-.74	1.42	2.02
Percent Forecast Error	49.77	293.76	82,296.44

New York wholesale carcass price. This resulted in the weight discount applied to the heavier carcasses on a wholesale weight basis. This figure was converted to a live weight basis by using an assumed dressing percentage of fifty percent. The wholesale weight discount was multiplied by the assumed dressing percentage and divided by one hundred (to get it to cents/cwt.) to derive a live weight, heavy lamb discount.

Presentation of the Model

The econometric model for weight discounts was estimated to be the following:

$$\begin{aligned} PWD = {} & 2.721 + .805LWD - .148D1 - .658D2 - 1.773D4 - 2.32D5 - \\ & (3.37) \quad (S19.40) \quad (-.16) \quad (-.71) \quad (-1.94)^{**} \quad (-2.49)^{***} \\ & 2.311D6 - 2.35D7 - 2.567D8 - 2.512D9 - 1.793D10 - \\ & (-2.38)^{***} \quad (-2.36)^{***} \quad (-2.58)^{***} \quad (-2.49)^{***} \quad (-1.77)^{*} \\ & .226D11 - .978D12. \\ & (-.24) \quad (-1.08) \end{aligned} \tag{3.4}$$

$R^2 = .81$ F-Value - 68.87***

T-values in Parenthesis

Significance Levels: ($P < .1$)=* ($P < .05$)=** ($P < .01$)=***

where, PWD, LWD, D1, D2, D4, D5, D6, D7, D8, D9, D10, D11 and D12 are, respectively, predicted weight discount, lagged wholesale weight discount and seasonal dummy variables for January, February, April, May, June, July, August, September, October, November and December. Again, no correction was made for autocorrelation. The R^2 value indicated that the independent variables explained about 81 percent of the variation in the dependent variable, next weeks forecasted weight discount. Furthermore, the F-value was statistically significant and

rejects the null hypothesis that all of the regression coefficients are equal to zero.

All the relationships between the dependent and independent variables were as expected. Lagged weight discounts varied positively with the forecasted weight discount and all the dummy variable relationships were negative as was expected. The peak month for weight discounts, as measured by the previously developed seasonal index for weight discounts, is March. Therefore, if the equation were constructed assuming March as the peak, all other monthly variables would have an inverse relationship with the dependent variable, which is what was found.

The probability of the regression coefficient of LWD being zero was low ($P < .0001$). Also, dummy variables D4 through D10 exhibited a high degree of significance ($P < .07$). However, coefficients on other dummy variables (D11, D12, D1 and D2) did not differ significantly from zero.

Evaluation of the Forecast Model

The plots of the actual and predicted weight discounts are shown in Figure 12, while the difference in the two is plotted in Figure 13. Again, the econometric model performed well when there was little or no movement in the actual weight discount from week to week. The actual price seemed to lead the forecasted price, as was the case with the live price model. This is probably due to the lagged value of the variable which had the biggest impact on the total equation, lagged weight discount. In Table 4 the mean, standard deviation and variance are given. The forecast error statistics seem to indicate that the

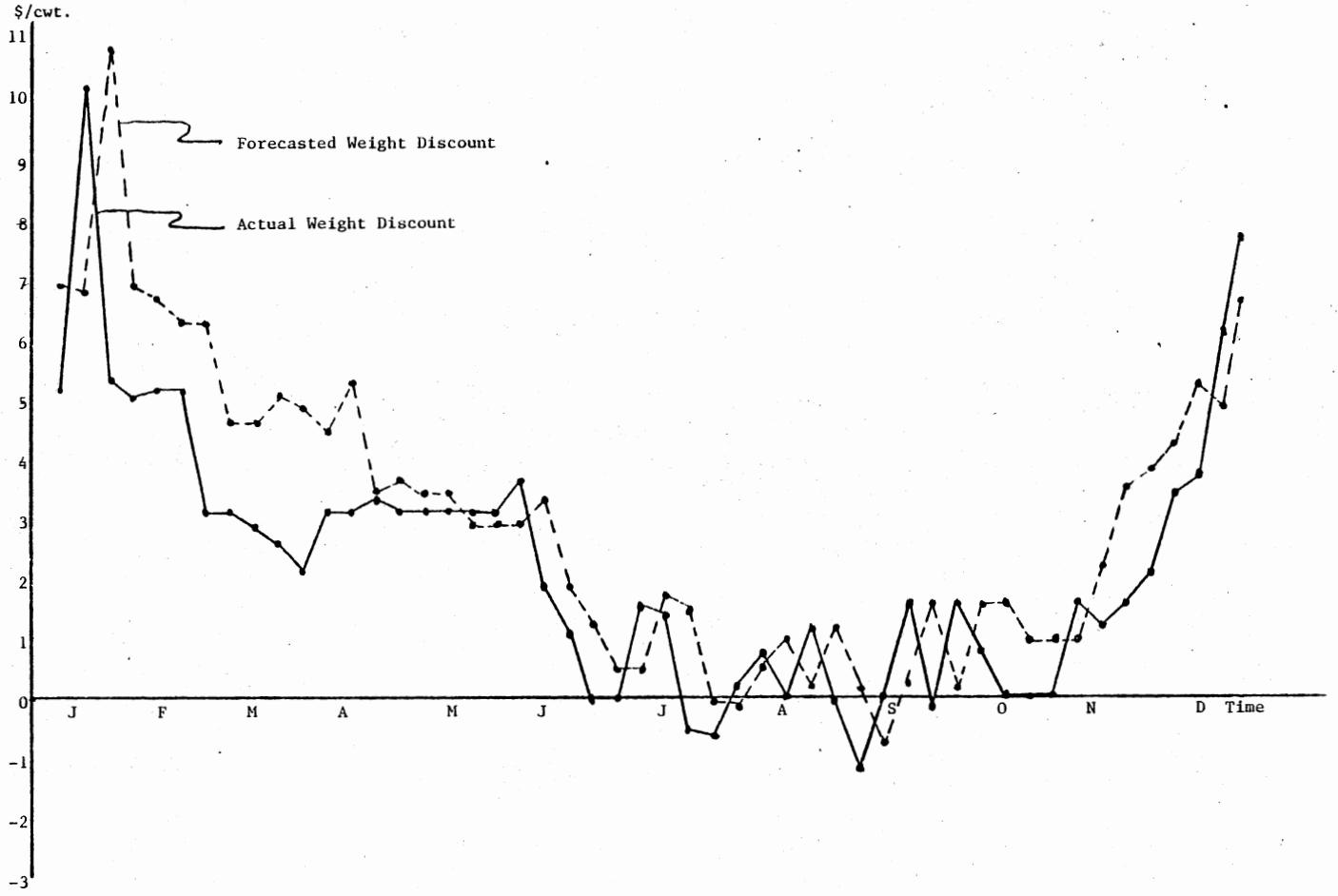

Figure 12. New York Wholesale Weight Discount and Forecasted Wholesale Weight Discount

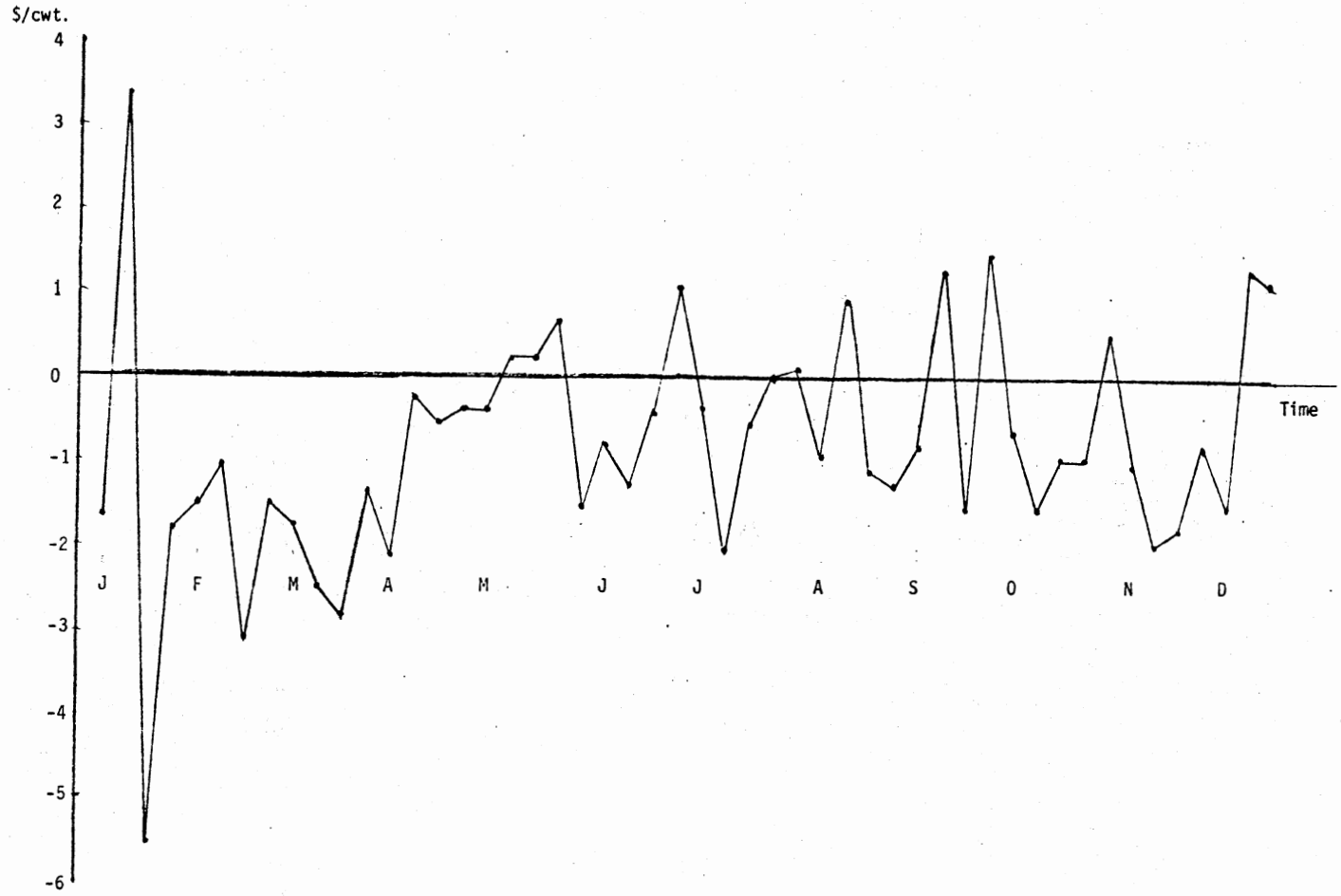

Figure 13. Forecast Error for Wholesale Weight Discount and Forecasted Wholesale Weight Discount

model may forecast accurately, however, the percent forecast error is quite large (49.77 percent) and the values of the standard deviation and variance (293.76 and 82,296.44, respectively) indicate a large degree of variation in the model.

Cost Assumptions

The total cost function for slaughter lambs varies from one producer to another. The relevant costs in the application of the marginal cost-marginal revenue approach are those which change from the present period to the next. Those costs may include feed, interest and veterinary expenses, among others, with feed being the most significant. In the model which was developed, a constant marginal cost was assumed over the entire feeding period of the lambs. This assumption was made to help isolate the influence of weight discounts and price changes on marketing decisions.

In Table 5 the marginal cost for holding a lamb one day is computed. A ration from the Sheepman's Production Handbook (15) was used with prices form a local feed store as of February 1, 1983. The feed efficiency and average daily gain were assumed to be 7.5 lbs. of feed per lb. of gain and .71 lbs. per day, respectively. These values were assumed to be constant over the entire feeding period of the lambs. After feed costs were computed, daily charges for interest costs, veterinary costs, yardage, etc., were made and all costs were totaled. This charge of $.40/head/day ($2.80/head/week) was assumed to be a MEDIUM marginal cost. Ten cents per day greater ($.50/head/day) and ten cents per day less ($.30/head/day) than the computed $.40/head/day were assumed to be HIGH ($3.50/head/week) and

Table 5. Derivation of MEDIUM Marginal Costs

Feed Costs

Ration			Prices*	
Corn	(58.75%)	x	$6.11/cwt.	= 3.59/cwt.
Alfalfa Hay	(40.00%)	x	$85.00/ton	= 1.70/cwt.
5BM	(1.25%)	x	$2.11/ton	= .13/cwt.
Processing			$30.00/ton	= 1.50/cwt.
				$6.92/cwt.
7.5 lb. feed/ lb. gain		x	.714 ADG	= 5.36 lb. feed/day
5.36 lb. feed/ day		x	$.0692/ lb. feed	=$ .37/day
Interest, Vet and other Costs				$ .03/day
				$ .40/day

*February 1, 1983, Stillwater Milling Company

LOW ($2.10/head/week) marginal costs. Several combinations of feed costs, veterinary expenses, feed consumption and feed efficiency can be made to arrive at the three previously mentioned marginal cost levels.

Example of Application

An example of the marginal cost-marginal revenue approach to lamb marketing using the forecasted live slaughter price and forecasted weight discount is shown in Table 6. The week ending April 17, 1982 was used to illustrate the application of the concept. The beginning weight of lambs was 110 lbs. and it was assumed lambs gained .714 lbs./day or 5 pounds during the next week. The weight at which the weight discount was to begin was 110 lbs. and the MEDIUM marginal cost $2.80/head/week ($.40/head/day) was assumed.

Table 6 shows the procedure for both the decision based on forecasted prices and weight discounts and the actual decision of the producer, given perfect information about future price and weight discount changes. The method of determining the total value of lambs each week is exactly the same for all decisions. Therefore, for ease in explanation only the forecasted decision will be discussed.

There were to be 5 pounds discounted (115 lbs., the forecasted weight, minus 110 lbs., the weight at which the weight discounts began). The calculations for deriving the discount to be subtracted directly from the forecasted live price are as follows:

$$WD = \frac{(LW - BWD)}{100} * FWD * \frac{DP}{100} \tag{3.5}$$

or,

$$\$.0875 = \frac{(115 - 110)}{100} * 3.50 * \frac{50}{100} \tag{3.6}$$

Table 6. Example of Marginal Cost - Marginal Revenue Approach to Lamb Marketing

	This Week	Next Week	
		Predicted	Actual
Live Weight (lbs.)	110	115	115
Live Price ($/cwt.)	61.50	63.76	63.00
Wholesale Weight Discount ($/cwt.)	3.00	3.50	3.00
Pounds for Discount	0	5	5
Live Weight Discount	0	.088	.075
Net Price	61.50	63.67	62.93
Total Value	67.65	73.22	72.36
Marginal Revenue		5.37	4.71
Marginal Cost		2.80	2.80
Decision		HOLD	HOLD
Breakeven Price		61.35	61.34
Breakeven Weight		110.49	111.83
Assumptions:			
Dressing Percentage		50%	
Weight which Weight Discounts Begin		110	

where, WD, LW, BWD, FWD and DP are the live weight discount, live weight, beginning weight for discounting, forecasted wholesale weight discount and the expected dressing percentage, respectively. Therefore, the net live price received by the producer is the forecasted live price minus the live weight discount or $63.67/cwt. ($63.76/cwt. - $.0875/cwt.). The forecasted total revenue per head is $73.22/head ($63.67/cwt. x 115 lbs./head).

To obtain the forecasted marginal revenue for this example, the total revenue for week one must be subtracted from the forecasted total revenue calculated above ($73.22/head - $67.65/head = $5.37/head/week). As mentioned earlier, the actual marginal revenue may be calculated using the same procedure. As is shown in Table 6, the calculated marginal revenue for both the forecasted price and actual price marketing strategies is greater than marginal cost. This means that the rate at which total revenue is increasing is greater than the rate at which total costs are increasing. Thus, it would be more profitable for the producer to keep the lambs at least one more week (e.g. a HOLD decision).

The breakeven price represents the level at which the live price would have to obtain for the producer to be indifferent between selling this week or holding the lambs and selling them next week. The same is true for the breakeven weight. If the lambs obtain the breakeven weight during the next week, the producer would be indifferent between selling this week and selling next week, provided all other variables are correct.

CHAPTER IV

MODEL ANALYSIS

Application to Previous Years, 1978-1982

A hypothetical set of lambs was put on feed with the beginning weight at 90 pounds and ending weight at 130 pounds for every week from 1978 through 1982. Each week a marketing decision was made to SELL the lambs that particular week or HOLD them for one more week. Due to price fluctuations, it was common for the SELL and HOLD signals to change back and forth several times during the nine decisions made for lambs from 90 to 130 pounds. Consequently, the marketing rule of selling at the first SELL signal was established. Using the marginal cost-marginal revenue approach to find profit maximization, the optimal selling weight for nine pens of lambs was determined for each week from 1978 through 1982 for three different marginal costs (e.g. $2.10/week, $2.80/week and $3.50/week). Similarly, the optimum selling weight was found using forecasted prices and weight discounts to estimate expected marginal revenues for 1982.

Table 7 illustrates the findings from this portion of the analysis. The highest average price in the last five years was in 1979, with the lowest average price in 1982. The price range (maximum minus minimum) remained relatively constant at $18.00 to $22.00 from 1978 through 1982. Furthermore, the data seem to indicate that as the

Table 7. Mean Sale Price and Optimal Sale Weight for Three Levels of Marginal Cost, 1978 Through 1982 and Forecasted 1982

	Year					
	1978	1979	1980	1981	1982	1982[2]
Price ($/cwt.)						
Mean	65.30	68.64	66.23	58.38	55.94	55.70
High	77.50	80.00	71.00	68.55	66.00	65.30
Low	56.5	62.00	59.50	48.50	47.00	47.21
Low Marginal Cost ($2.10/week)						
Mean	104.13	107.98	104.61	101.63	104.90	101.54
High	>130	>130	>130	130	>130	>130
Low	90	90	90	90	90	90
No SELL Decision[1]	3	8	3	0	7	2
Medium Marginal Cost ($2.80/week)						
Mean	103.08	102.12	100.58	95.58	94.62	95.48
High	>130	>130	>130	115	>130	>130
Low	90	90	90	90	90	90
No SELL Decision[1]	3	1	1	0	1	3
High Marginal Cost ($3.50/week)						
Mean	98.94	97.21	94.42	91.63	91.82	90.86
High	>130	125	120	100	105	100
Low	90	90	90	90	90	90
No SELL Decision[1]	1	0	0	0	0	0

[1]Number of times sale weight exceeded 130 pounds.

[2]Forecasted.

average price (nominal) decreased over time the optimal sale weight decreased. This was especially true for HIGH marginal cost levels.

Another pattern observed was that as marginal costs increased the optimal selling weight was lower. When marginal costs were HIGH ($3.50/head/week), the average optimal sale weight was never above 100 pounds. Additionally, when marginal costs were LOW ($2.50/head/week) the average optimal sale weight was never below 100 pounds. This pattern is in agreement with theory and may be interpreted to mean that when the rate which total costs are increasing is greater than the rate total revenues are increasing, it would be more profitable to sell at a lower weight. Also, the lower producers' costs are, the more flexibility they will have in their marketing decisions.

The actual weight discount applied to the heavy lambs was also taken into consideration. However, there was only one time period when weight discounts seemed to have an influence on the sale time and weight. This time period was in February and March of 1981. Although there were other years which had as high or higher weight discounts, live prices remained constant or increased in those years, while in 1981 live lamb prices steadily decreased during this period. Therefore, a combination of price decreases and large weight discounts must be held accountable for the consistent selling at 110 pounds in early 1981. Also, the influence of weight discounts was more dramatic when costs were MEDIUM and HIGH relative to the LOW cost operations.

Comparison of Marketing Strategies

To test the marketing tool for accuracy using forecasted prices and price discounts, a hypothetical set of nine pens of lambs were put

on feed each of the first fifty weeks of 1982. These lambs were marketed using forecasted prices and forecasted weight discounts in the marginal cost-marginal revenue framework described int he previous chapter. This marketing strategy will be referred to as the Forecasted Price marketing strategy. The Forecasted Price strategy was compared to the Actual Price marketing strategy, which used perfect information about live slaughter prices and wholesale weight discounts to arrive at the optimal marketing decision. A marketing decision was made for the Forecasted Price and Actual Price marketing strategies for every week and every pend of lambs from 90 to 130 pounds (9 weeks). This resulted in 9 decisions for each period or 450 decisions. Due to the price fluctuations from week to week, some pens had HOLD decisions after the first SELL signal. Therefore, a marketing rule that all pens would be sold on the first SELL signal was implemented.

The Forecasted Price strategy matched SELL signals with the Actual Price strategy 7 times at LOW marginal costs, 18 times at MEDIUM marginal costs and 33 times at HIGH marginal costs during the 52 weeks of 1982. At HIGH and MEDIUM marginal costs many of the sell signals were at 90 pounds. This may suggest that costs were too high to be feeding slaughter lambs and the producers may have been better off selling the lambs as feeder lambs. Also, there was no apparent pattern in the times that the SELL signals matched up other than 90 pounds.

The above procedure tests the marketing tool for accuracy, but it does not give any indication of whether or not it is better than what is being used at the present time. To do this three more strategies

were established, each representing possible marketing strategies which may be used by producers today.

The One-Weight strategy assumes that all lambs are sold when they reach 100 pounds. The Two-Weight marketing strategy specifies that the lambs will be sold at 120 pounds during the months of February through May (when seasonal price indices are highest) and sold at 90 pounds the remaining months of the year. This strategy attempts to take advantage of the seasonal increase in prices. The Last Week's Price strategy uses last week's price as the forecast price. Again, the marketing rule was to sell the lambs at the first SELL signal.

The Actual, One-Weight, Two-Weight, Last Week's Price and Forecasted Price strategies were all compared on the basis of a calculated average net return (ANR) for 1982. This value is the total value (TV) of the lambs at selling time (per each individual marketing strategy) minus forty dollars (estimated cost of rearing a lamb to 90 pounds) (4) minus an assumed marginal cost (MC), either HIGH, MEDIUM, or LOW, multiplied by the number of weeks on feed after reaching 90 pounds (WKS). Finally, the net revenues per week were summed and divided by fifty (number of weeks used in the study) to arrive at the average net revenue for each marketing strategy at each level of marginal cost. Equation 4.1 illustrates this calculation:

$$ANR = \Sigma[(TR - \$40.00) - (MC * WKS)] \div 50 \qquad (4.1)$$

These average net return values are shown in Table 8 with their respective standard deviations and variances.

As expected, net returns from the Actual Price strategy were highest for all levels of marginal costs. However, as Table 9 illustrates, the means of the Actual Price strategy were significantly

Table 8. Mean Standard Deviation and Variance of Net Returns For 5 Marketing Strategies and 3 Marginal Costs

Strategy	Average Net Returns	Standard Deviation	Variance
		LOW Marginal Cost ($2.10/week)	
Actual	14.36	6.88	47.36
One-Weight	11.89	5.52	30.47
Two-Weight	12.40	9.12	83.16
Last Week's Price	11.14	5.43	29.46
Forecasted Price	12.21	5.92	35.02
		MEDIUM Marginal Cost ($2.10/Week)	
Actual	12.15	5.89	34.69
One-Weight	10.50	5.51	30.41
Two-Weight	11.12	7.34	53.50
Last Week's Price	11.04	5.34	28.50
Forecasted Price	11.06	5.22	27.25
		HIGH Marginal Cost ($3.50/week)	
Actual	11.65	5.42	29.40
One-Weight	9.10	5.51	30.40
Two-Weight	9.78	6.20	38.45
Last Week's Price	10.59	5.11	26.14
Forecasted Price	10.60	5.14	26.48

higher than the One-Weight and Last Week's Price strategies when marginal costs were LOW and the One-Weight strategy when marginal costs were HIGH. Furthermore, the variance of the Actual Price strategy was significantly lower than the One-Weight, Two-Weight and Last Week's Price strategies when marginal costs were LOW. The variance of the Actual Price strategy was significantly lower than the One-Weight marketing strategy when marginal cost was HIGH. THe mean and variance of the average net revenue for the Forecasted Price strategy were not statistically different from mean and variance of the Actual Price strategy for the tree levels of marginal cost.

The means of the One-Weight, Two-Weight and Last Week's Price marketing strategies were not statistically different from the mean of the Forecasted Price strategy (Table 9). This suggests that the Forecasted Price marketing strategy did not display significantly higher average net returns relative to the above mentioned marketing strategies. The variance of the Forecasted Price strategy was significantly lower with respect to the Two-Weight marketing strategy at LOW and MEDIUM marginal costs. There was no other significant differences between the variances of the marketing strategies at the three levels of marginal cost.

Figure 14 illustrates the relationship between the means and variances of the five marketing strategies and three marginal cost levels. The vertical axis is a measure of returns (average net revenue) and the horizontal axis is a measure of risk (the variance of the average net revenue). The optimal area on this diagram is in the upper left corner (higher returns and low variance). Conversely, the least desirable portion of the diagram is in the lower right corner

Table 9. Statistical Tests Between the 5 Different Marketing Strategies and 3 Marginal Cost Levels

Strategies	Marginal Cost ($/week) LOW ($2.10)		MEDIUM ($2.80)		HIGH ($3.50)	
	t[1]	F[2]	t	F	t	F
Actual vs. One-Weight	1.93*[3]	1.55*	1.44	1.14	2.13**	1.03
Actual vs. Two-Weight	1.17	1.76*	.77	1.55*	1.61	1.31
Actual vs. Last Week's Price	2.63***	1.61*	.99	1.23	1.01	1.12
Actual vs. Forecasted Price	1.63	1.35	.98	1.27	.93	1.11
Forecasted Price vs. One-Weight	.27	1.14	.52	1.12	1.41	1.15
Forecasted Price vs. Two-Weight	-.12	2.35***	-.04	1.96**	.71	1.45
Forecasted Price vs. Last Week's Price	.37	1.19	.02	1.05	.01	1.01

1) t = Ho: $\bar{X}_1 = \bar{X}_2$

2) F = Ho: $S_1^2 = S_2^2$

3) Significance Levels: (P<.01)=*** (P<.05)=** (P<.1)=*

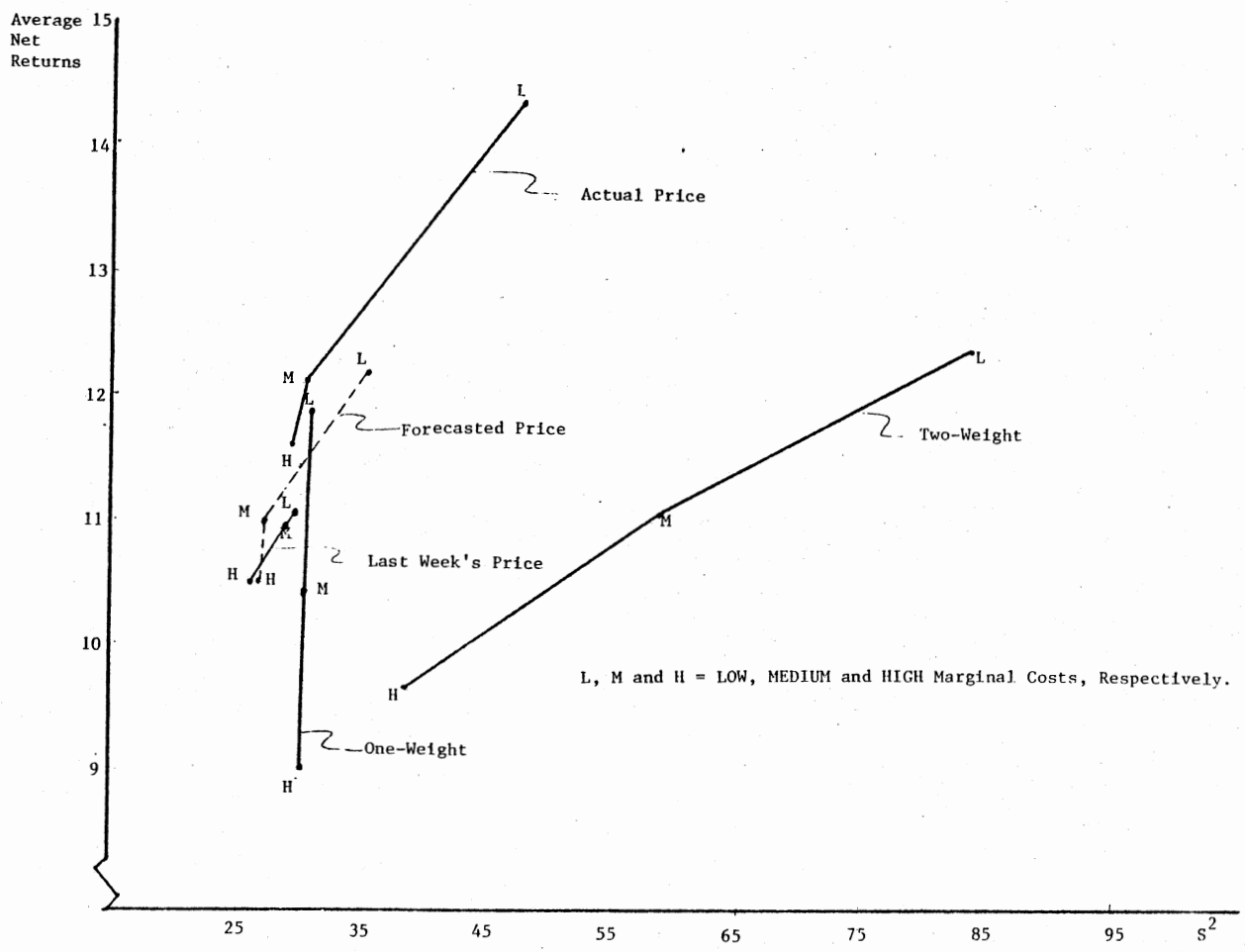

Figure 14. Average Net Return and Variance for 5 Marketing Strategies and 3 Marginal Costs.

(low returns and high variance). The average net return and variance of the average return for the five marketing strategies and three marginal costs are plotted in Figure 14.

As expected, the Actual Price strategy is nearest to the upper left corner making it the most optimal solution. The Two-Weight strategy is nearest the lower right corner making it the least desirable solution. This is due to the significantly higher variance at LOW and MEDIUM marginal costs. The One-Weight marketing strategy displayed the same level of variance for three levels of marginal cost, while Last Week's Price strategy had the smallest change in the levels of variance and returns among the three marginal costs. The Forecasted Price marketing strategy had the same shape as the Actual Price strategy, however, the curve was lower and to the right of the Actual Price curve. Also, the Forecasted Price curve is mostly above the other three marketing strategies suggesting that it could return a higher average net revenue with lower variation (lower risk) in returns.

CHAPTER V

USER INSTRUCTIONS

The decision making tool for the individual producer was developed for application on a micro-computer. This particular program was written for an Apple II Plus and 3.3 DOS using the electronic spreadsheet VISICALC. However, the concept and program may be rewritten for many of the spreadsheets and micro-computers available on the market.

The template which was developed to assist the producer in marketing slaughter lambs is shown in Table 10. The first page of the program is the input page. The producer may input the number of lambs, number of tailed lambs and number of rams, among others in the upper portion of the input page for both the beginning and ending date of the time period to be analyzed. Next, the user must input the corresponding discount or premium for each of the items to be evaluated. The user has the option of inputing the values required for computing a forecasted live price and heavy weight discount or inputing his own estimated future price and weight discount.

Additional information needed to complete the calculations may be entered in the lower portion of the worksheet. These items may include costs in dollars per week, average daily gain, the beginning weight of the lamb and the number of days included in the decision

Table 10. Visicalc Template for Lamb Marketing

MARGINAL COST-MARGINAL REVENUE APPROACH TO LAMB MARKETING

ITEM: MONTH OF YEAR----> ..	THIS PERIOD'S DATA	NEXT PERIOD'S DATA
NUMBER OF LAMBS:		
TOTAL LAMBS----->	1	1
RAMS---------->	.....	.....
WOOLED LAMBS--->	.....	.....
NO. 1 PELTS---->	.....	.....
NO. 2 PELTS---->	.....	.....
NO. 3 PELTS---->	.....	.....
TAILS---------->	.....	.....
OLD CROPS------>	.....	.....
GOODS---------->	.....	.....
OTHER---------->	.....	.....
DISCOUNTS ($/CWT):		
RAMS---------->	.....	.....
WOOLED LAMBS--->	.....	.....
NO. 1 PELTS---->	.....	.....
NO. 2 PELTS---->	.....	.....
NO. 3 PELTS---->	.....	.....
TAILS---------->	.....	.....
OLD CROPS------>	.....	.....
GOODS---------->	.....	.....
OTHER---------->	.....	.....
YOUR ESTIMATES: (MUST BE ZERO IF FORCASTING)		
LIVE PRICE------>	.....	.....
WEIGHT DISCOUNT->	.....	.....
BEG. DISC. WT.-->	.....	.....
FORCASTING NEXT WEEK'S PRICE AND WEIGHT DISCOUNT		
LAST WEEK'S: (DATA FROM LIVESTOCK MEAT WOOL MARKET NEWS)		
LIVE SAN ANGELO SLAUGHTER PRICE>	.....	
NO. 1 PELT PRICE>	.....	
AVERAGE DRESSED WEIGHT (LBS.)-->	.....	
TOTAL KILL (1,000 HEAD)--->	.....	
FORCASTED PRICE->	NA	
LAST WEEK'S N.Y. WHOLESALE PRICE:		
50-55 LB CAR.-->	.....	
55-65 LB CAR.-->	.....	
FORCASTED DISC.->	NA	
COST OF HOLDING LAMB		
FEED ($/100)---->	.....	
FEED EFFICIENCY (LB FEED/LB GA.)	.....	
INTEREST ($/LAMB /DAY)---------->	.....	
VET COST ($/LAMB /DAY)---------->	.....	
OTHER ($/LAMB/ DAY)---------->	.....	
OTHER INFORMATION:		
AVG. DAILY GAIN-->	.....	
TODAY'S WEIGHT--->	.....	
DECISION PERIOD (DAYS)--------->	.....	

Table 10. (Continued)

```
-----------------------------------------------------------------

RETURNS/TIME PERIOD:
 PRICE---------->              0.00                NA
 LAMB WEIGHT----->                0                 0
 DISCOUNTS:
  RAMS---------->              0.00              0.00
  WOOLED LAMBS--->             0.00              0.00
  NO. 1 PELTS---->             0.00              0.00
  NO. 2 PELTS---->             0.00              0.00
  NO. 3 PELTS---->             0.00              0.00
  TAILS---------->             0.00              0.00
  OLD CROPS------>             0.00              0.00
  GOODS---------->             0.00              0.00
  OTHER---------->             0.00              0.00
  WEIGHT--------->             0.00              0.00
  TOTAL DISCOUNTS>             0.00              0.00
 NET PRICE------->             0.00                NA
TOTAL REVENUES--->             0.00                NA

MARGINAL REVENUE->                      NA

-----------------------------------------------------------------

COSTS/TIME PERIOD:
  FEED---------->                    0.00
  INTEREST------>                    0.00
  VET----------->                    0.00
  OTHER---------->                   0.00

MARGINAL COSTS--->                   0.00

-----------------------------------------------------------------

DECISION: IF...
 ONE THEN HOLD--->
 ZERO THEN SELL-->                      NA

-----------------------------------------------------------------

BREAKEVEN ANALYSIS: (SEE EXPLANATION BELOW)
 (THESE ANALYSES ARE INDEPENDENT OF EACH OTHER.)

 BREAKEVEN:
  PRICE---------->                $    ERROR /CWT.
  WEIGHT--------->                        NA POUNDS
  A.D.G.--------->                        NA LBS/DAY

-----------------------------------------------------------------

EXPLANATION OF BREAKEVEN:  (SAME CONCEPT WORDED DIFFERENTLY)
 PRICE-IF THE ABOVE WEIGHTS AND GAINS ARE ASSUMED CORRECT,
       THIS IS NEXT WEEK'S ACTUAL PRICE YOU WOULD BE EXACTLY
       INDIFFERENT TO SELLING NOW OR HOLDING ONE WEEK.
 WEIGHT-IF ALL OTHER VARIABLES ARE ASSUMED CORRECT, THE
       LAMBS WOULD HAVE TO GAIN TO THE BREAKEVEN WEIGHT TO BE
       AS WELL OFF AS SELLING TODAY.
 A.D.G.-FOR EXAMPLE, IF THE ABOVE VAIABLES ARE CORRECT,
       YOU WOULD BE JUST AS WELL OFF BY SELLING THIS WEEK
       OR GETTING THIS BREAKEVEN A.D.G. AND SELLING NEXT WEEK.

-----------------------------------------------------------------
```

period. Feed costs may be calculated if the price of the feed ($/cwt.) and feed efficiency are entered into the appropriate spaces.

It should be noted that if the forecasted live price and weight discount option is chosen, the decision period must be one week. These forecasts would be invalid for any other length of time because the econometric models were only developed to forecast prices and weight discounts one week forward. Furthermore, if the forecasting models are to be used, the individual's estimates of the live price and weight discount must be zero.

The output page is the second part of the decision making tool (Table 10, continued). Given the assumptions and numbers in part one, the program calculates the applicable discounts, prices, total values, marginal revenue and marginal cost for the producer. Also, a decision (SELL or HOLD) is recommended by the program and breakeven statistics are calculated. The breakeven values for live price, weight and average daily gain are computed and interpretations are given.

List of Formulas

A complete list of formulas used in the template is shown in Table 11. To interpret the formulas, Table 12 was constructed with row and column designations. For example, in calculating cell F110 (breakeven price), F96 (marginal cost) is added to E84 (total revenue in period one), multiplied by 100 and divided by G70 (the lamb weight in period two). G82 (total discounts in period two) is added to the above and F110 is computed. A listing of the program for the entire template appears in Appendix B.

Table 11. Listing of Formulas Used in Visicalc Template

```
)F112:/F$(((E84+F96)*100/G69)-F61)/F63
)F111:/F$(E84+F96)*100/G69
)F110:/F$((E84+F96)*100/G70)+G82
)F102:@IF(F86)F96,1,0)
)F96:/F$@SUM(F91...F94)
)F94:/F$+F58*F63
)F93:/F$+F56*F63
)F92:/F$+F54*F63
)F91:/F$+F50/100*F52*(G70-E70)
)F86:/F$+G84-E84
)G84:/F$+G83*G70/100
)E84:/F$+E83*E70/100
)G83:/F$+G69-G82
)E83:/F$+E69-E82
)G82:/F$@SUM(G72...G81)
)E82:/F$@SUM(E72...E81)
)G81:/F$@IF((G70-G31))0,(@IF(G30=0,(G70
     -G31)*F47,(G70-G31)*G30)),0)
)E81:/F$@IF((F61-E31))0,(F61-E31)*E30,0
     )
)G80:/F$+G16/G7*G26
)E80:/F$+E16/E7*E26
)G79:/F$+G15/G7*G25
)E79:/F$+E15/E7*E25
)G78:/F$+G14/G7*G24
)E78:/F$+E14/E7*E24
)G77:/F$+G13/G7*G23
)E77:/F$+E13/E7*E23
)G76:/F$+G12/G7*G22
)E76:/F$+E12/E7*E22
)G75:/F$+G11/G7*G21
)E75:/F$+E11/E7*E21
)G74:/F$+G10/G7*G20
)E74:/F$+E10/E7*E20
)G73:/F$+G9/G7*G19
)E73:/F$+E9/E7*E19
)G72:/F$+G8/G7*G18
)E72:/F$+E8/E7*E18
)G70:(F60*F63)+F61
)E70:/FG+F61
)G69:/F$@IF(G29=0,F42,G29)
)E69:/F$+E29
)F47:/F$(((F45-F46)*.8045)+2.721-@CHOOS
     E(D4,.1476,.6577,0,1.773,2.32,2.3
     1,2.35,2.567,2.512,1.793,.226,.97
     8))*.005
)F42:/F$(.8549*F36)-(.000451*F39*F41)+(
     .2046*F37)+10.78-@CHOOSE(D4,1.175
     ,.4495,.69,-1.355,0,1.413,1.018,1
     .45,.829,.954,1.73,.294)
```

Table 12. Row and Column Designations for the Visicalc Template

		COLUMNS						
		B	C	D	E	F	G	H
ROWS	1	MARGINAL COST-MARGINAL REVENUE APPROACH TO LAMB MARKETING						
	2							
	3	ITEM:			THIS PERIOD'S		NEXT PERIOD'S	
	4	MONTH OF YEAR----> ..			DATA		DATA	
	5							
	6	NUMBER OF LAMBS:						
	7	TOTAL LAMBS----->			1		1	
	8	RAMS---------->			.....		.....	
	9	WOOLED LAMBS--->			.....		.....	
	10	NO. 1 PELTS---->			.....		.....	
	11	NO. 2 PELTS---->			.....		.....	
	12	NO. 3 PELTS---->			.....		.....	
	13	TAILS---------->			.....		.....	
	14	OLD CROPS------>			.....		.....	
	15	GOODS---------->			.....		.....	
	16	OTHER---------->			.....		.....	
	17	DISCOUNTS ($/CWT):						
	18	RAMS---------->			.....		.....	
	19	WOOLED LAMBS--->			.....		.....	
	20	NO. 1 PELTS---->			.....		.....	
	21	NO. 2 PELTS---->			.....		.....	
	22	NO. 3 PELTS---->			.....		.....	
	23	TAILS---------->			.....		.....	
	24	OLD CROPS------>			.....		.....	
	25	GOODS---------->			.....		.....	
	26	OTHER---------->			.....		.....	
	27							
	28	YOUR ESTIMATES: (MUST BE ZERO IF FORCASTING)						
	29	LIVE PRICE------>			.....		.....	
	30	WEIGHT DISCOUNT->			.....		.....	
	31	BEG. DISC. WT.-->			.....		.....	
	32							
	33	FORCASTING NEXT WEEK'S PRICE AND WEIGHT DISCOUNT						
	34	LAST WEEK'S: (DATA FROM LIVESTOCK MEAT WOOL MARKET NEWS)						
	35	LIVE SAN ANGELO						
	36	SLAUGHTER PRICE>				.....		
	37	NO. 1 PELT PRICE>				.....		
	38	AVERAGE DRESSED						
	39	WEIGHT (LBS.)-->				.....		
	40	TOTAL KILL						
	41	(1,000 HEAD)--->				.....		
	42	FORCASTED PRICE->				NA		
	43	LAST WEEK'S N.Y.						
	44	WHOLESALE PRICE:						
	45	50-55 LB CAR.-->				.....		
	46	55-65 LB CAR.-->				.....		
	47	FORCASTED DISC.->				NA		
	48							
	49	COST OF HOLDING LAMB						
	50	FEED ($/100)---->				.....		
	51	FEED EFFICIENCY						
	52	(LB FEED/LB GA.)				.....		
	53	INTEREST ($/LAMB						
	54	/DAY)---------->				.....		
	55	VET COST ($/LAMB						
	56	/DAY)---------->				.....		
	57	OTHER ($/LAMB/						
	58	DAY)----------->				.....		
	59	OTHER INFORMATION:						
	60	AVG. DAILY GAIN-->				.....		
	61	TODAY'S WEIGHT--->				.....		
	62	DECISION PERIOD						
	63	(DAYS)--------->				.....		

Table 12. (Continued)

```
                                  COLUMNS
        <---B---><---C---><---D---><---E---><---F---><---G---><---H--->
ROWS 66-------------------------------------------------------------------
     67
     68RETURNS/TIME PERIOD:
     69 PRICE----------->                  0.00                    NA
     70 LAMB WEIGHT----->                    0                     0
     71 DISCOUNTS:
     72  RAMS----------->                  0.00                  0.00
     73  WOOLED LAMBS--->                  0.00                  0.00
     74  NO. 1 PELTS---->                  0.00                  0.00
     75  NO. 2 PELTS---->                  0.00                  0.00
     76  NO. 3 PELTS---->                  0.00                  0.00
     77  TAILS---------->                  0.00                  0.00
     78  OLD CROPS------>                  0.00                  0.00
     79  GOODS---------->                  0.00                  0.00
     80  OTHER---------->                  0.00                  0.00
     81  WEIGHT--------->                  0.00                  0.00
     82  TOTAL DISCOUNTS>                  0.00                  0.00
     83 NET PRICE------->                  0.00                    NA
     84TOTAL REVENUES--->                  0.00                    NA
     85
     86MARGINAL REVENUE->                              NA
     87
     88-------------------------------------------------------------------
     89
     90COSTS/TIME PERIOD:
     91  FEED----------->                            0.00
     92  INTEREST------->                            0.00
     93  VET------------>                            0.00
     94  OTHER---------->                            0.00
     95
     96MARGINAL COSTS--->                            0.00
     97
     98-------------------------------------------------------------------
     99
    100DECISION: IF...
    101 ONE THEN HOLD--->
    102 ZERO THEN SELL-->                             NA
    103
    104------------------------------------------------------------------
    105
    106BREAKEVEN ANALYSIS: (SEE EXPLANATION BELOW)
    107 (THESE ANALYSES ARE INDEPENDENT OF EACH OTHER.)
    108
    109 BREAKEVEN:
    110  PRICE---------->                    $     ERROR /CWT.
    111  WEIGHT--------->                          NA POUNDS
    112  A.D.G.--------->                          NA LBS/DAY
    113
    114------------------------------------------------------------------
    115
    116EXPLANATION OF BREAKEVEN:  (SAME CONCEPT WORDED DIFFERENTLY)
    117 PRICE-IF THE ABOVE WEIGHTS AND GAINS ARE ASSUMED CORRECT,
    118       THIS IS NEXT WEEK'S ACTUAL PRICE YOU WOULD BE EXACTLY
    119       INDIFFERENT TO SELLING NOW OR HOLDING ONE WEEK.
    120 WEIGHT-IF ALL OTHER VARIABLES ARE ASSUMED CORRECT, THE
    121       LAMBS WOULD HAVE TO GAIN TO THE BREAKEVEN WEIGHT TO BE
    122       AS WELL OFF AS SELLING TODAY.
    123 A.D.G.-FOR EXAMPLE, IF THE ABOVE VAIABLES ARE CORRECT,
    124       YOU WOULD BE JUST AS WELL OFF BY SELLING THIS WEEK
    125       OR GETTING THIS BREAKEVEN A.D.G. AND SELLING NEXT WEEK.
    126
    127------------------------------------------------------------------
```

CHAPTER VI

SUMMARY AND CONCLUSIONS

Introduction

The major objective of this study was to develop a model which could be used by lamb producers to increase returns by marketing lambs at the most profitable weight and time. First, personal interviews were conducted with two lamb buyers to gain a better understanding of the price discovery process for slaughter lambs.

Second, seasonal indices were computed for several relevant variables and were used in the development of price forecasting tools. Several price forecasting methods were attempted, such as, moving averages, frequency distributions, probability distributions and the relative strength index, but results were unsatisfactory. An econometric model seemed to be the appropriate approach for forecasting lamb prices. Models for both live slaughter lamb prices and wholesale weight discounts were estimated and tested.

The marginal cost-marginal revenue approach to profit maximization was applied to data from 1978 through 1982. Mean prices and optimal sale weights were computed and analyzed for these five years. Net returns from the Actual Price and the Forecasted Price marketing strategy were compared and studied. Also, the Forecasted Price strategy average net returns were compared to the average net returns for three alternative marketing strategies (e.g. One-Weight, Two-Weight and Last Week's Price).

Summary of Findings

Pricing Process

In the discussions with lamb buyers it was determined that packers' profit function is dependent on several factors. These include the weight and price of wholesale carcasses, pelt prices, live prices and the weight of slaughter lambs, slaughter costs, the supply-demand situation, and competition among buyers. Several of these factors were used in determining variables to use in the econometric models, in developing the marketing tool, and in writing the computer program.

Seasonal Indices

Indices calculated exhibited an annual high in the spring months ranging from March to May. This suggests that seasonal total production and live price peaks occurred at the same time of the year. This phenomenon is contradictory to what theory would suggest, but may be explained by the seasonal increase in consumer demand for lamb in these months. The weight discount index follows the live price index, but peaks earlier than live prices do. This suggests that producers anticipate higher prices in the spring and carry lambs to heavier weights to take advantage of higher price levels.

Econometric Models

The live slaughter lamb price forecasting model predicted prices more accurately when price changes were small or constant and when live prices were decreasing. The forecast error and percent forecast

error were considerably smaller during these periods. However, when prices were increasing the model displayed the most forecast error. This error may be attributed to the bias of the larger values in the econometric model. The model was always one week behind during periods when prices were increasing rapidly. The mean forecast error for the model was $.25 which suggests that the forecasted price was high more times than it was low. However, the standard deviation of the forecast error was $1.30 which suggests considerable variation in forecasted prices.

The weight discount forecasting model did not perform as well as the live price model. The mean forecast error of the weight discount model was comparable, but the percent forecast error was many times larger than that of the live price model because the price to be predicted was so much smaller. Although the weight discounts were low in value ($2.00 to $20.00), the wholesale prices which they were calculated from were large (e.g. $110.00 to $130.00) and a $1.00 change at this price level would not have the impact that a $1.00 change in weight discount would have.

Marketing Tool

The marketing tool demonstrated that lambs could be carried to heavier weights economically in years when prices were relatively high or when marginal costs are relatively LOW. Also, when marginal cost was HIGH (LOW) the optimal sale weight was lower (heavier). This suggests that producers with lower marginal costs have more flexibility in their marketing program.

The average net return for the Actual Price marketing strategy was always higher than the Forecasted Price strategy and the three alternative marketing strategies. Use of the marketing tool and the econometric models did not significantly increase average net returns or increase stability in the returns.

Recommendations

The marketing tool may be used as one phase of the marketing program by a producer. Other considerations may include the individual producers' supply and demand situation, alternative marketing decision aids, information the producer may obtain which cannot be taken into account by this marketing tool, hauling distances, load size restraints and cash flow considerations, among others. All of these factors must be considered in making sound marketing decisions.

The value of the decision from the marketing tool depends on the assumptions and inputs the producer has made. The assistance of the micro-computer with the computations of this type of analysis assists the producer by decreasing the time and effort involved in making a sound, informed decision.

This tool may be used not only for lambs which are ready to be sold but also it may be used in common management decisions a producer must make. For instance, a producer may be contemplating the profitability of shearing feeder lambs as summer starts (resulting in faster gaining and more efficient lambs) vs. feeding them straight through to market (resulting in slower gaining, less efficient lambs, but with no shearing costs or pelt discounts). The relevant values

may be entered on the input page and a decision made for the specific circumstances. This then becomes another piece of information in the total decision making process.

BIBLIOGRAPHY

(1) Adams, Robert L. "Feed Efficiency and Carcass Characteristics of Ram and Ewe Lambs Fed for Two Weight Intervals and Slaughtered at Two Live Weights." Unpub. M.S. thesis, Oklahoma State University, 1975.

(2) Cornelius, J. C., J. E. Ikerd, and A. G. Nelson. "A Preliminary Evaluation of Price Forecasting Performance by Agricultural Economists." American Journal of Agricultural Economics, Vol. 63, No. 4 (1980): pp. 712-714.

(3) DeWeese, W. P., H. A. Glimp, H. D. Kemp and D. G. Ely. "Performance and Carcass Characteristics of Rams and Wethers Slaughtered at Different Weights." Kentucky Agricultural Experiment Station, PR 181, 1969.

(4) Doye, Damona G. "An Economic Evaluation of Alternative Sheep Production Systems in Oklahoma." Unpub. M.S. thesis, Oklahoma State University, 1981.

(5) Gould, J. P. and C. E. Ferguson. Microeconomic Theory, 5th Ed. Homewood, Illinois: Richard D. Irwin, Inc., 1980.

(6) Gould, M. B. and J. V. Whiteman. "Association of Certain Variables with the Performance of Spring vs. Fall-Born Lambs." Journal of Animal Science, Vol. 33, No. 3 (1971): pp. 531-536.

(7) Herriman, R. D., R. L. Adams, L. E. Walters, J. V. Whiteman and J. E. Fields. "Comparison of Feed Efficiency for Two Weight and Ewe Lambs." Animal Science Research Report: Beef and Dairy Cattle, Swine, Sheep and Their Products. Oklahoma Agricultural Experiment Station, MP-103 (April 1978): pp. 140-146.

(8) Jordan, R. M. and H. E. Hanke. "Effect of Sale Weight and Time on Feed, on Weight Gains, Feed Intake, Feed Efficiency, Feed Costs, and Profit Margin of Feedlot Lambs." University of Minnesota Institute of Agriculture West Central Experiment Station MORRIS, 5-165, 1981.

(9) Just, R. E., and G. C. Rausser. "Commodity Price Forecasting with Large-Scale Econometric Models and the Futures Market." American Journal of Agricultural Economics, Vol. 63, No. 2 (1981): pp. 197-288.

(10) Kohls, Richard L. and Joseph N. Uhl. Marketing of Agricultural Products, 5th Ed., New York: Macmillan Publishing Co., Inc., 1980.

(11) Meyers, Cecil H. Elementary Business and Economic Statistics, 2nd Ed. Belmont, California: Wadsworth Publishing Company, Inc., 1970.

(12) Orskov, E. R., C. Fraser and J. C. Gill. "A Note on the Effect of Time of Weaning and Weight at Slaughter of Feed Utilization of Intensively Fed Lambs." Anim. Prod., Vol. 16 (1973): pp. 311.

(13) Orskov, E. R., I. McDonald, C. Fraser and Elizabeth L. Corse. "The Nutrition of the Early Weaned Lamb: The Effect of ad libitum Intake of Kiets Varying in Protein Concentration on Performance and Body Composition at Different Live Weights." Journal of Animal Science, Vol. 77 (1971): pp. 351.

(14) Quam, Bob. Personal Interview. San Angelo, Texas, January 7, 1982.

(15) Scott, George. The Sheepman's Production Handbook, 2nd Ed. Denver, Colorado: Abegg Printing, 1975.

(16) Sents, A. E., D. L. Beerwinkle, J. V. Whiteman, L. E. Walters and J. E. Fields. "Feed Efficiency and Carcass Characteristics of Ram Lambs Born in Three Seasons and Slaughtered at Four Weights." Animal Science Research Report: Beef and Dairy Cattle, Swine, Sheep and Their Products. Oklahoma Agricultural Experiment Station, MP-107 (April, 1980): pp. 31-36.

(17) Shelton, Maurice and A. L. Carpenter. "Influence of Sex, Stilbestrol Treatment and Slaughter Weight on Performance and Carcass Traits of Slaughter Lambs." Journal of Animal Science, Vol. 34 (1972): pp. 203.

(18) Thomas, D. L., J. V. Whiteman and L. E. Walters. "Carcass Traits of Lambs Produced by Crossbred Dams of Finnsheep, Dorset and Rambouillet Breeding and Slaughtered at Two Weights." Journal of Animal Science, Vol. 43, No. 2 (1976): pp. 373-379.

(19) Thomsen, Frederick L. and Richard J. Foote. Agricultural Prices, 2nd Ed. New York: McGraw-Hill Book Company, Inc., 1952.

(20) Tomek, William G. and Kenneth L. Robinson. Agricultural Product Prices, 2nd Ed. New York: Cornell University Press, 1982.

(21) U. S. Department of Agriculture. Agricultural Prices: Annual Summary 1981. Washington: Crop Reporting Board. Economics, Statistics, and Cooperative Service, 1982.

(22) _____. Agricultural Prices: Annual Summary 1980. Washington, D. C.: Crop Reporting Board. Economics, Statistics, and Cooperative Service, 1981.

(23) _____. The Lamb Industry: An Economic Study of Marketing Structure, Practices, and Problems. Washington, D. C.: Packers and Stockyards Administration, Economic Research Service, 1973.

(24) _____. Livestock and Meat Statistics: Supplement for 1980. Washington, D. C.: U.S. Government Printing Office, 1981.

(25) _____. Livestock and Meat Statistics: Supplement for 1981. Washington, D. C.: U.S. Government Printing Office, 1982.

(26) _____. Livestock-Meat-Wool Market News: Weekly Summary and Statistics, Vols. 46-50. Washington, D. C.: Livestock, Meat, Grain and Seed Division, Agriculture Marketing Service, 1978-82.

(27) _____. Outlook and Situation: Livestock and Poultry. Washington, D. C.: Economic Research Service, 1983.

(28) Usman, Mohammad and C. Kerry Gee. Prices and Demand For Lamb in the United States. Fort Collins, Colorado: State University Experiment Station, Technical Bulletin 132. 1976

(29) Ward, Clement E. "Market Information and Its Application in Lamb Marketing Decisions." Proceedings, National Lamb Marketing Symposium. Denver, Colorado: Sheep Industry Development, 1981.

(30) _____. "Marketing Lambs by Tele-auction." Stillwater: Oklahoma State University Cooperative Extension Service. OSU Extension Facts No. 456, October, 1980.

(31) _____. "Marketing Lambs for Increased Profit." Stillwater: Oklahoma State University Cooperative Extension Service. OSU Extension Facts No. 441, July, 1979.

APPENDIXES

APPENDIX A

SUPPLEMENTARY FIGURES AND TABLES

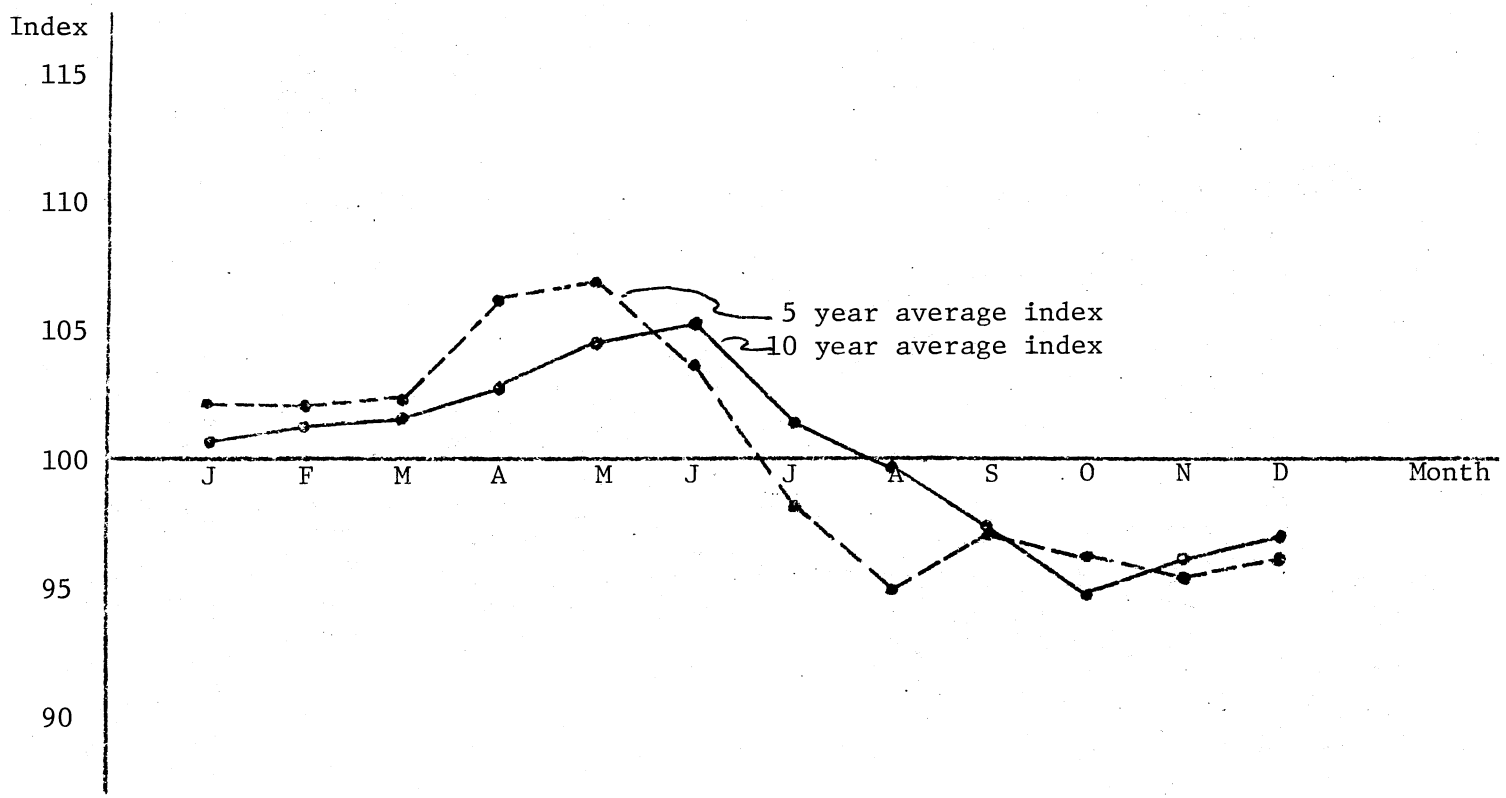

Figure 15. Seasonal Index for Wholesale Lamb Carcass Prices, Ten Year and Last Five Year Averages (January, 1971 - December, 1980)

Table 13. Seasonal Index for Wholesale Lamb Carcuss Prices, Ten Year and Last Five Year Averages (January, 1971 - December, 1980)

	10-Year Index			Last 5-Year Index		
	Average	Standard Error	Standard Deviation	Average	Standard Error	Standard Deviation
January	100.4	1.3	4.2	102.3	1.4	3.1
February	101.1	1.5	4.9	102.3	1.5	3.3
March	101.6	1.6	5.1	102.6	1.5	3.3
April	103.0	1.7	5.3	106.8	1.0	2.3
May	104.9	2.6	8.3	107.6	5.0	11.3
June	105.4	1.5	4.9	104.1	2.5	5.7
July	101.3	1.4	4.5	97.8	1.3	2.9
August	99.9	2.9	9.1	94.1	2.4	5.3
September	96.6	1.6	5.2	96.5	3.2	7.2
October	94.0	1.6	5.2	95.6	2.0	4.6
November	95.6	1.2	3.8	94.9	1.2	2.6
December	96.3	1.3	4.2	95.5	2.3	5.0

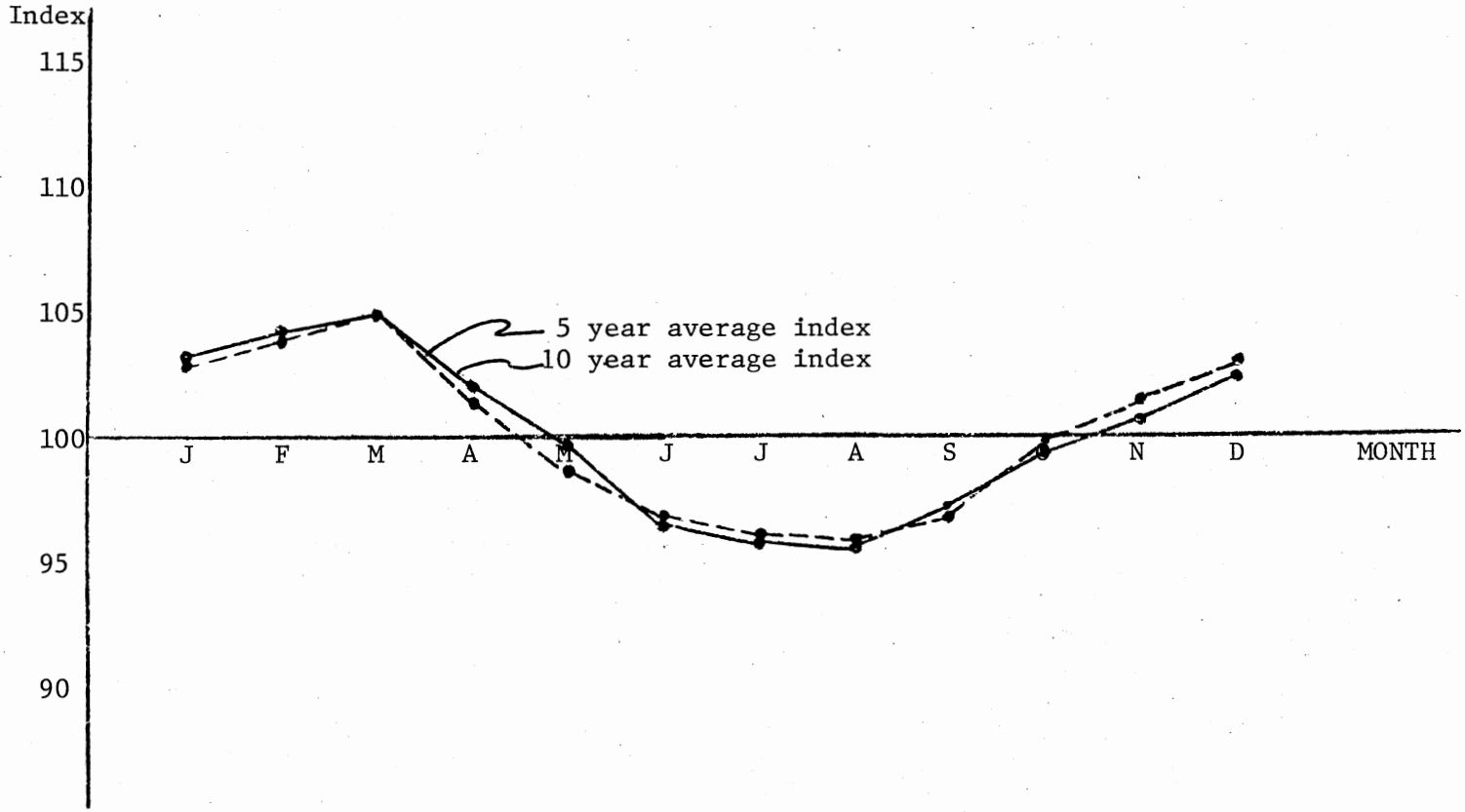

Figure 16. Seasonal Index of Average Dressed Weight for Lamb, Ten Year and Last Five Year Averages (January, 1971 - December, 1980)

Table 14. Seasonal Index of Average Dressed Weight for Lamb, Ten Year and Last Five Year Averages (January, 1971 - December, 1980)

	10-Year Index			Last 5-Year Index		
	Average	Standard Error	Standard Deviation	Average	Standard Error	Standard Deviation
January	103.5	0.5	1.6	103.4	0.9	2.0
February	104.2	0.4	1.2	104.1	0.6	1.3
March	105.2	0.5	1.6	105.2	0.8	1.7
April	102.0	0.4	1.4	101.3	0.7	1.6
May	99.5	0.9	2.7	98.8	1.0	2.2
June	96.1	0.5	1.4	96.3	0.6	1.4
July	95.5	0.6	2.0	95.7	1.1	2.5
August	95.1	0.4	1.3	95.3	0.8	1.8
September	96.5	0.5	1.5	96.2	0.9	1.9
October	99.1	0.4	1.1	99.3	0.6	1.3
November	100.7	0.3	1.0	101.2	0.4	0.9
December	102.7	0.5	1.4	103.1	0.8	1.8

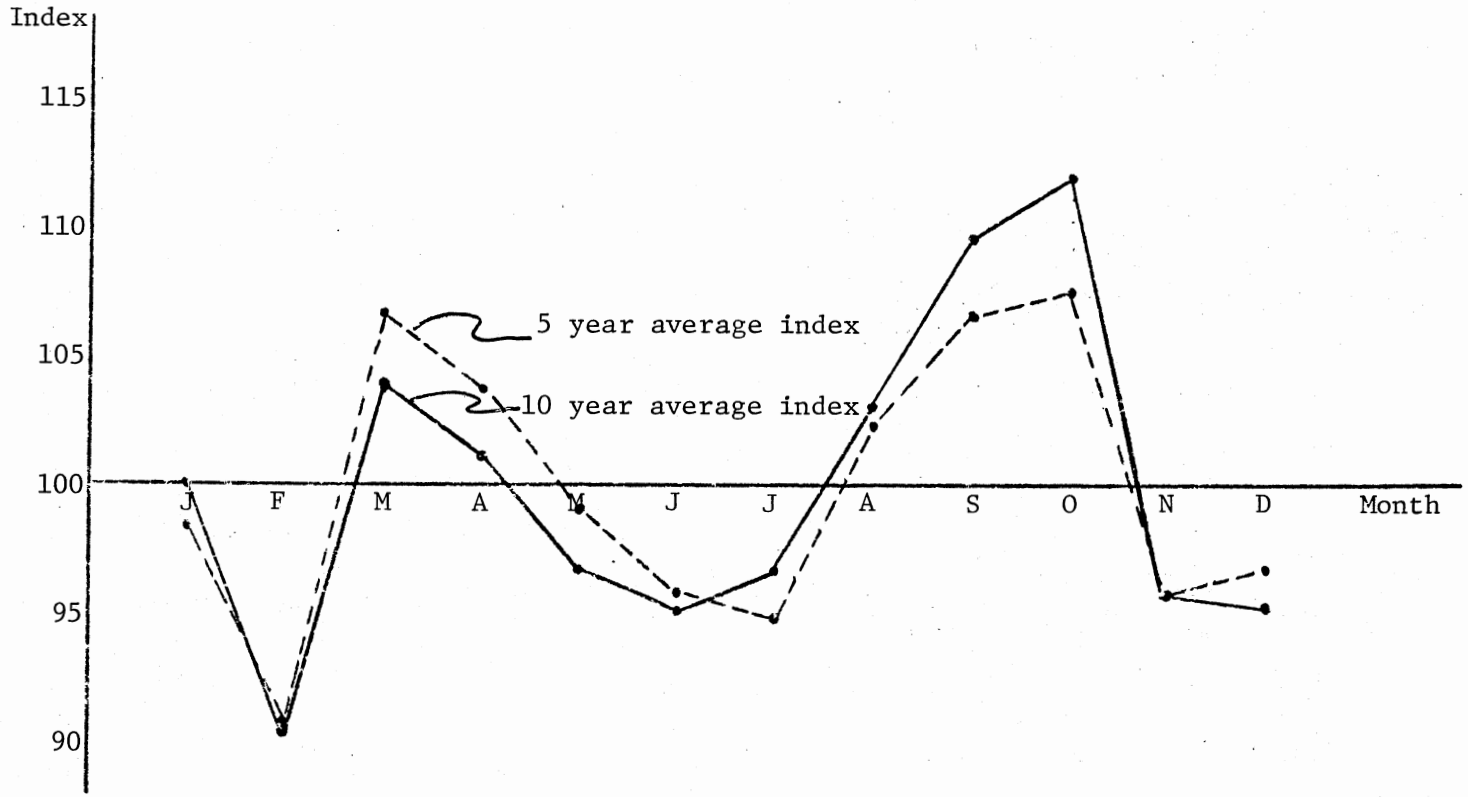

Figure 17. Seasonal Index for Number of Lambs Slaughtered, Ten Year and Last Five Year Averages, (January, 1971 - December, 1980)

Table 15. Seasonal Index for Number of Lambs Slaughtered, Ten Year and Last Five Year Averages, (January, 1971 - December, 1980)

	10-Year Index			Last 5-Year Index		
	Average	Standard Error	Standard Deviation	Average	Standard Error	Standard Deviation
January	100.0	1.7	5.4	98.3	3.2	7.2
February	89.3	1.5	4.8	89.7	2.4	5.4
March	104.3	1.9	6.2	107.5	0.9	2.0
April	101.0	2.1	6.8	104.1	2.0	4.5
May	96.7	2.8	8.9	98.2	3.3	7.3
June	94.6	2.2	6.9	96.5	3.3	7.4
July	96.7	1.5	4.8	94.6	1.0	2.1
August	103.6	1.9	5.9	102.9	2.6	5.8
September	110.2	2.7	8.4	107.4	3.7	8.2
October	113.0	1.9	6.1	108.6	1.1	2.5
November	95.6	1.7	5.4	95.6	1.7	3.9
December	94.9	2.0	6.4	96.6	2.1	4.7

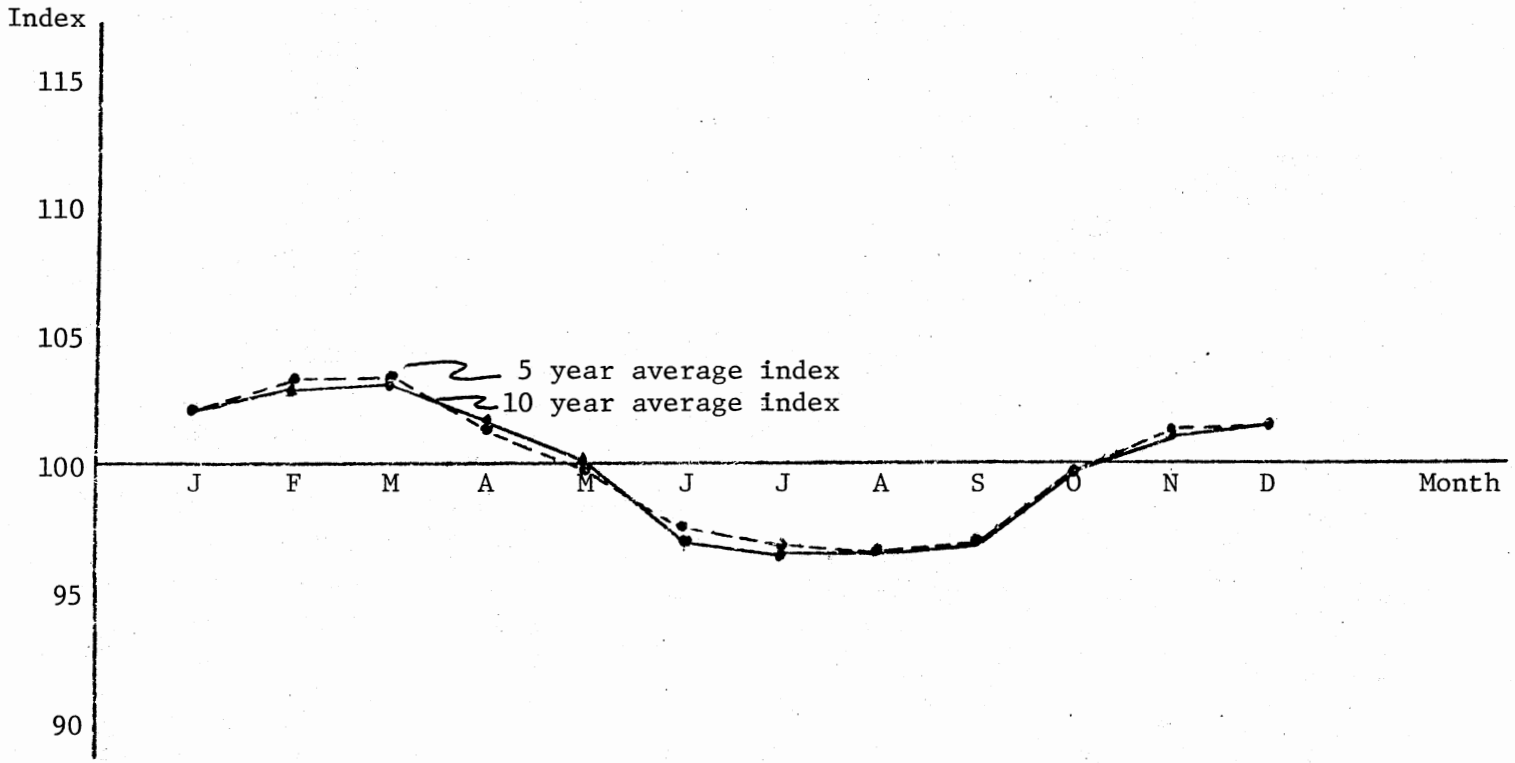

Figure 18. Seasonal Liveweight Index for Slaughter Lamb, Ten Year and Last Five Year Averages, January, 1971 - December, 1980)

Table 16. Seasonal Liveweight Index for Slaughter Lamb, Ten Year and Last Five Year Averages, (January, 1971 - December, 1980)

	10-Year Index			Last 5-Year Index		
	Average	Standard Error	Standard Deviation	Average	Standard Error	Standard Deviation
January	102.1	0.3	1.0	102.1	0.6	1.4
February	103.4	0.3	0.9	103.7	0.5	1.1
March	103.8	0.3	1.1	103.9	0.5	1.2
April	101.5	0.4	1.2	101.0	0.6	1.4
May	100.0	0.6	2.1	99.8	0.9	1.9
June	96.9	.0.4	1.2	97.1	0.6	1.3
July	96.4	0.5	1.5	96.6	0.9	2.0
August	96.2	0.3	0.8	96.2	0.5	1.1
September	96.9	0.4	1.3	96.9	0.7	1.6
October	99.8	0.3	1.1	99.8	0.5	1.2
November	101.1	0.2	0.7	101.2	0.4	0.9
December	101.8	0.3	1.1	101.8	0.7	1.5

Table 17. Average Live Weight, Dressed Weight and Dressing Percentage of Sheep and Lambs Under Federal Inspection, 1970-81

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Average Live Weight	104.5	104.0	105.3	107.5	105.1	104.7	109.0	108	113	114	112	110
Average Dressed Weight	51.1	51.2	52.1	52.9	51.7	51.3	54.1	54	56	57	56	55
Average Dressing Percentage	48.9	49.2	49.5	49.2	49.2	49.0	49.6	50.0	49.6	50.0	50.0	50.0

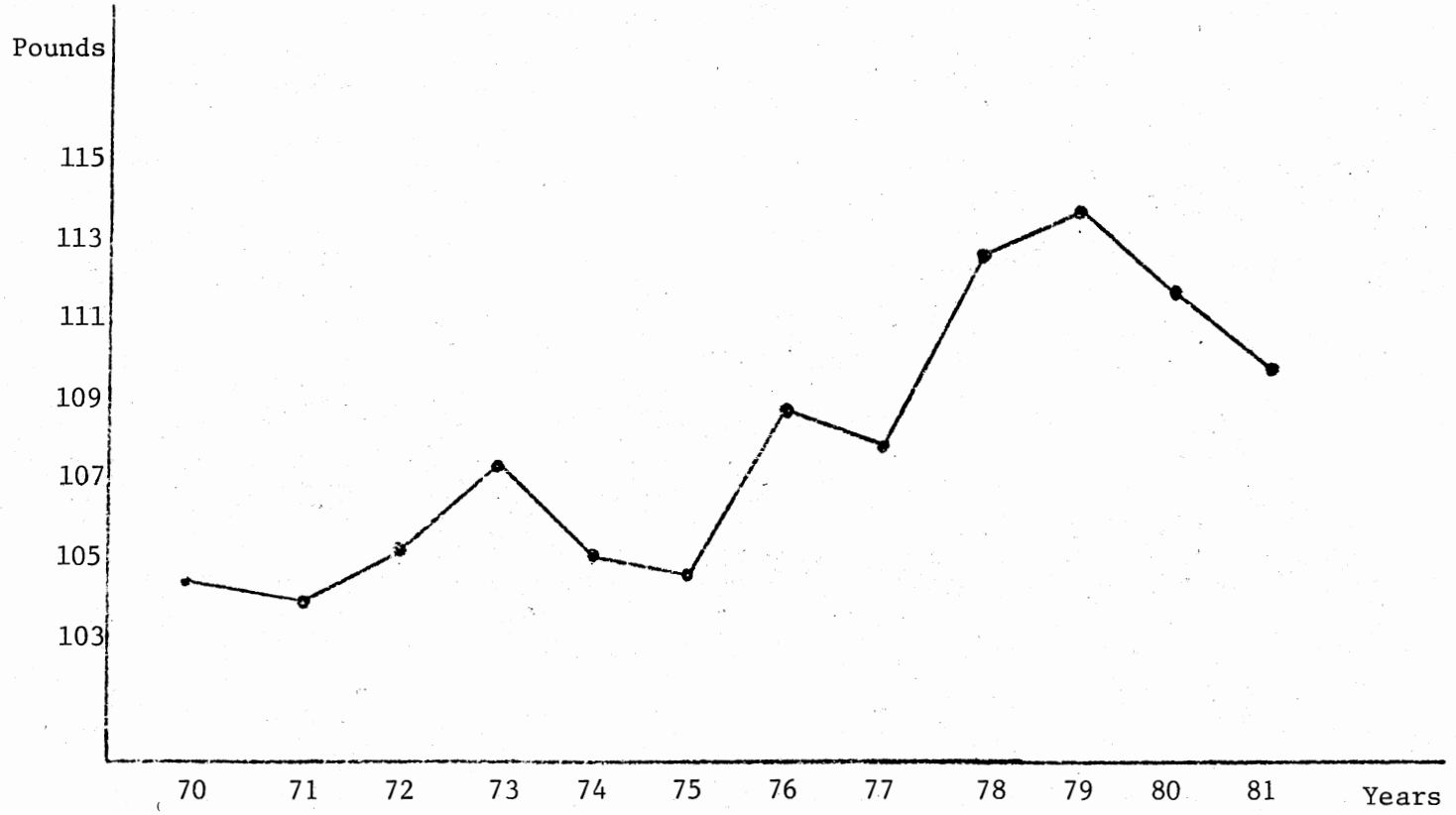

Figure 19. Annual Average Live Weight of Sheep and Lambs Under Federal Inspection, 1980-81

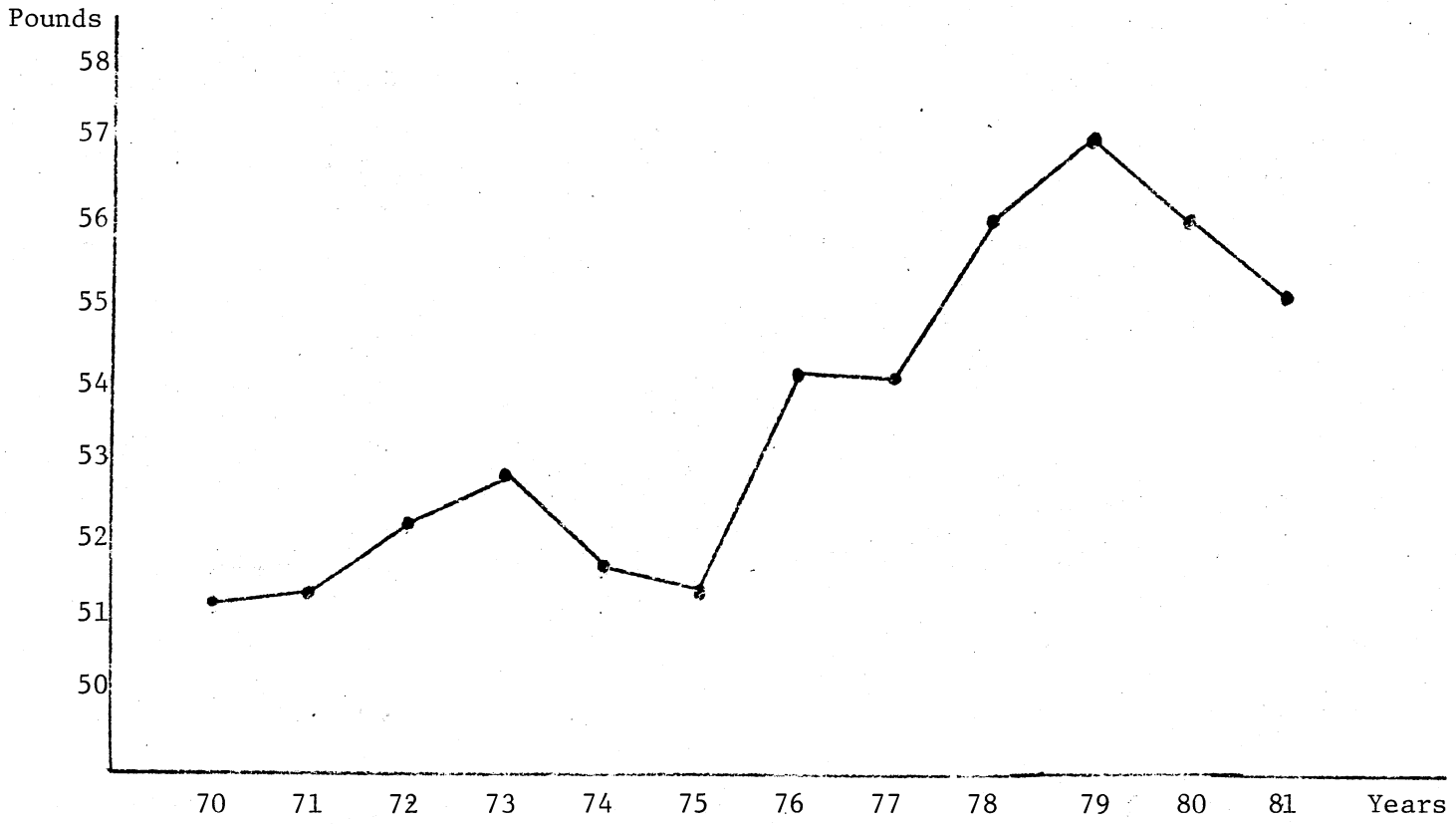

Figure 20. Annual Average Dressed Weight of Sheep and Lambs Under Federal Inspection, 1970-81

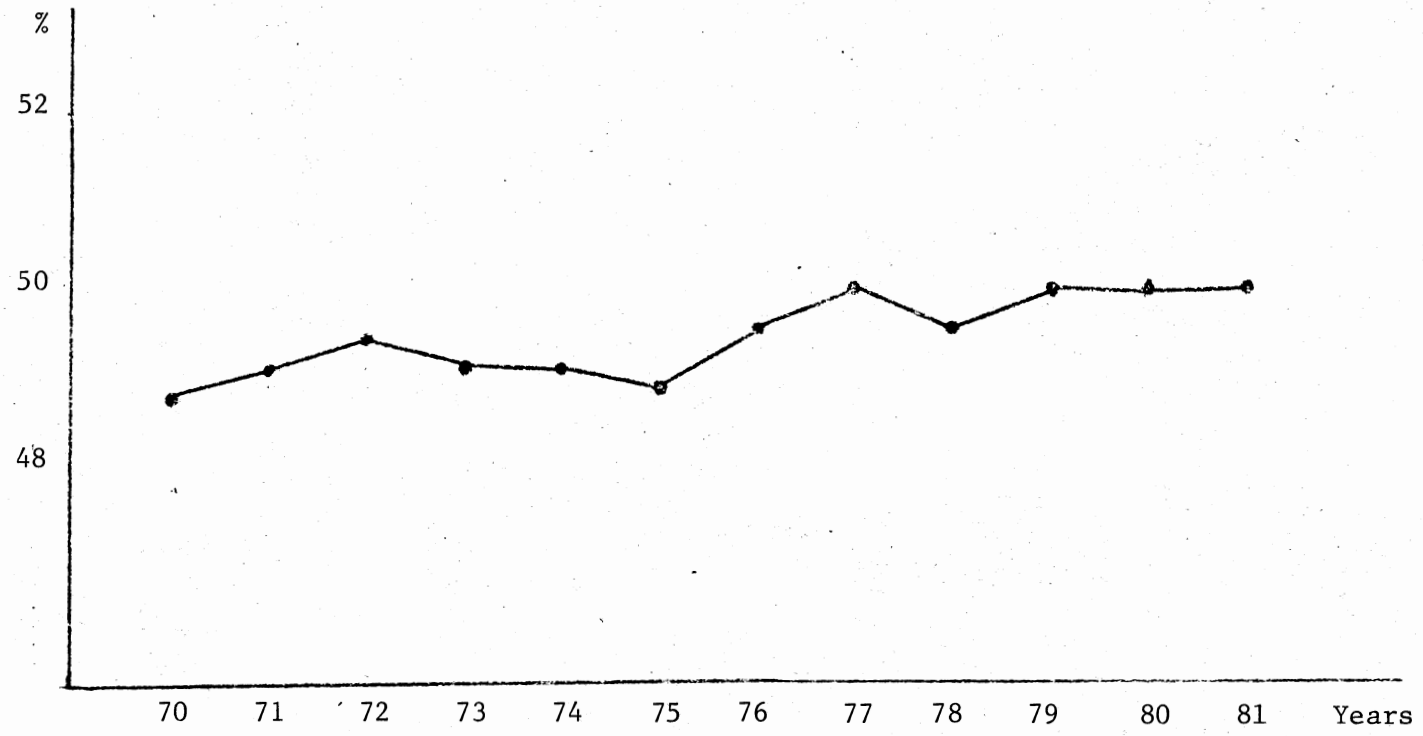

Figure 21. Annual Dressing Percentage of Sheep and Lambs Under Federal Inspection, 1970-81

APPENDIX B

PROGRAM LISTING

Table 18. Program Listing

```
)H127:/--
)G127:/--
)F127:/--
)E127:/--
)D127:/--
)C127:/--
)B127:/--
)H125:"XT WEEK.
)G125:"ELLING NE
)F125:".G. AND S
)E125:"KEVEN A.D
)D125:"THIS BREA
)C125:" GETTING
)B125:"          OR
)H124:"EEK
)G124:"NG THIS W
)F124:" BY SELLI
)E124:" WELL OFF
)D124:"E JUST AS
)C124:"U WOULD B
)B124:"          YO
)H123:",
)G123:"E CORRECT
)F123:"IABLES AR
)E123:" ABOVE VA
)D123:"E, IF THE
)C123:"OR EXAMPL
)B123:" A.D.G.-F
)E122:"NG TODAY.
)D122:" AS SELLI
)C122:" WELL OFF
)B122:"          AS
)H121:"T TO BE
)G121:"VEN WEIGH
)F121:"HE BREAKE
)E121:"GAIN TO T
)D121:" HAVE TO
)C121:"MBS WOULD
)B121:"          LA
)H120:"E
)G120:"RRECT, TH
)F120:"SSUMED CO
)E120:"LES ARE A
)D120:"ER VARIAB
)C120:"F ALL OTH
)B120:" WEIGHT-I
)G119:"ONE WEEK.
)F119:" HOLDING
)E119:"NG NOW OR
)D119:" TO SELLI
)C119:"DIFFERENT
)B119:"          IN
)H118:"XACTLY
)G118:"OULD BE E
)F118:"ICE YOU W
)E118:"ACTUAL PR
)D118:"T WEEK'S
)C118:"IS IS NEX
)B118:"          TH
)H117:"ECT,
)G117:"UMED CORR
)F117:"S ARE ASS
)E117:" AND GAIN
)D117:"E WEIGHTS
)C117:" THE ABOV
)B117:" PRICE-IF
)H116:"ENTLY)
)G116:"ED DIFFER
)F116:"CEPT WORD
)E116:"(SAME CON
)D116:"AKEVEN:
)C116:"ON. OF BRE
)B116:"EXPLANATI
)H114:/--
)G114:/--
)F114:/--
)E114:/--
)D114:/--
)C114:/--
)B114:/--
)G112:" LBS/DAY
)F112:/F$(((E84+F96)*10
      0/G69)-F61)/F63
)C112:"---------)
)B112:"   A.D.G.-
)G111:" POUNDS
)F111:/F$(E84+F96)*100/
      G69
)C111:"---------)
)B111:"   WEIGHT-
)G110:" /CWT.
)F110:/F$((E84+F96)*100
      /G70)+G82
)E110:"          $
)C110:"---------)
)B110:"   PRICE--
)C109:"N:
)B109:" BREAKEVE
)G107:"R.)
)F107:"EACH OTHE
```

Table 18. (Continued)

```
)E107:"NDENT OF
)D107:"RE INDEPE
)C107:"NALYSES A
)B107:" (THESE A
)F106:" BELOW)
)E106:"PLANATION
)D106:": (SEE EX
)C106:" ANALYSIS
)B106:"BREAKEVEN
)H104:/--
)G104:/--
)F104:/--
)E104:/--
)D104:/--
)C104:/--
)B104:/--
)F102:@IF(F86)F96,1,0)
)C102:"N SELL--)
)B102:" ZERO THE
)C101:" HOLD---)
)B101:" ONE THEN
)C100:" IF...
)B100:"DECISION:
)H98:/--
)G98:/--
)F98:/--
)E98:/--
)D98:/--
)C98:/--
)B98:/--
)F96:/F$@SUM(F91...F94)
)C96:"COSTS---)
)B96:"MARGINAL
)F94:/F$+F58*F63
)C94:"---------)
)B94:" OTHER--
)F93:/F$+F56*F63
)C93:"---------)
)B93:" VET----
)F92:/F$+F54*F63
)C92:"T--------)
)B92:" INTERES
)F91:/F$+F50/100*F52*(G
      70-E70)
)C91:"---------)
)B91:" FEED---
)C90:"E PERIOD:
)B90:"COSTS/TIM
)H88:/--
)G88:/--
)F88:/--
)E88:/--
)D88:/--
)C88:/--
)B88:/--
)F86:/F$+G84-E84
)C86:"REVENUE-)
)B86:"MARGINAL
)G84:/F$+G83*G70/100
)E84:/F$+E83*E70/100
)C84:"ENUES---)
)B84:"TOTAL REV
)G83:/F$+G69-G82
)E83:/F$+E69-E82
)C83:"E--------)
)B83:" NET PRIC
)G82:/F$@SUM(G72...G81)
)E82:/F$@SUM(E72...E81)
)C82:"ISCOUNTS)
)B82:" TOTAL D
)G81:/F$@IF((G70-G31))0
      ,(@IF(G30=0,(G70-G
      31)*F47,(G70-G31)*
      G30)),0)
)E81:/F$@IF((F61-E31))0
      ,(F61-E31)*E30,0)
)C81:"---------)
)B81:" WEIGHT-
)G80:/F$+G16/G7*G26
)E80:/F$+E16/E7*E26
)C80:"---------)
)B80:" OTHER--
)G79:/F$+G15/G7*G25
)E79:/F$+E15/E7*E25
)C79:"---------)
)B79:" GOODS--
)G78:/F$+G14/G7*G24
)E78:/F$+E14/E7*E24
)C78:"PS------)
)B78:" OLD CRO
)G77:/F$+G13/G7*G23
)E77:/F$+E13/E7*E23
)C77:"---------)
)B77:" TAILS--
)G76:/F$+G12/G7*G22
)E76:/F$+E12/E7*E22
)C76:"ELTS----)
)B76:" NO. 3 P
)G75:/F$+G11/G7*G21
)E75:/F$+E11/E7*E21
```

Table 18. (Continued)

```
)C75:"ELTS----)
)B75:"  NO. 2 P
)G74:/F$+G10/G7*G20
)E74:/F$+E10/E7*E20
)C74:"ELTS----)
)B74:"  NO. 1 P
)G73:/F$+G9/G7*G19
)E73:/F$+E9/E7*E19
)C73:"LAMBS---)
)B73:"  WOOLED
)G72:/F$+G8/G7*G18
)E72:/F$+E8/E7*E18
)C72:"--------)
)B72:"  RAMS---
)C71:"S:
)B71:" DISCOUNT
)G70:(F60*F63)+F61
)E70:/FG+F61
)C70:"GHT-----)
)B70:" LAMB WEI
)G69:/F$@IF(G29=0,F42,G
      29)
)E69:/F$+E29
)C69:"--------)
)B69:" PRICE---
)D68:"D:
)C68:"IME PERIO
)B68:"RETURNS/T
)H66:/--
)G66:/--
)F66:/--
)E66:/--
)D66:/--
)C66:/--
)B66:/--
)H64:/--
)G64:/--
)F64:/--
)E64:/--
)D64:/--
)C64:/--
)B64:/--
)F63:"    .....
)C63:"--------)
)B63:"  (DAYS)-
)C62:"PERIOD
)B62:"DECISION
)F61:"    .....
)C61:"EIGHT---)
)B61:"TODAY'S W
)F60:"    .....
)C60:"Y GAIN--)
)B60:"AVG. DAIL
)C59:"ORMATION:
)B59:"OTHER INF
)F58:/F$"    .....
)E58:/F$
)C58:"--------)
)B58:"  DAY)---
)C57:"/LAMB/
)B57:" OTHER ($
)F56:/F$"    .....
)E56:/F$
)C56:"--------)
)B56:"  /DAY)--
)C55:" ($/LAMB
)B55:" VET COST
)F54:/F$"    .....
)E54:/F$
)C54:"--------)
)B54:"  /DAY)--
)C53:" ($/LAMB
)B53:" INTEREST
)F52:"    .....
)C52:"D/LB GA.)
)B52:"  (LB FEE
)C51:"ICIENCY
)B51:" FEED EFF
)F50:/F$"    .....
)E50:/F$
)C50:"100)----)
)B50:" FEED ($/
)D49:"MB
)C49:"OLDING LA
)B49:"COST OF H
)H48:/--
)G48:/--
)F48:/--
)E48:/--
)D48:/--
)C48:/--
)B48:/--
)F47:/F$(((F45-F46)*.80
      45)+2.721-@CHOOSE(
      D4,.1476,.6577,0,1
       .773,2.32,2.31,2.3
       5,2.567,2.512,1.7
      93,.226,.978))*.005
)C47:"D DISC.-)
```

Table 18. (Continued)

```
)B47:"  FORCASTE
)F46:/F$"     ......
)E46:/F$
)C46:"B  CAR.--)
)B46:"   55-65 L
)F45:/F$"     ......
)C45:"B  CAR.--)
)B45:"   50-55 L
)F44:/F$
)E44:/F$
)C44:"E  PRICE:
)B44:"  WHOLESAL
)C43:"'S N.Y.
)B43:"LAST  WEEK
)F42:/F$(.8549*F36)-
      (.000451*F39*F41)
      +(.2046*F37)+10.78
      -@CHOOSE(D4,1
      .175,.4495,.69,-1.355
      ,0,1.413,1.018,1.45,
      .829,.954,1.73,.294)
)E42:/F$
)C42:"D  PRICE-)
)B42:"  FORCASTE
)F41:"     ......
)C41:"HEAD)---)
)B41:"   (1,000
)C40:"LL
)B40:"  TOTAL KI
)F39:"     ......
)C39:"(LBS.)--)
)B39:"   WEIGHT
)F38:/F$
)E38:/F$
)C38:"DRESSED
)B38:"  AVERAGE
)F37:/F$"     ......
)C37:"LT  PRICE)
)B37:"  NO. 1 PE
)F36:/F$"     ......
)E36:/F$
)C36:"ER  PRICE)
)B36:"   SLAUGHT
)C35:"  ANGELO
)B35:"  LIVE SAN
)H34:"WS)
)G34:"MARKET NE
)F34:"EAT  WOOL
)E34:"VESTOCK M
)D34:"A  FROM LI
)C34:"'S:   (DAT
)B34:"LAST  WEEK
)G33:"UNT
)F33:"GHT  DISCO
)E33:"E  AND  WEI
)D33:"EK'S  PRIC
)C33:"G  NEXT  WE
)B33:"FORCASTIN
)H32:/--
)G32:/--
)F32:/--
)E32:/--
)D32:/--
)C32:/--
)B32:/--
)G31:"     ......
)E31:"     ......
)C31:"C.  WT.--)
)B31:"  BEG.  DIS
)G30:/F$"     ......
)E30:/F$"     ......
)C30:"ISCOUNT-)
)B30:"  WEIGHT  D
)G29:/F$"     ......
)E29:/F$"     ......
)C29:"CE------)
)B29:"  LIVE  PRI
)F28:"CASTING)
)E28:"RO  IF  FOR
)D28:"UST  BE  ZE
)C28:"MATES:  (M
)B28:"YOUR  ESTI
)H27:/--
)G27:/--
)F27:/--
)E27:/--
)D27:/--
)C27:/--
)B27:/--
)G26:/F$"     ......
)E26:/F$"     ......
)C26:"--------)
)B26:"   OTHER--
)G25:/F$"     ......
)E25:/F$"     ......
)C25:"--------)
)B25:"   GOODS--
)G24:/F$"     ......
)E24:/F$"     ......
)C24:"PS------)
```

Table 18. (Continued)

```
)B24:"   OLD CRO
)G23:/F$"     .....
)E23:/F$"     .....
)C23:"--------)
)B23:"   TAILS--
)G22:/F$"     .....
)E22:/F$"     .....
)C22:"ELTS----)
)B22:"   NO. 3 P
)G21:/F$"     .....
)E21:/F$"     .....
)C21:"ELTS----)
)B21:"   NO. 2 P
)G20:/F$"     .....
)E20:/F$"     .....
)C20:"ELTS----)
)B20:"   NO. 1 P
)G19:/F$"     .....
)E19:/F$"     .....
)C19:"LAMBS---)
)B19:"   WOOLED
)G18:/F$"     .....
)E18:/F$"     .....
)C18:"--------)
)B18:"   RAMS---
)C17:"  ($/CWT):
)B17:"DISCOUNTS
)G16:"    .....
)E16:"    .....
)C16:"--------)
)B16:"   OTHER--
)G15:"    .....
)E15:"    .....
)C15:"--------)
)B15:"   GOODS--
)G14:"    .....
)E14:"    .....
)C14:"PS------)
)B14:"   OLD CRO
)G13:"    .....
)E13:"    .....
)C13:"--------)
)B13:"   TAILS--
)G12:"    .....
)E12:"    .....
)C12:"ELTS----)
)B12:"   NO. 3 P
)G11:"    .....
)E11:"    .....
)C11:"ELTS----)
```

```
)B11:"   NO. 2 P
)G10:"    .....
)E10:"    .....
)C10:"ELTS----)
)B10:"   NO. 1 P
)G9:"     .....
)E9:"     .....
)C9:"LAMBS---)
)B9:"   WOOLED
)G8:"     .....
)E8:"     .....
)C8:"--------)
)B8:"   RAMS---
)G7:1
)E7:1
)C7:"MBS-----)
)B7:"  TOTAL LA
)C6:"  LAMBS:
)B6:"NUMBER OF
)H5:/--
)G5:/--
)F5:/--
)E5:/--
)D5:/--
)C5:/--
)B5:/--
)G4:"     DATA
)E4:"     DATA
)D4:/FL"  ..
)C4:"YEAR----)
)B4:"MONTH OF
)H3:"D'S
)G3:"EXT PERIO
)F3:"D'S      N
)E3:"HIS PERIO
)D3:"         T
)B3:"ITEM:
)H2:/--
)G2:/--
)F2:/--
)E2:/--
)D2:/--
)C2:/--
)B2:/--
)H1:"KETING
)G1:"  LAMB MAR
)F1:"PROACH TO
)E1:"EVENUE AP
)D1:"ARGINAL R
)C1:"AL COST-M
```

Table 18. (Continued)

```
)B1:"     MARGIN
/W1
/GOR
/GRM
/GC9
/X!/X)A1:)A1:
```

VITA

Mark Thomas Detten

Candidate for the Degree of

Master of Science

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