4-1970

Evaluating Economic Efficiency by Relative Price Analysis (Feed, Livestock and Product Sectors)

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Research Bulletin

239

April, 1970

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Issued April, 1970 1,500

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INTRODUCTION

The market price system plays an important role in a free economic society. It provides an indicator for the allocation of scarce resources among alternatives. It helps individuals as well as the group make decisions to obtain certain objectives or to achieve maximum satisfaction.

If a price and marketing system operates efficiently in the economy, there will be good functional performance in the production and marketing sectors. In reverse, it is believed that relevant indicators of efficient or inefficient production and marketing can be developed from price interrelationship with respects to space, form and time. Specific price analyses can evaluate economic efficiency as well as market performance relative to expected results for a competitive system.

There are some basic characteristics in agriculture (biological production, the inelastic demand for products, and the competitive market structure) which cause disorderly production and market performance. Because of the biological nature of production, it is difficult to control the output subject to weather and disease. Moreover, there is a time lag between production initiation and output results so the producer must make production plans based on current prices and uncertain expected prices. In this case, it is hard to make any significant adjustment or reallocation of resources in response to changing prices after the production plan is put into action. This is one of the reasons for the disorderly production in agriculture and the undesirable disequilibrium price results.

The competitive market structure in agriculture has several implications.

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First, there are a large number of firms in the industry and, therefore, no individual operator can control total output, price or the rate of adoption of new technology. All they can do is make decisions or changes which they believe will be most profitable.

Second, a homogeneous product, at least within fairly broad categories, must be expected in a competitive industry. So, the price received by an individual producer cannot vary significantly from that of others for similar products.

Third, there are few or no barriers to entry in a competitive industry. These conditions generally exist in agriculture, both in the industry as a whole and in the production of certain crops or livestock. Because of the competitive structure in agriculture, the total amount of output produced is difficult to control.

The total amount produced in aggregate is the sum of the amounts which individuals produce. Individual plans are made without full knowledge of the plans of all others and their economic results and what motivates one producer tends to motivate too many others and excessive aggregate adjustments result.

In addition, the characteristic of inelastic demand of farm products must be considered as an important factor which results in disequilibrium production and marketing in agriculture. The inelastic demand means that modest fluctuations in the output on the market will lead to large fluctuations in the price of the product. These price changes can be quite large, especially in an unsupported market. It creates a serious problem for resource allocation in farming as well as income distribution in the industry.

The combination of these characteristics stated above causes disequilibrium production and market performance in many sectors of the agricultural industry. In some crop and livestock sectors, the production and prices follow a cycle based on the famous "cobweb" pattern. This is a recurring pattern of high production and low prices followed by lower production and higher prices. It results from the fact that the individual operator tends to produce output in response to the current price level. Good examples are reflected by feed-grain, cattle and hog cycles. The length of these cycles depends on the length of time required to bring about significant changes in the output of the product involved.

The specific objective of this research is to delineate efficient and inefficient economic performance areas and thereby locate the more significant problem aspects for research and program attention. Specific price analyses will be used to evaluate the price interrelationships for functional efficiency in the dimensions of space, form and time. Not only the efficient aspects of production and marketing will be indicated by the analyses but the inefficient aspects of economic performance will be stressed also. This research will provide some foundational information for making decisions, both public and private. Moreover, it will direct the attention of researchers or program makers toward the specific aspects where problems exist which need further research or corrective action.

In this research the theoretical expected values for specific price relationship parameters will be regarded as the hypothetical bases for efficient relative price results. The evaluation of economic performance will be based on the comparison between estimated values and hypothetical values for parameters involved in each specific case. Relationships to be evaluated will be in the dimensions of space, form and time, with the latter two being the principal aspects. For the analyses among different types of form, certain reasonable cost or constant transformation rates will be assumed. If the analyses involve the time factor, it will be necessary to consider long-period and short-period separately.

Long-period price analyses will be employed to estimate the trends during certain periods of time primarily associated with technological changes.

Short-period price analyses will check the effectiveness of production and marketing decisions in maintaining orderly rates of production and sale. They evaluate the efficiency of immediate adjustments to cause price changes consistent with adjustment costs.

The mathematical form of the price relationships will be established on the basis of competitive economic theory. Using sample data, the estimation and evaluation analyses will employ the multiple regression model. Two criteria will be essential to evaluate production efficiency and marketing performance.

One of them is the R-squared value which indicates the strength of the association between the dependent variable and independent variables. The R-squared value will show the proportion of variation of the dependent variable which is explained by the independent variables.

The other criterion is the consistency of estimated parameters with the hypothetical values stated. The t-test will be used to test the significance of differences between these two values.

The specific area to be analyzed in this research will be limited to the feed, livestock and animal product sectors in agriculture. The analyses of certain price relationships with respect to space, form and time will be stated one by one. The analyses will be in the following order:

Feed Price Relationships

A. Between feed grains

B. Between processed feeds and feed grains

Livestock and Feed Relationships

A. Long-period
B. Short-period

Livestock and Animal Products Relationships

A. Between market levels
B. Between final products and intermediate animal products

Most data used in these analyses are found in published reports of the United States Department of Agriculture. They are monthly, quarterly, or yearly, depending on different circumstances and actual requirements. Most of the analyses will be based on monthly data from January, 1950 to December, 1967. The quarterly data run through the same period. Annual data cover 17 years, 1950 to 1966. See the Appendix for specific definitions, sources and usages of data for this study.

FEED PRICE RELATIONSHIPS

In this chapter the principal aspects to be analyzed are the price relationships among feed grains and between processed feeds and feed grains. The theoretical bases are developed from the assumption that the market structure is competitive in both production and marketing.

In this research, we are not trying to analyze the general demand and supply conditions which determine the price level in the system. Instead, we will evaluate utilization efficiency and marketing performance in those dimensions (relative) which are independent of the price level. That is to say, we accept the price level as given and evaluate relative prices for substitution efficiency among feed grains and production costs for processed feeds.

The analyses will be divided into two sections.

The first section includes the evaluations of price relationships among different feed grains in which a monthly time period will be used. The basic assumption for the theoretical argument is the strong substitution equivalence among feed grains when used in livestock feeding.

The second section consists of the analyses of price relationships between processed feeds and feed grains where an annual time period will be employed. The theoretical reasoning for these analyses is that the price levels of processed feeds should reflect the physical composition and competitive supply costs of the raw materials, mainly the feed grains which are close substitutes.

Between Feed Grains

Feed grains to be considered in this section are corn, barley, grain sorghum and oats. We will treat the price of corn as the independent variable and the prices of other grains as dependent variables. It is also assumed that there is a very strong and fixed substitution equivalence among feed grains for nutritional usage by livestock under the competitive market structure. If the market price system functions efficiently and livestock feeders are sensitive to the substitution rates among feed grains, the prices of feed grains will have ratios equivalent to their substitution rates. This is the theoretical basis for evaluation.

Barley - Corn Analysis

The first regression analysis considers the price of barley per bushel as a function of the price of corn per bushel and a seasonal variable, S_3. If corn and barley substitute pound for pound for each other, the price of barley per bushel should be equal to 86% (or 48/56 = 0.85714) of the price of corn per bushel in order to have the same values for barley and corn at the same weight. The function was estimated as follows:

$$P_{barley} = 0.09510 + \underset{(0.02330)}{0.71932} P_{corn} - \underset{(0.01116)}{0.10661} S_3$$

$$R^2 = 0.82097,$$

where S_3 indicates the third quarter of the year and the numbers in parentheses are estimated standard deviations of the regression coefficients.

The R-squared value is quite high in the analysis and indicates there is a strong association between the price of barley and that of corn and the seasonal variable, S_3. The constant term of the regression equation is not significant from zero. All tests in this report use a level of significance of 5%.

The coefficient of the price of corn is 0.71932 which is about 84% of the theoretically expected value 0.85714.

The coefficient on the seasonal variable, S_3, was tested to be significant from zero. It indicates that there is a significant seasonal drop in the price of barley. The barley price tended to be depressed about 10¢ per bushel during the summer season. The summer season is the time for barley harvest and the increasing quantitative supply causes the price to go down because of weak producer reservation demand and forward storage risk.

We can conclude that the price of barley is strongly consistent with the price of corn but with a seasonally depressed price during the harvest period in summer and an effective price substitution rate which appears to be significantly below the nutritional substitution rate.

Milo - Corn Analysis

The second regression analysis is concerned with the price relationship between grain sorghum and corn and seasonal variables. If corn and milo substitute for each other efficiently in response to changing relative prices and were assumed to be nutritionally equivalent, the price of milo per hundredweight would be expected to be 1.79 (or 100/56 = 1.78571) times the price of corn per bushel. Because of probable nutritional difference and greater storage risk, the price ratio will be adjusted to 95% of the equivalence one, i.e., 1.70 (or 1.78571 x 0.95 = 1.69642). The estimated equation is as follows:

$$P_{milo} = 0.05447 + \underset{(0.04134)}{1.48147} P_{corn} - \underset{(0.02085)}{0.07333} S_3 - \underset{(0.02077)}{0.07556} S_4$$

$$R^2 = 0.86308$$

The correlation coefficient shows a strong relationship between the price of grain sorghum and that of corn and the seasonal variables. Again, the constant term is not significantly different from zero. The regression coefficient for corn price is 1.48147, which is about 87% of the value that we expected theoretically.

The coefficients on the two seasonal variables, S_3 and S_4, were tested to be significant from zero. They indicate that the price of milo becomes depressed about 7¢ per hundredweight during the second half of the year. This could result from the fact that milo is more susceptible to spoilage in storage than corn and the weak reservation demand of producers during the harvest period. As a consequence, there is a strongly consistent price relationship between grain sorghum and corn but with some evidence that grain sorghum is priced slightly below its nutritional equivalence.

Oats - Corn Analysis

The third price relationship to be evaluated is the price of oats related to the price of corn and the seasonal variable, S_3. The theoretically expected price ratio would be 0.57 (or 32/56 = 0.57134) if equal substitution between corn and oats exists. However, some nutritionists believe this should be reduced by 10% to .51. The coefficient on the seasonal variable is expected to be negative to indicate that the price of oats will be depressed during harvest period. The result was estimated as follows:

$$P_{oats} = 0.31093 + \underset{(0.01736)}{0.32699} P_{corn} - \underset{(0.00832)}{0.07060} S_3$$

$$R^2 = 0.64487$$

The R-squared value is relatively low and indicates the moderate correlation between the prices of corn and oats. This could be caused by the high variability in quality of oats from year to year. Moreover, the constant value is too high in the equation. Conversely, the regression coefficient for corn price is too low compared to what we expected theoretically.

The coefficient on the seasonal variable S_3 is tested to be significant and the price of oats tends to be depressed during harvest.

We conclude that the price of oats is not efficiently consistent with the price of corn. The "flat" price relationship could be related to the fact that there has been a very low production of oats in Nebraska during recent years with an inactive market. Also, much of the oats production is used in processed feeds for which "flat" pricing tends to ignore short-run price variation in ingredients.

Between Processed Feeds and Feed Grains

Price relationships between processed feeds and feed grains will be evaluated in this section. The processed feeds to be considered are the dairy ration, broiler growing ration, turkey growing ration and laying mash. Theoretically, it is assumed that the price levels of processed feeds should be consistent with the supply costs of raw materials. It is also assumed that there are certain constant percentages of feed grains to be used in different types of processed feeds. Actually, the close substitute relationship exists among feed grains and the proportions of the feed grains used in rations will be adjusted subject to changing prices. It is difficult to fix the proportions of feed grains which specific processed feeds contain.

Dairy Ration Analysis

The fourth price relationship to be evaluated is the value of dairy ration per hundredweight related to the prices of corn per bushel, cottonseed meal per hundredweight and time. It is assumed that dairy ration contains corn ingredient up to 30%. So, the theoretical value to be expected will be .54 (or 0.30 x 100/56 = 0.53571) for the coefficient of corn price. The estimated result is as follows:

$$P_{D.R.} = 0.60903 + \underset{(0.50764)}{0.65482}\, P_{corn} + \underset{(0.17313)}{0.38678}\, P_{C.M.} - \underset{(0.01953)}{0.00410}\, t$$

$$R^2 = 0.85477$$

The R-squared value is strong in the analysis. The constant term indicates that there are some non-ingredient costs involved which are not in the model. The regression coefficient for corn price is consistent with the theoretical value stated but the standard error is large.

Moreover, the coefficients of cottonseed meal and time are tested to be insignificant from zero. The price of the dairy ration moderately reflects the prices of its raw materials, mainly corn and cottonseed meal.

The fifth evaluation to be considered is the price relationship between dairy ration and oats, cottonseed meal and time. It is assumed that dairy ration contains 40% of oats. The expected coefficient for oats price will be 1.25 (or 0.40 x 100/32 = 1.25000), if decisions are made correctly. The time factor will be expected to be negative to show the technological improvements in non-feed cost items. The regression equation is as follows:

$$P_{D.\ R.} = 0.47303 + \underset{(1.02424)}{0.83828\ P_{oats}} + \underset{(0.12922)}{0.50352\ P_{C.\ M.}} - \underset{(0.01282)}{0.01892\ t}$$

$$R^2 = 0.84421$$

The correlation coefficient between dependent and independent variables is strong. The constant value should be positive to reflect non-ingredient production costs. The coefficient of the price of oats is 0.83828 which is not significantly different from what we expected theoretically. But the standard error is so large that oats price is tested to be insignificant. The regression coefficient of cottonseed meal is tested to be significant from zero but we do not know the specific percentage to be contained in the dairy ration. The time factor coefficient is negative but tested not significant from zero. We conclude that the price of dairy ration is moderately sensitive to the prices of oats and cottonseed meal.

Broiler Ration Analysis

The sixth price relationship to be analyzed is the price of broiler growing ration related to those of corn per bushel and soybean meal per ton. Broiler growing ration is assumed to contain 65% corn and 10% soybean meal. In this case, the theoretical coefficients for corn and soybean meal will be expected to be 1.16 (or 0.65 x 100/56 = 1.16071) and 0.005 (or 0.10 x 100/2000 = 0.0050) respectively. The regression equation is estimated as follows:

$$P_{B.\ G.\ R.} = 3.28416 + \underset{(0.11710)}{1.16416\ P_{corn}} + \underset{(0.00232)}{0.00204\ P_{S.\ M.}}$$

$$R^2 = 0.90150$$

The R-squared value indicates an excellent correlation between the price of broiler growing ration and those of corn and soybean meal. The constant value is 3.28416 which is obviously very large and above what would be expected for other ingredients and conversion costs. The coefficient of soybean meal is too low compared to what we expected theoretically. It was tested to be not significant. The regression coefficient of corn is significant and consistent with the theoretically expected value. So, the price of broiler growing ration is sensitive to the price of corn but only moderately to the price of soybean meal. The pricing policy tends to be rigid in the short run, indicated by the large fixed cost constant term.

Turkey Ration Analysis

The seventh evaluation is based on the price relationship between the turkey growing ration and corn, soybean meal and time. It is assumed that turkey growing ration contains 50% corn and 10% soybean meal. So, the expected coefficients for corn and soybean meal are 0.89 (or 0.50 x 100/56 = 0.89286) and 0.005 (or 0.10 x 100/2000 = 0.00500) respectively. The result is estimated as follows:

$$P_{T.\,G.\,R.} = 3.55174 + \underset{(0.26358)}{0.81686}\, P_{corn} + \underset{(0.00365)}{0.00698}\, P_{S.\,M.} - \underset{(0.01053)}{0.01672}\, t$$

$$R^2 = 0.92724$$

The high R-squared value indicates a strong association. The results parallel those given for the broiler growing ration and the conclusions are similar.

Laying Ration Analysis

The eighth relationship to be evaluated is the price of laying mash related to the prices of corn, soybean meal and time. It is assumed that 70% corn and 12% soybean meal are contained in the laying mash. So, the expected coefficients of corn and soybean meal are 1.25 (or 0.70 x 100/56 = 1.2500) and 0.006 (or 0.12 x 100/2000 = 0.00600) respectively. The following result is estimated:

$$P_{L.\,M.} = 3.21232 + \underset{(0.22237)}{0.66616}\, P_{corn} + \underset{(0.00308)}{0.00962}\, P_{S.\,M.} - \underset{(0.00888)}{0.01694}\, t$$

$$R^2 = 0.94063$$

The high R-squared value indicates an excellent correlation between laying mash and corn, soybean meal and time. Obviously, the constant value is too high in the equation. Some other essential factors such as medicine, vegetable oil and animal protein sources may be picked up by this constant value. The coefficient of corn is relatively low and conversely that of soybean meal is relatively high compared to the theoretically expected values. The time factor is negative but not significant from zero. So, we can conclude that the price of laying mash is moderately sensitive to the prices of corn and soybean meal. Again, evidence of "flat" pricing is indicated by the large constant term.

Conclusions

Generally speaking, the evaluation of the price relationships among feed grains indicates a satisfactory market performance. The prices of barley and grain sorghum are consistent with corn price but with seasonal variation during the harvest period and some discounting of nutritional values.

The price relationships between processed feeds and feed grains are not satisfactory through the analyses. The evaluation indicates that only broiler growing ration and turkey growing ration are sensitive to corn price changes. The other processed feeds do not efficiently reflect the supply costs of raw materials, mainly feed grains. Moreover, the time factor is not significant for all processed feeds to indicate any technological improvement in non-feed cost factors through time. Significant evidence of a "flat" short-run pricing policy for the processed feeds exists.

LIVESTOCK AND FEED RELATIONSHIPS

In this chapter the evaluations of economic efficiency and market performance will be developed from the analyses of the livestock and feed price relationships. We evaluate the price relationships of animals related to feeds, more specifically, cattle and hogs related to corn and others related to processed feeds. It is assumed that a competitive market structure exists in both the production and marketing sectors. The animal-feed conversion rates are either assumed to be constant or changing linearly with time in the analyses. The evaluation will be divided into two sections, long-period and short-period.

The long-period price analyses will be employed to evaluate the consistency of animal prices with long-run supply costs during certain periods of time.

The short-period price analyses will check the effectiveness of production and marketing decisions during short-run periods in maintaining orderly rates of production and sale. It also evaluates the efficiency of immediate adjustments to cause price changes consistent with adjustment costs in relatively short time periods.

Long - period

Feeder - Slaughter Steer Analysis

The first evaluation will be based on the price of feeder steers per hundredweight at time (t–6) related to the price of slaughter steers for the consistent weight at time t, the average price of corn per bushel for six months and time.

The logical reasoning is that the value of the feeder animal at time (t–6) should be equal to the value of slaughter animal at time t minus the costs of feeding from (t–6) to t time periods. It is assumed that nearly six months will be required to bring a 700-lb. feeder steer to a 1,000-lb. slaughter steer. It is also assumed that the concentrate conversion rate is about eight pounds of corn equivalent to one pound of gain on cattle. Theoretically, the result would be expected as follows:

$$7P_{F.\,S.} = 10P_{S.\,S.} - 300 \times 8/56\ P_{corn} + C' + D'\,t$$
$$P_{F.\,S.} = 10/7\ P_{S.\,S.} - 300 \times 8/\ (7 \times 56)\ P_{corn} + C + D\,t$$
$$P_{F.\,S.} = 1.42857\ P_{S.\,S.} - 6.12245\ P_{corn} + C + D\,t$$

We expect the constant term to be negative to indicate some non-feed costs involved. The estimated result is as follows:

$$P_{F.\,S.} = 1.01421 + \underset{(0.06302)}{0.91970\ P_{S.\,S.}} - \underset{(1.34173)}{0.27035\ P_{corn}} + \underset{(0.05533)}{0.15908\ t}$$
$$R^2 = 0.50838$$

The R-squared value indicates a moderate association between the prices of feeder steers and slaughter steers, corn and time. The constant term is positive which is not consistent with what we expected theoretically. The coefficient of slaughter steer price is 0.91970 which is about 65% of the expected value 1.42857. The coefficient of corn price is relatively low compared to the theoretical value stated. The standard error of corn is so large that the coefficient of corn price was tested to be insignificant from zero. The time factor is positive which indicates that non-feed costs tended to be reduced through time.

We conclude that the R-squared value resulted from the fact that price levels of cattle change less in six months' time than over the cycle and are proportionately related in the short run. Consequently, the value relationships do not reflect market valuation efficiency because the critical coefficients are not consistent with expected values.

Hog - Corn Analysis

The second analysis to be evaluated is the relationship between the price of hogs per hundredweight and the average price of corn for six months, time and seasonal variables, S_2, S_3 and S_4. Theoretically, the price of hogs should be equal to the supply cost of hogs at any given time. It is assumed that the corn-hog conversion rate is six to one (increased to cover some reproduction costs and non-corn additives) and the average weight of hogs is 230 lbs. We expect that the coefficient of corn price should be 10.71 (or 6 x 230/(56 x 2.30) =

10.71429) and the constant term should be positive. The result was estimated as follows:

$$P_{hogs} = 9.87572 + \underset{(1.39726)}{6.41944}\, P_{corn} + \underset{(0.05358)}{0.10427}\, t + \underset{(0.62985)}{0.91674}\, S_2 + \underset{(0.63438)}{1.51271}\, S_3 - \underset{(0.63347)}{1.02950}\, S_4$$

$$R^2 = 0.16407$$

The R-squared value indicates a relatively weak correlation between hogs and corn, time and seasonal variables. The constant term is 9.87572 which is associated with the non-feed costs involved. The coefficient of corn price is relatively low compared to what we expected theoretically. The time variable indicates that the non-feed costs tended to increase through time. The coefficients of time, seasonal variables, S_2, S_3 and S_4, were tested to be insignificant from zero.

We conclude that the price of hogs is only moderately consistent with the price of corn and an unsatisfactory market performance is indicated with respect to the price of hogs associated with supply cost.

Milk - Dairy Ration Analysis

The third evaluation is the price of manufacturing grade milk per hundredweight related to the price of dairy ration per hundredweight, the index numbers of composite wage rates and time. The calendar years 1957–1959 are regarded as the base period of the index numbers of wage rates. We expect that the coefficients of dairy ration and wage rates would be positive to reflect the supply costs of the milk production. Theoretically, the price of milk should be consistent with the price of dairy ration and wage rates. The result was estimated as follows:

$$P_{milk} = -1.98277 + \underset{(0.07283)}{0.57325}\, P_{D.\,R.} + \underset{(0.00357)}{0.04004}\, Wages - \underset{(0.01360)}{0.12096}\, t$$

$$R^2 = 0.73300$$

The correlation coefficient indicates a strong association between dependent and independent variables.

The coefficient of the dariy ration is 0.57325 which seems reasonable but a little higher than the expected value 0.4.

The coefficient of the wage rate index seems to be reasonable but a study of labor requirements would be required to establish what we should expect theoretically.

The coefficient of the time factor is negative and tested to be significant from zero. It indicates that the price of milk tended to be depressed about 12¢ per hundredweight annually and would be a reflection of increased efficiency from other factors in production. The constant term is negative and would indicate that sale of vealer calves and eventual culling of cows more than offsets production costs excluding feed and labor. Again, a production cost study would be required to establish the expected value for this coefficient.

We conclude that the price of milk is consistent with the supply costs of the dairy ration and wages but production function data would be necessary to conclude that this consistency was efficient.

Broiler - Feed Analysis

The fourth analysis to be evaluated is based on the relationship between the price of broilers per pound and the price of broiler growing ration per hundredweight and time. The conversion rate is assumed to have been about five pounds of broiler growing ration to one pound of broiler at the beginning of the period and declined to a level of about three. The constant term is expected to be positive to indicate the non-feed costs. The coefficient of the price of broiler growing ration is expected to be about five theoretically. The regression equation was estimated as follows:

$$P_{\text{broiler}} = -9.68778 + \underset{(0.62188)}{7.33689}\, P_{\text{B. G. R.}} - \underset{(0.00695)}{0.15617}\, t\, P_{\text{B. G. R.}}$$

$$R^2 = 0.85402$$

The R-squared value indicates a strong correlation between the price of broiler and that of broiler growing ration and time. The constant term is negative which is not consistent with what we expected theoretically. It could result from structural changes in the industry whereby many non-feed costs are being subsidized by low feed prices. The coefficient of the broiler growing ration is 7.33689 which is relatively high compared to the expected value. The coefficient of the product of time and broiler growing ration is about equal to that expected theoretically. We conclude that the price of broiler is moderately consistent with the price of broiler growing ration and time, in terms of productivity changes, but low feed prices are tending to cover other costs of production.

Turkey - Feed Analysis

The fifth analysis is concerned with the price of turkey per pound related to the price of turkey growing ration per hundredweight and time. It is assumed that the conversion rate was six pounds of turkey growing ration to one pound of turkey at the beginning of the period and declined to slightly under five. The coefficient of turkey growing ration will be expected to be six theoretically. The computed regression function is as follows:

$$P_{turkey} = -1.38381 + 6.84123 \; P_{T.\,G.\,R.} - 0.13604 \; t \; P_{T.\,G.\,R.}$$
$$\qquad\qquad\qquad (0.61892) \qquad\qquad (0.00710)$$
$$R^2 = 0.81939$$

The results and evaluation are parallel to those given in the previous analysis with regard to broiler and broiler growing ration. The constant term is negative but not significant from zero. The coefficient of turkey growing ration is slightly above expected value and, conversely, that of the product of time and turkey growing ration is slightly below the expected value. Consequently, the price of turkey is moderately consistent with the supply cost of turkey growing ration in the long-run evaluation.

Egg - Feed Analysis

The sixth evaluation to be considered is the price of eggs per dozen associated with the price of laying mash per hundredweight and time. The conversion rate is assumed to be ten or eleven, theoretically, and declining with some improvements in nutritional efficiency. The result was estimated as follows:

$$P_{eggs} = 13.94942 + 6.04602 \; P_{L.\,M.} - 0.10036 \; t \; P_{L.\,M.}$$
$$\qquad\qquad\qquad (1.58062) \qquad\qquad (0.01832)$$
$$R^2 = 0.28553$$

The low R-squared value indicates a weak correlation between the prices of eggs and laying mash and time. The constant term is positive and is probably too high for the non-feed costs involved.

The coefficient of egg laying mash is about 60% of the expected value stated. The coefficient of the product of time and egg laying mash is quite close to what we expected theoretically.

As a consequence, we conclude that the price of eggs is only moderately consistent with the price of egg laying mash and time.

Short - period

In this section the evaulations to be considered are associated with short-period price analyses. This short-period evaluation will check the effectiveness of production and marketing decisions in maintaining orderly rates of production and sale. It also evaluates the efficiency of immediate adjustments to cause price changes consistent with adjustment costs.

Heavy - Light Slaughter Steer Analysis

The seventh analysis is concerned with the price of heavy slaughter cattle per hundredweight at time t related to the price of lighter slaughter cattle at time (t–3), the price of corn per bushel at time (t–3) and time. Approximately three months will be required to bring a 1,000-lb. slaughter animal to a 1,200-lb. weight. The theoretical reasoning is that the value of heavy slaughter cattle at time t should be equal to the value of lighter slaughter cattle at time (t–3) plus the costs of feeding from (t–3) to t. The conversion rate is assumed to be eight pounds (corn equivalent) of feed to one pound of animal. The theoretically expected results would be as follows:

$$12\ P_{C.\ H.} = 10\ P_{C.\ L.} + 8 \times 200/56\ P_{corn} + C' + D'\ t$$
$$P_{C.\ H.} = 10/12\ P_{C.\ L.} + 8 \times 200/\ (12 \times 56)\ P_{corn} + C + D\ t$$
$$P_{C.\ H.} = 0.83333\ P_{C.\ L.} + 2.38095\ P_{corn} + C + D\ t$$

Here, C is the constant term and expected to be positive to indicate certain non-feed costs involved. The coefficient of corn price would be positive theoretically to show the supply cost of feeding. The actual results were estimated as follows:

$$P_{C.\ H.} = 9.00860 + \underset{(0.03879)}{0.82921\ P_{C.\ L.}} - \underset{(0.79335)}{0.74551\ P_{corn}} - \underset{(0.03199)}{0.15948\ t}$$
$$R^2 = 0.72965$$

The R-squared value indicates a relatively strong association. The constant value is positive as we expected theoretically. The coefficient of the price of lighter slaughter cattle is 0.82921, consistent with the expected value 0.83333. This strong association of the prices between heavy and lighter slaughter cattle is because the prices do not vary much during the relatively short time period, three months.

The coefficient of corn price is negative which is not logically consistent with what we expected. Moreover, this coefficient was tested to be insignificant from zero.

The coefficient of the time factor is negative and significant from zero. It indicates that non-feed costs per hundredweight tended to decline through time.

We conclude that the prices of heavy and lighter slaughter cattle tended to move together in the short-period with the evidence that non-feed costs were reduced through time. The price of slaughter cattle did not efficiently reflect the price of corn during a relatively short time period.

The eighth evaluation is associated with the changes in cattle value per hundredweight related to the price of corn per bushel at time (t–3) and time. This evaluation is related to the previous one but with special attention to the *changes* in cattle value related to corn price. The logical reasoning is that the changes in cattle value should be consistent with the price of corn for feeding. Theoretically, the changes in value would be expected to be positive. The expected results were converted as follows:

$$12\ P_{C.\ H.} - 10\ P_{C.\ L.} = 8 \times 200/56\ P_{corn} + C' + D'\ t$$
$$(P_{C.\ H.} - 5/6\ P_{C.\ L.}) = 8 \times 200/\ (12 \times 56)\ P_{corn} + C + D\ t$$
$$\Delta Value/cwt. = 2.38095\ P_{corn} + C + D\ t$$

Again, the constant term and the coefficient of corn price are expected to be positive. The estimated results were as follows:

$$\Delta Value/cwt. = 8.90441 - \underset{(0.79292)}{0.75012}\ P_{corn} - \underset{(0.03135)}{0.15859}\ t$$
$$R^2 = 0.12636$$

Results indicate the same evidence as given in the previous analysis. The very low R-squared value shows the weak association between the *changes* in cattle value and the price of corn. Again, the coefficient of corn price is negative and insignificant from zero.

We conclude that changes in cattle values were not consistent with the price of corn in the short run.

Heavy - Light Hog Analysis

The ninth analysis is based on the relationship between the price of heavy hogs per hundredweight at time t related to the price of lighter hogs at time (t–2), the price of corn per bushel at time (t–2) and time. This analysis is trying to evaluate the production and marketing performance of hog producers in response to changing supply costs in the short run. We assume that about two months will be required to gain the 60-lb. weight, from 210 to 270 pounds. The actual time span is needed only to define the proper prices to be used. The conversion rate is assumed to be about six pounds of corn equivalent to one pound of animal. The theoretically expected results would be as follows:

$$2.7\ P_{H.\ H.} = 2.1\ P_{H.\ L.} + 6 \times 60/56\ P_{corn} + C' + D'\ t$$
$$P_{H.\ H.} = 2.1/2.7\ P_{H.\ L.} + 6 \times 60/\ (2.7 \times 56)\ P_{corn} + C + D\ t$$
$$P_{H.\ H.} = 0.77778\ P_{H.\ L.} + 2.38095\ P_{corn} + C + D\ t$$

The actual results were estimated. They are:

$$P_{H.\ H.} = 3.83806 + \underset{(0.04209)}{0.81179}\ P_{H.\ L.} - \underset{(0.87729)}{0.31088}\ P_{corn} - \underset{(0.03266)}{0.02801}\ t$$
$$R^2 = 0.67140$$

The correlation coefficient is fairly high in the analysis. The constant term is positive as we expected. The coefficient of the price of lighter hogs is highly consistent with the theoretical value stated. The coefficient of corn price is negative which is not logically reasonable. The standard error of the coefficient of corn price is so large that the coefficient was tested to be insignificant from zero. The time variable was tested to be not significant.

We conclude that the price of heavy hogs is strongly related to that of lighter hogs but hog prices do not tend to reflect the price of corn in the short period. As with cattle, the high R^2 is more related to the stable price level for hogs during short time periods than the forces of short-period supply costs.

The tenth analysis evaluates the same evidence as the previous analysis but from a different point of view. It is concerned with the relationship between the changes in hog value per hundredweight and the price of corn per bushel at time (t–2) and the time variable.

We assume that the value of hogs would be increased from (t–2) to t time periods. The theoretical basis is that the changes in real value of hogs should be equal to the cost of feeding. Then, the expected results would be as follows:

$$2.7\ P_{H.\ H.} - 2.1\ P_{H.\ L.} = 6 \times 60/56\ P_{corn} + C' + D'\ t$$

$$(P_{H.\ H.} - 2.1/2.7\ P_{H.\ L.}) = 6 \times 60/\ (2.7 \times 56)\ P_{corn} + C + D\ t$$

$$\triangle Value/cwt. = 2.38095\ P_{corn} + C + D\ t$$

The actual results were estimated. They are:

$$\triangle Value/cwt. = 4.11268 - \underset{(0.81234)}{0.04144}\ P_{corn} - \underset{(0.03222)}{0.02355}\ t$$

$$R^2 = 0.00344$$

This result indicates the same evidence as that of the previous one. The R-squared value is very low which indicates the weak association between the *changes* in hog value and the price of corn. When one considers changes in value, the direct correlation is eliminated. The coefficient of corn price is negative which is not logically reasonable. These two variables were tested to be insignificant in the analysis.

We conclude that there has been relatively inefficient performance in the production and marketing of hogs in response to the supply cost of corn in the short run.

Broiler - Feed Analysis

The eleventh evaluation to be analyzed is the relationship of the first difference in the price of broilers per pound from time (t–3) to t, related to the first difference in the price of broiler growing ration per hundredweight from time (t–6) to (t–3) and the time variable. Theoretically, the changes in the broiler price should be consistent with the short-run adjustment costs; i.e., the changes in the price of broiler growing ration. The regression equation was estimated as follows:

$$\triangle P_{broiler} = -0.21898 + \underset{(2.50725)}{2.80321}\ \triangle P_{B.\,G.\,R.} - \underset{(0.28115)}{0.81769}\ t\ \triangle P_{B.\,G.\,R.}$$
$$R^2 = 0.05762$$

The very low correlation coefficient indicates a weak association between the differences in broiler price and broiler ration price. The constant term is approximately zero as expected. The coefficient of the difference in broiler ration price is slightly low compared with what we expected. Moreover, the standard error is so large that this coefficient was tested to be insignificant from zero.

We conclude that the changes in the prices of broilers did not efficiently reflect the changes in the price of broiler growing ration in the short run.

Egg - Feed Analysis

The twelfth evaluation will be parallel to the previous one but with respect to eggs and egg laying mash. Theoretically, the changes in egg price from time (t–3) to t should be consistent with the changes in the price of egg laying mash from (t–6) to (t–3), if the price responds to supply costs efficiently. The results were estimated as follows:

$$\triangle P_{eggs} = -0.22350 + \underset{(6.62738)}{2.87166}\ \triangle P_{L.\,M.} - \underset{(0.83204)}{0.94997}\ t\ \triangle P_{L.\,M.}$$
$$R^2 = 0.00897$$

Results are similar to those given in the previous analysis. We conclude that the small changes in the price of egg laying mash were not efficiently reflected in the price of eggs in the short run.

Turkey - Feed Analysis

The last evaluation to be considered is the first difference in turkey price between years related to the first difference in the price of turkey growing ration between years and time. We assume that six months will be required for turkey production and the consumption of turkey is more or less seasonal. In this case, we only consider the prices of turkey from September to December and those of turkey growing ration from March to June respectively. The theoretical basis is that the changes in turkey price should be consistent with those in turkey growing ration. The estimated function is as follows:

$$\triangle P_{turkey} = -0.80770 + \underset{(2.87523)}{2.57783}\ \triangle P_{T.\,G.\,R.} - \underset{(0.39492)}{0.60066}\ t\ \triangle P_{T.\,G.\,R.}$$
$$R^2 = 0.03570$$

The R-squared value indicates a weak association. The coefficient of the changes in turkey ration prices is relatively low and that of the product of time and changes in turkey ration is also relatively low in a negative sense. These two coefficients were tested to be insignificant from zero.

We conclude that the price of turkey did not efficiently reflect the changes in supply cost in the short run.

Conclusions

In general, evaluations of livestock and feed relationships indicate a fairly satisfactory market performance. In the long-period analyses, the livestock and animal product prices tended to be moderately consistent with the long-run supply costs of feeds and processed feeds, but least effectively for cattle and hogs. This indicates problems of disorderly production levels. In the short-period analyses, the prices of livestock and poultry did not efficiently reflect feeding costs, the prices of feeds and processed feeds. This indicates problems of disorderly short-run marketing and production.

LIVESTOCK AND ANIMAL PRODUCTS RELATIONSHIPS

Price relationships between livestock and animal products will be evaluated in this chapter. The theoretical bases are developed from the assumption that the market structure is competitive. Two sections will be considered.

The first section will be concerned with price analyses between different market levels: farm, wholesale and retail. The theoretical reasoning is based on the assumption that the value at the lower level should equal the value at higher level minus marketing and processing costs which include reasonable returns to management. In the margin analyses of beef and pork, realistic physical conversion rates were employed by the U.S.D.A. to convert the wholesale and farm values to those equivalent to one pound of retail cuts. When broilers are considered, the conversion rate will be estimated in the relationship between farm and retail prices.

The second section will cover price analyses between final products and intermediate animal products. Specific consideration will be given to manufacturing grade milk prices related to the prices of dairy products: butter, nonfat solids, American cheese and evaporated milk. Manufacturing grade milk can be used in the production of butter, cheese and evaporated milk. Theoretically, the price levels of manufacturing grade milk used for butter, cheese and evaporated milk should be equal (except for location and composition differences) if price and allocation system functions efficiently. Moreover, the price of milk used for production of each individual dairy product should be derived from the value of the products minus the processing costs. These are the theoretical bases for evaluation.

Between Market Levels

The first three evaluations are developed from quarterly data used for margin analyses by the U.S.D.A. for cattle, beef carcasses and retail beef.

The retail price of beef per pound is the weighted average price of retail cuts from Choice grade carcasses. For convenience of comparison, the prices at the live and wholesale levels were converted to a retail weight basis.

The wholesale value of beef carcass is about 1.35 times the wholesale price per pound of Choice grade beef carcass.

The net farm value of beef is approximately the value of 2.25 pounds of Choice grade beef cattle less the value of the by-products. The price analyses to be evaluated are the relationships between farm-wholesale, wholesale-retail and farm-retail respectively. The logical reasoning assumes that the value at the lower level should equal the value at the higher level minus the economic costs of marketing and processing. In this case, the coefficient of the value at the higher level should be equal to one theoretically. The constant term in the regression function is expected to be negative to indicate certain processing costs as well as by-product allowance.

Retail - Wholesale - Farm Beef Value Analyses

The first evaluation is concerned with the net farm value of beef cattle related to the wholesale value of beef carcasses and time. The result was estimated as follows:

$$\text{N. F. V.}_{beef} = -9.99015 + \underset{(0.01703)}{1.01943}\ \text{Whse}_{beef} - \underset{(0.02014)}{0.09336}\ t$$

$$R^2 = 0.98183$$

The very high R-squared value indicates an excellent association between cattle and beef carcass values on a retail weight basis. The constant term indicates that the processing cost (after by-product allowances) from the farm to the wholesale level is about 10¢ per pound of retail beef.

The coefficient of the wholesale value of beef carcass is 1.01943 which is strongly consistent with the expected value, one. The time factor coefficient is negative and tested to be significant from zero. It indicates that the farm-wholesale spread tended to increase through time. These increases appear to be the results of increasing costs (due to higher factor prices) of labor, material and transportation for marketing and processing.

As a matter of fact, these increases have been offset by increases in efficiency from improved technology and specialization. The rate of increase in the farm-wholesale spread is about 1% per year which is lower than the general price index for the same period concerned.

We conclude that the net farm value of beef cattle is strongly consistent with the wholesale value of beef carcasses and indicates that the market system operates efficiently through time.

The second evaluation is based on the marketing margin analysis between wholesale and retail levels. The wholesale value of beef carcasses is a function of the retail price of beef and time. The following result was estimated:

$$\text{Whse}_{\text{beef}} = -6.33937 + \underset{(0.02547)}{0.88664}\ \text{R. P.}_{\text{beef}} - \underset{(0.03479)}{0.55265}\ t$$

$$R^2 = 0.94695$$

The correlation coefficient indicates an excellent association between the values of beef carcasses and retail beef. The constant value is −6.33937 and probably below the margin costs.

The coefficient of the retail price of beef is 0.88664 which is relatively low compared to what we expected theoretically. This may result from the fact that the by-product allowance from retail cuts is not included in the retail price. The coefficient on the time variable indicates that the wholesale-retail spread of beef tended to increase during the 1950–1967 period. The rate of increase was about 0.55¢ per year. This increase could result from the general increasing costs of processing and distribution as well as the increased services performed by the marketing system.

Consequently, we conclude that the wholesale value of beef carcasses is strongly consistent with the retail price of beef. The current dollar costs of marketing between wholesale and retail levels increased through time. It should be pointed out that if one takes into account *changes* in per capita beef supplies on a quarterly basis, then the price relationship between wholesale and retail levels tends to widen and narrow during short periods of time as supply levels increase and decrease.

The third margin analysis is concerned with the net farm value of beef cattle related to the retail price of Choice grade beef and time. The farm-retail relationship should be approximately additive of the previous two analyses, farm-wholesale and wholesale-retail. The results were estimated as follows:

$$N.F.V._{beef} = -16.82236 + \underset{(0.02799)}{0.90888}\, R.P._{beef} - \underset{(0.03824)}{0.65904}\, t$$

$$R^2 = 0.94095$$

The results are very close to what we expected theoretically. The constant term indicates that the cost of marketing a pound of beef is approximately 17¢ (after by-product allowances) which is about the sum of the marketing costs for farm-wholesale and wholesale-retail separately.

The coefficient of the retail beef price is 0.90888 which is strongly consistent with the expected value, one. The time factor indicates an upward trend of the farm-retail spread during the period 1950–1967. The cost of marketing one pound of beef tended to increase 0.66¢ or about 4% annually. It is believed that most of the increases in marketing costs occurred at the retail level.

We conclude that the market performance of beef marketing is very satisfactory from the viewpoint of competitive efficiency. The values of cattle, beef carcasses and retail beef are strongly consistent with each other on a retail weight basis but with evidence that the costs (in current dollar values) of processing and marketing tended to increase through time.

Retail - Wholesale - Farm Pork Value Analyses

The next three evaluations are developed from the marketing margins data with respect to the values of live hogs, wholesale pork cuts and retail pork cuts. These margin analyses are based on the relative price relationships between different market levels: farm, wholesale and retail.

For convenience of comparison, the U.S.D.A. converted the prices at different market levels to a retail weight basis according to certain physical conversion rates. The retail price of pork per pound is the weighted average price of ham, bacon, loins, picnics, sausage, butts, spareribs and bacon squares. A pound of pork at the wholesale level yields approximately a pound of pork at retail. Therefore, no weight adjustment is necessary for the wholesale price equivalent to one pound of retail cuts. Here, the wholesale value of pork is the weighted average calculated from wholesale prices of individual products at Chicago.

At the farm level, it takes about two pounds of live hog to make one pound of wholesale and retail cuts (excluding lard). The net farm value of hogs is the average price of two pounds of live hog less the value of by-products.

The theoretical basis assumes that the value at the lower market level should be equal to the value at the higher level minus certain marketing and processing costs. In the regression function, the coefficient of the value at the higher level should be equal to one, if the price system works efficiently. It is also assumed that the constant term should be negative to indicate the costs of marketing as well as the by-product allowance.

The fourth evaluation is concerned with the market margin between the net farm value of hogs and the wholesale value of pork and time. The computed regression function is as follows:

$$N.F.V._{pork} = -12.86336 + \underset{(0.01661)}{1.03004}\, Whse_{pork} - \underset{(0.01769)}{0.14086}\, t$$

$$R^2 = 0.98241$$

The very high R-squared value indicates the strong correlation between the hog value at farm and the wholesale value of pork and time. The constant term is negative as we expected. It indicates that the marketing cost between farm and wholesale levels is about 13¢ per pound of wholesale pork cuts.

The coefficient of the wholesale value of pork is 1.03004 which is consistent with the expected value, one. The time factor coefficient is negative and tested to be significant from zero. It reflects the fact that the farm-wholesale spread tended to be widened in the period of 1950—1967. The rate of increase in marketing cost was about 0.14¢ or 1% annually which is less than the general price level increase.

We conclude that the net farm value of hogs is strongly consistent with the wholesale value of pork with the evidence that marketing costs tended to increase through time.

The fifth margin analysis to be evaluated is the wholesale price of pork related to the retail price of pork and time. The prices of pork at the wholesale and retail levels are based on the same weight basis, a pound. The result was estimated as follows:

$$Whse_{pork} = -10.52037 + \underset{(0.02922)}{0.99083}\, R.P._{pork} - \underset{(0.03345)}{0.39906}\, t$$

$$R^2 = 0.94364$$

The high correlation coefficient indicates the strong association between dependent and independent variables. The constant value is −10.52037 which reflects retailing costs, such as advertising, overhead, labor and some cutting and trimming losses.

The coefficient of the retail pork price is 0.99083 which is consistent with what we expected theoretically. The time variable indicates that the retailing cost tended to increase during the period of 1950–1967. The annual increase rate is about 0.40¢ per pound of pork cuts or 4% between the wholesale and retail levels. It may have resulted from increasing costs of labor, material and transportation (primarily from increasing prices) and additional services performed by the marketing system.

We conclude that the wholesale and retail prices of pork move close together with the evidence that the retailing cost (in current dollars) tended to increase through time.

The sixth margin analysis to be considered is the net farm value of hogs related to the retail price of pork and time. This farm-retail relationship is approximately additive of the previous two analyses, farm-wholesale and wholesale-retail. The following result was estimated:

$$N.F.V._{\cdot pork} = -22.89580 + \underset{(0.04026)}{1.00605} \, R.P._{\cdot pork} - \underset{(0.04609)}{0.54498} \, t$$

$$R^2 = 0.90083$$

The R-squared value indicates a strong association between the net farm value of hogs and the retail price of pork and time. The constant term is −22.89580 which is about the sum of the constant values of the previous two equations. It indicates that the marketing cost is about 23¢ for one pound of retail pork cuts. This constant value includes a portion of the value of by-products on processing.

The coefficient of the retail pork price is 1.00605 which is consistent with the theoretically stated value, one. The time factor coefficient is negative and tested to be significant from zero. It reflects the upward trend of the costs of pork marketing and processing during the period 1950–1967. The average increase rate is about 0.54¢ for one pound of retail pork cuts or 2.4% per year. This increase appears to be the result of the increasing cost of marketing and processing as well as providing additional consumer services.

Consequently, we conclude that retail, wholesale and farm prices tend to have the same patterns and move close together but with increasing marketing cost over time.

Retail - Farm Broiler Analysis

The seventh evaluation is concerned with the price of live broilers per pound at the retail level and time. It is assumed that the yield rate is about 0.70 between the live and retail market forms. The constant term is expected to be negative to indicate processing and distribution costs. The result was estimated as follows:

$$P_{B.\ at\ farm} = -12.28511 + \underset{(0.01792)}{0.66164} \, P_{B.\ retail} + \underset{(0.03033)}{0.05005} \, t$$

$$R^2 = 0.97140$$

The R-squared value indicates the excellent correlation between the price of live broilers and that of retail broilers and time. The constant term is negative as we expected. It indicates that the cost of marketing one pound of broiler is about 12¢.

The coefficient of the retail broiler price is 0.66164 which is consistent with the theoretically expected value 0.70. The coefficient on the time variable is positive which shows that the broiler marketing cost tended to be reduced through time. It was tested to be insignificant from zero.

We conclude that the relationship between live and retail broiler prices reflects accurately the yield rate as well as the costs of processing and distribution which are consistent with a competitive market structure.

Retail - Farm Egg Analysis

The eighth evaluation to be considered is the price of eggs per dozen at the farm level related to the retail price of eggs per dozen and time. Since all egg usage is on a shell egg equivalent basis, the dozen measurement requires no physical conversion between farm-retail levels. Theoretically, the coefficient of retail egg price should be equal to one and the constant term should be negative to indicate the marketing cost. The regression equation was estimated as follows:

$$P_{\text{eggs at farm}} = -6.78759 + \underset{(0.01562)}{0.74068}\, P_{\text{retail eggs}} + \underset{(0.02548)}{0.05296}\, t$$

$$R^2 = 0.93436$$

The correlation coefficient indicates a strong association between the price of eggs at farm and the retail egg price and time. The constant value is negative as we expected.

The coefficient of the retail egg price is 0.74068 which is relatively low compared to what we expected theoretically. This low coefficient on retail price appears to result from the fact that eggs can be used as either fresh or processed eggs. It is believed that the farm price of fresh eggs to be used in the retail store is higher than that of processed eggs used for bakery products and in ice cream. Therefore, the coefficient on the retail egg price in the equation should be expected to be less than one.

The time factor is positive which indicates that egg marketing cost tended to decrease through time. This variable was tested to be insignificant from zero.

Consequently, we conclude that the price of eggs at farm level is consistent with the retail egg price. The coefficient of the retail egg price tends to be lower than the logical conversion rate because of the different prices in fresh and processed egg channels.

Between Final Products and Intermediate Animal Products

The price relationships between final products and intermediate animal products will be evaluated in this section. *Specific considera-*

tion will be given to the manufacturing grade milk related to certain dairy products, mainly butter, nonfat solids, American cheese and evaporated milk. The theoretical reasoning is developed from the fact that the manufacturing grade milk is a non-specialized raw material which can be used in the production of alternative, standardized, final products in the competitive structure.

Theoretically, the prices of the manufacturing grade milk used for butter, cheese and evaporated milk should and do move close together at any given time. The value of milk used for producing a given dairy product should be consistent with the price of that product, the conversion rate and processing costs. It is assumed that the physical yield rates are constant for the conversion of milk to specific dairy products over time.

Milk - Butter Analysis

The ninth evaluation considers the price per hundredweight of manufacturing grade milk used for butter related to the price of butter per pound, the price of nonfat solids per pound and time. The physical yield rates are assumed to be 5% for butter and about 8% for nonfat solids, respectively. The constant is expected to be negative to indicate the processing cost. The estimated result is as follows:

$$P_{\text{milk}} = -0.95276 + \underset{(0.00143)}{0.04937}\, P_{\text{butter}} + \underset{(0.00410)}{0.06227}\, P_{\text{N. F. S.}} + \underset{(0.00121)}{0.01980}\, t$$

$$R^2 = 0.94174$$

The high R-squared value indicates a strong association between independent and dependent variables. The constant term is negative as we expected. It indicates that the processing cost is about 95¢ to convert 100 lbs. of milk to five pounds of butter and eight pounds of nonfat solids.

The coefficient of the price of butter is 0.04937 which is consistent with the expected value 0.05.

The coefficient of the nonfat solid price is 0.06227 which is relatively low compared to the expected value 0.08. If the processing costs had been distributed to whole milk and directly to each of the products (about 5¢/lb. for butter and 6¢/lb. for N. F. S. to be subtracted first from their prices), these two coefficients would have been higher and nearer to expected values. The constant term would have been smaller negative. The time factor coefficient is positive and tested to be significant from zero. It indicates that the processing cost tended to decline through time.

We conclude that the price of manufacturing grade milk reflects effectively the value of butter and nonfat solids in terms of physical yield rates with processing cost decreasing through time.

Milk - Cheese Analysis

The tenth evaluation is based on the relationship between the price per hundredweight of manufacturing grade milk used for cheese and the price of American cheese per pound and time. The expected yield rate is 10% for the conversion of milk to American cheese. The constant term is expected to be negative to show the processing costs involved. The result was estimated as follows:

$$P_{milk} = 0.10553 + \underset{(0.00212)}{0.09879}\, P_{cheese} - \underset{(0.00151)}{0.02911}\, t$$

$$R^2 = 0.90996$$

The R-squared value indicates a strong correlation between the price of milk and that of American cheese and time. The constant term is positive which is not consistent with what we expected theoretically. This value is not significant from zero. This can be explained if the value of the processed by-product, whey, and standardization allowances are about equal to the processing costs. The coefficient of the price of American cheese is 0.09879 which is consistent with the expected value 0.10. The time factor is negative which indicates that the processing cost tended to increase over time.

Milk - Evaporated Milk Analysis

The last evaluation to be analyzed is the price per hundredweight of manufacturing grade milk used for condensed milk related to the price of evaporated milk per case of 48–14½ oz. cans and time. The physical yield rate should be one, theoretically. The following result was estimated:

$$P_{milk} = -1.47225 + \underset{(0.04174)}{0.86944}\, P_{evap.\ milk} - \underset{(0.00325)}{0.04645}\, t$$

$$R^2 = 0.67184$$

The R-squared value indicates a moderate association between the price of milk and that of evaporated milk and time. The processing cost is about $1.47 per case of evaporated milk. The coefficient of the price of evaporated milk is 0.86944 which is relatively low compared to the expected value, one. The time factor indicates a very small price inflation through time.

We conclude that the price of manufacturing grade milk moderately reflects the value of evaporated milk. The moderate price relationship may be caused by the fact that the price of evaporated milk is not flexible due to the large case unit and the small can unit. Moreover, the price of evaporated milk is more likely to be set by manufacturers for rather lengthy periods instead of being linked continuously to the milk cost.

Conclusions

Generally speaking, evaluations of the livestock and animal products relationships indicate a very satisfactory market performance. In the market margin analyses with respect to beef and pork, the consistency of the values at different levels indicates the efficiency and effectiveness in the marketing and processing of livestock and animal products. Also for broilers and eggs, the relationships between the prices at farm and at retail levels reflect the yield rates and processing costs consistent with a competitive structure.

In the price analyses between manufacturing grade milk and dairy products, excellent market performance and economic efficiency were indicated. The prices of butter, American cheese and evaporated milk move together because they must reflect a common competitive value to the raw material, manufacturing grade milk in a market with sensitive raw material allocation shifts.

SUMMARY AND CONCLUSIONS

Price relationships between feed, livestock and product sectors were evaluated. We evaluated economic efficiency and market performance by relative price analyses with respects to space, form and time dimensions. The multiple regression model was employed as the mathematical form for estimating and evaluating the price relationships. The market structure was assumed to be competitive in production and marketing from which the theoretical expectations were developed. In some specific evaluations, the efficiency and effectiveness of production and marketing were indicated on the basis of comparative evidence. Much of the evidence indicated that the pricing mechanism was remarkably compatible with a competitive system.

On the other hand, some indications of persistent inconsistencies in the price relationships implying disorderly production and marketing performance were disclosed by the analyses. Here, it should be stressed that there was no intention in this research to propose any remedial programs for removing the inconsistencies and disequilibrium in certain aspects of the production and marketing functions. Instead, we only intended to delineate efficient and inefficient economic performance areas and thereby locate the more significant problem aspects for research and program attention.

The evaluation of the price relationships among feed grains indicated a satisfactory market performance. The prices of barley, grain sorghum and oats were moderately consistent with the price of corn but with seasonal variation during the harvest periods. The substitution efficiency among feed grains appears to be satisfactory and reflects stable relative relationships.

In the price analyses between feed grains and processed feeds, relatively poor market performance was indicated through the evaluations. The price levels of processed feeds did not efficiently reflect the physical composition and competitive supply costs of raw materials, mainly feed grains. Moreover, significant evidence of flat pricing in processed feeds was indicated. That is to say, the price levels of processed feeds tended to be rigid and ignore short-run price variation in ingredients. This inconsistency in the prices of processed feed and supply costs indicated a problem which needs further research or corrective action.

The evaluations of the livestock and feed relationships indicated a relatively weak market performance both in the long-period and short-period analyses. In the long-run evaluation, price levels of cattle and hogs did not efficiently reflect the long-run supply costs of production.

This inconsistency in the prices of livestock and feeds was even worse in the short-run evaluation. This indicated the problems of disorderly production and marketing. Considering milk, the price of manufacturing grade milk tended to be consistent with the supply costs of dairy ration and wage rates. The price levels of broiler, turkey and eggs were moderately consistent with the long-run supply costs, the prices of feeds and processed feeds. But, a very poor market performance was indicated in the evaluations of short-run price response in the poultry sectors.

Consequently, the disequilibrium in the production and marketing of cattle and hogs suggested that further research is needed and essential in these problem areas. Furthermore, special attention should be given to the disorderly short-run production and marketing in the broiler, turkey and egg sectors.

The specific evidence of excellent market performance was indicated in the evaluations of livestock and animal products relationships. In the margin analyses with respect to beef and pork, the values at different market levels were strongly consistent with each other on a retail weight basis. The consistency of the prices at farm, wholesale and retail levels indicated that the marketing system functioned efficiently, and independent of the price levels. For broilers and eggs, the prices at the farm level were relatively consistent with those at the retail level in terms of physical yield rates and processing costs.

Very satisfactory economic efficiency was disclosed in the evaluation of the price relationships between manufacturing grade milk and dairy products. Manufacturing grade milk was considered as the homogeneous raw material in the production of butter, American cheese and evaporated milk. The price analyses indicated that the value of dairy products was consistently reflected in the price of milk. Moreover, the price levels of butter, American cheese and evaporated milk tended to have the same patterns because of the effective competition in the usage of milk.

The price of evaporated milk was not sufficiently flexible to efficiently reflect the changing price of milk. This may be caused by a stable sale price policy by manufacturers, with only periodic adjustment when competitive milk prices change sufficiently. Excellent economic efficiency and market performance were indicated for the marketing and processing of livestock and animal product sectors.

In general, persistent disorderly production of feeds and livestock was indicated by the evaluation. The production of cattle and hogs tended to cycle and to be inconsistent with feeding costs in the long run as well as in the short run.

The price level and production of cattle and hogs were more likely to follow a "cobweb" pattern.

The price of feed grains tended to have seasonal variation year by year. Inversely, the marketing and processing between livestock and animal products tended to be very efficient and effective through the analyses.

From evaluations stated above, we are satisfied with certain aspects where satisfactory efficiency and performance were indicated. However, we should concentrate research attention on the problem areas where disorderly production and marketing exist.

APPENDIX

This appendix provides more complete description and sources for data used in the analyses. The time periods covered in this research were from 1950 through 1967 for analyses using monthly and quarterly data and through 1966 for analyses using yearly data. The time factor was given a value of one in the year 1950 and increased by one unit yearly for all regression analyses using this variable. The first seasonal variable, S_1, had a value of one for the first three months of the year and zero for other months. The same consideration was applied to the second, third and fourth seasonal variables respectively. Most of the data were collected from published reports by the United States Department of Agriculture. Some of the recent data were taken from Situation Reports.

FEED PRICE RELATIONSHIPS

Between Feed Grains

The data used for the analyses between feed grains were on a monthly basis covering 18 years, 1950–1967, and stated in dollar units.

The prices of corn per bushel, barley per bushel, grain sorghum per hundredweight and oats per bushel were the prices received by farmers in Nebraska. They were collected from Nebraska Agricultural Statistics Annual Reports.

Between Processed Feeds and Feed Grains

The data used for the price analyses between processed feeds and feed grains were on a yearly basis covering seventeen years, 1950–1966. All the data used in this section were collected from Feed Statistics, U.S.D.A. Statistical Bulletins No. 159, 410. The prices of processed feeds, dairy ration, broiler growing ration, turkey growing ration and laying mash were on the basis of dollars per hundredweight. They were average prices paid by farmers in the United States.

The price of corn per bushel was the average market price, No. 3, yellow, at Chicago.

The price of oats per bushel was the average market price, No. 1, white, at Chicago.

The price of soybean meal per ton was the average wholesale price, 44% protein, at Decatur.

The price of cottonseed meal per hundredweight was the price paid by farmers, 41% protein, in the United States.

All prices were in dollar units.

LIVESTOCK AND FEED RELATIONSHIPS

Long - period

In the price analysis between feeder steers and slaughter steers, corn and time, monthly data were employed. It was assumed that nearly six months was needed under average intensity to bring a 700-lb. feeder steer to a 1,000-lb. slaughter steer. Therefore, the price of feeder steers per hundredweight was the average monthly price of Choice 500–800 lb. feeder steers at time (t–6) at Omaha. The price of slaughter steers per hundredweight was the average monthly price of Choice 900–1,100 lb. slaughter steers at time (t) at Omaha. Both prices for feeder and slaughter steers were collected from Livestock and Meat Statistics, U.S.D.A. The price of corn per bushel was the average price for the six-month period from time (t–5) through (t) and based on prices received by farmers in Nebraska taken from the Nebraska Agricultural Statistics Annual Reports. All prices were in dollar units.

Monthly data were used to evaluate the price relationship between hogs and corn, time and seasonable variables. The price of hogs per hundredweight was the price of U.S. No. 1, 2 and 3, 200–220 lb. hogs at Omaha, taken from Livestock and Meat Statistics. The price of corn per bushel was the average price for the six-month period from (t–5) to (t), received by farmers in Nebraska. All prices were in dollar units.

The next analysis was the price of milk related to the price of dairy ration, wage rate and time.

The price of milk per hundredweight was the average monthly price of manufacturing grade milk used for butter, 3.5% fat basis, Minnesota, collected from Chicago Dairy Statistics Branch, U.S.D.A. and the Milk Production and Dairy Products Annual Statistical Summary.

The price of dairy ration per hundredweight was the monthly price paid by farmers, 16% protein content, United States, taken from Feed Statistics. The wage rate used was a yearly index number of composite wage rates based on 1957–1959 having a value of 100. This information was taken from Agricultural Statistics.

Prices were in dollar units.

In the evaluations of the prices of poultry and eggs related to those of growing rations and time, monthly data were used.

The prices of broiler per pound, turkey per pound and eggs per dozen were the prices received by farmers in the United States. These prices were in cent units.

The prices of broiler growing ration, turkey growing ration and laying mash per hundredweight were the prices paid by farmers in the United States.

These data were collected from the Egg and Poultry Statistics as well as the Feed Statistics.

These prices were in dollar units.

Short - period

In the short-period evaluations of livestock and feed price relationships, monthly data were employed. The first analysis was the price of heavy slaughter cattle related to the prices of lighter slaughter cattle, corn and time. It was assumed that three months are required to gain 200 lbs. of live weight, from 1,000–1,200 lb. slaughter cattle. Therefore, the price of heavy slaughter cattle per hundredweight was the average price of Choice 1,100–1,300 lb. steers at time (t–3) at Omaha. The price of lighter slaughter cattle was the price of Good 900–1,100 lb. steers at time (t–3) at Omaha.

These data were taken from Livestock and Meat Statistics, U.S.D.A. The price of corn per bushel was the price received by farmers in Nebraska at time (t–3), collected from Nebraska Agricultural Statistics Annual Reports.

All prices were in dollar units.

The second analysis directly considered the change in cattle value per hundredweight of final form related to the price of corn and time. The change in cattle value per hundredweight was the price of Choice slaughter steers 1,100–1,300 lb. at time (t) minus five-sixths (or 1,000/1,200) of the price of Good slaughter steers 900–1,100 lb. at time (t–3) at Omaha.

Data used for the price of corn were the same as the previous analysis.

Values were in dollar units.

The third price analysis was concerned with the price of heavy hogs related to the prices of lighter hogs, corn and time. It was assumed that sixty pounds was gained through two months of feeding. The 270-pound and 210-pound weight classes were used in the analysis.

Therefore, the price of heavy hogs per hundredweight was the price of 240–270 lb., U.S. 1–3 hogs at time(t) at Omaha.

The price of lighter hogs was the price of 200–220 lb., U.S. 1–3 hogs at time (t–2) at Omaha.

These data were taken from Livestock and Meat Statistics, U.S.D.A. The price of corn per bushel was the price received by farmers in Nebraska at time (t-2), taken from Nebraska Agricultural Statistics Annual Reports.

All prices were in dollar units.

The fourth analysis directly considered the change in hog value related to the price of corn and time. The same assumptions were applied to this evaluation. The change in hog value per hundredweight was the price of 240–270 lb., U.S. 1–3 hogs at time (t) minus seven-ninths (or 210/270) of the price of 200–220 lb., U.S. 1–3 hogs at time (t–2) at Omaha.

Data sources for hog and corn prices were the same as the previous analysis and values were in dollar units.

The fifth evaluation considered the difference in broiler price (cents per pound) related to the difference in the price of broiler growing ration (dollars per hundredweight) and time. The price of broilers per pound was the price received by farmers, live weight, United States, taken from Egg and Poultry Statistics. The difference in broiler price at time (t) was the broiler price at time (t) minus that at time (t–3).

The price of broiler growing ration per hundredweight was the price paid by farmers, United States, taken from Feed Statistics. The difference in broiler growing ration price at time (t) was the first difference in the prices of broiler growing ration from time (t–6) to (t-3). This was the short-period evaluation of changes in the prices of broiler and broiler growing ration.

The sixth analysis was concerned with the difference in egg price related to the difference in the price of laying mash and time. The theoretical assumption and estimated procedure were similar to those of previous analysis.

Data used in this evaluation came from Egg and Poultry Statistics.

The last analysis was associated with the relationship between the difference in turkey price (cents per pound) and that in turkey growing ration price and time. It was assumed that six months were required for turkey production and the consumption of turkey was seasonable during the year. The price of turkey per pound was the price received by farmers, live weight, United States, taken from Egg and Poultry Statistics. The difference in the price of turkey was the turkey price at time (t) minus that at time (t–1) for the same month in the previous year. Only four months, September, October, November and December, were considered.

The price of turkey growing ration per hundredweight was the price paid by farmers, United States, taken from Feed Statistics. The difference in the price of turkey growing ration was the first difference in turkey ration price between years. Only four months, March, April, May and June, were taken into consideration.

Because data were not available, the prices of broiler growing ration were used from 1949–1955 instead of those for turkey growing ration.

LIVESTOCK AND ANIMAL PRODUCTS RELATIONSHIPS

Between Market Levels

The first three market margin analyses were concerned with the interrelationships between the net farm value, wholesale value and retail price of beef. They were on a quarterly basis covering the period 1950–1966. Data sources were Price Spreads for Beef, U.S.D.A. Miscellaneous Publication No. 992 and Farm-Retail Spreads for Food Products, 1947–64, ERS-226.

The retail price of beef per pound was the weighted average price of retail cuts from a Choice grade carcass.

The wholesale value of beef was the wholesale value for a quantity of carcass beef equivalent to one pound of retail cuts calculated from the weighted average wholesale price of Choice grade carcass beef. A wholesale carcass equivalent of 1.25 pounds was used for 1949–51; it was increased gradually to 1.35 pounds for 1963 and later years.

The net farm value of beef was the gross farm value minus by product allowance. The gross farm value of beef was the payment to farmers for a quantity of Choice grade beef cattle equivalent to one pound of retail cuts. The farm-product equivalent for 1947-51 was 2.08 pounds; it was increased gradually to 2.25 pounds for 1963 and later years. The by-product allowance was the value attributed to edible and inedible by-products. Values were either cents per pound or dollars per hundredweight.

The next three market margin analyses were similar to the previous three analyses but with respect to pork instead of beef. Based on quarterly data, relationships between market levels at wholesale, retail and farm were evaluated. Data used were taken from Price Spreads for Pork, U.S.D.A. Miscellaneous Publication No. 1051.

The retail price of pork per pound was the weighted average price of hams, bacon, loins, picnics, sausage, butts, spareribs and bacon squares calculated from prices collected by the Bureau of Labor Statistics, U.S. Department of Labor.

The wholesale price of pork was the weighted average calculated from wholesale prices of individual products at Chicago. The net farm value of pork was the payment for two pounds of live hog minus by-product allowances.

The seventh analysis was concerned with the price of broilers at the farm related to the retail price of broilers and time. The price of broilers per pound at the farm was the monthly price received by farmers, live weight, United States, taken from Egg and Poultry Statistics. The retail price of broilers per pound was the average monthly price of ready-to-cook broilers, United States.

Data sources were Selected Statistical Series for Poultry and Eggs through 1964, ERS-232, and the Poultry and Egg Situation.

The last analysis in this section was the price of eggs at the farm related to the retail egg price and time. The egg price at the farm was the average price per dozen received by farmers, United States. The retail price of eggs per dozen was the average price for Grade A large eggs in retail stores in urban areas of the United States.

Data of egg prices on a monthly basis were taken from Selected Statistical Series for Poultry and Eggs through 1964, ERS-232, and the Poultry and Egg Situation.

Between Final Products and Intermediate Animal Products

In the analyses between final products and intermediate animal products, the main consideration was given to the relationships between the price of milk and the prices of dairy products.

Monthly data were employed throughout the analyses. The first evaluation in this section was the price of milk related to the prices of butter and nonfat solid and time.

The price of milk per hundredweight was the price of manufacturing grade milk used for butter, 3.5% fat basis, *Minnesota.*

Data were taken from Chicago Dairy Statistics Branch, U.S.D.A., and Milk Production and Dairy Products Annual Statistical Summary.

The price of butter per pound was the average wholesale price, 92 score, Chicago, collected from Dairy and Poultry Market Statistics.

The price of nonfat solid per pound was the spray processed, carlot basis price at Chicago, taken from the same sources as the price of milk.

Values were in cents per pound or dollars per hundredweight.

The second analysis considered the price of milk related to that of American cheese and time.

The price of milk per hundredweight was the price of manufacturing grade milk used for American cheese, Wisconsin, taken from the same source as the milk price in the previous analysis.

The price of American cheese per pound was the weighted average price of sales on the Wisconsin Cheese Exchange, American Cheddars, taken from Dairy Statistics.

The last analysis was associated with the price of milk related to the price of evaporated milk and time.

The price of milk per hundredweight was the price of manufacturing grade milk for use in evaporated milk plants for Wisconsin.

The price of evaporated milk was the manufacturers' average selling price per case of 48 14½ oz. cans of evaporated whole milk, East North Central Region.

Data were taken from Chicago Dairy Statistics Branch, U.S.D.A., and Milk Production and Dairy Products Annual Statistical Summary.

This appendix was written to assist the reader with more detailed information about the data. No tabulation of the data will be given because they are widely available in the indicated public sources.

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