

PRODUCTION COST COMPARISONS BETWEEN
BEEF, PORK AND CHICKEN

James N. Trapp

Department of Agricultural Economics
Oklahoma State University

CHANGING PRODUCTION METHODS

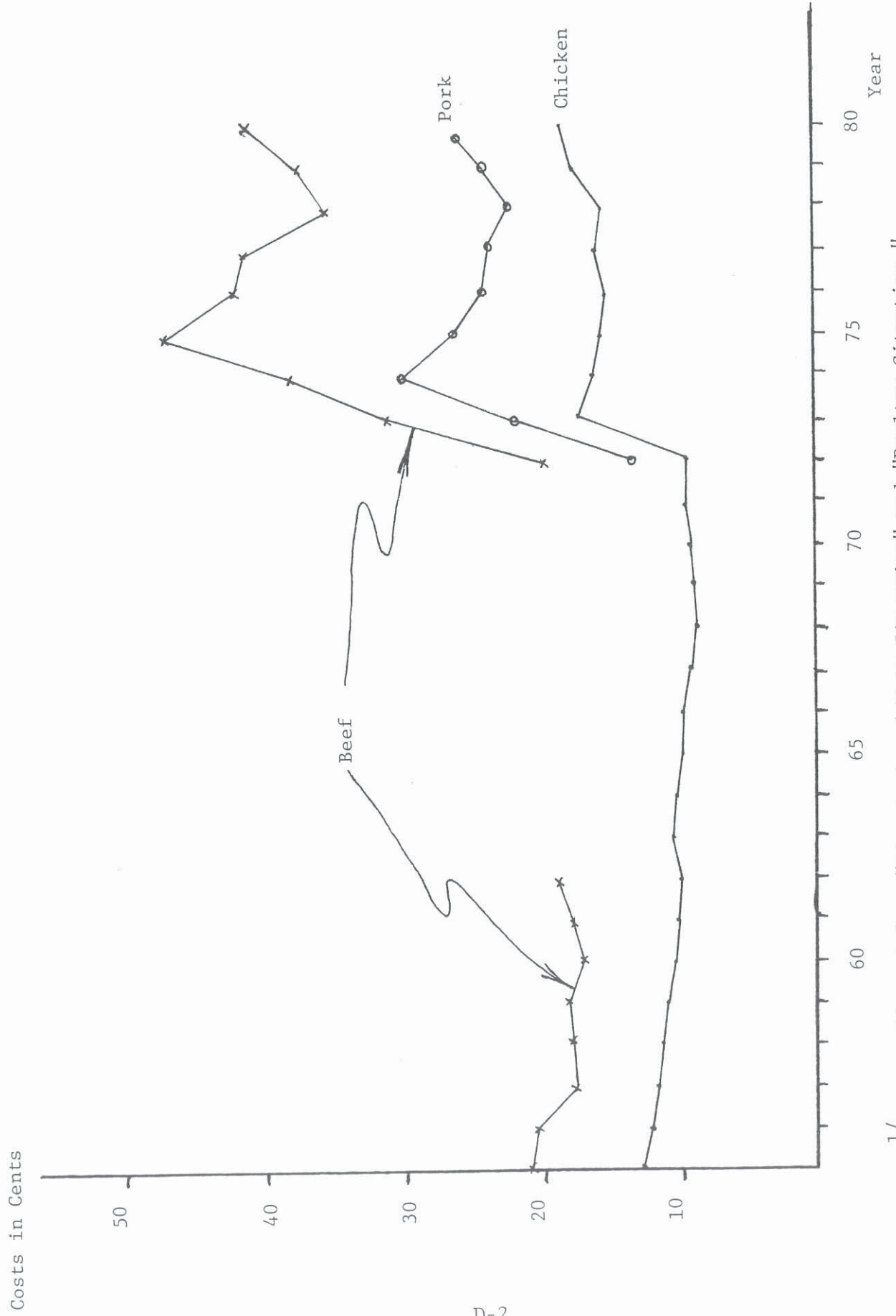
Casual reflection upon the nature of the changes in the production processes for beef, pork and chicken over the past twenty-five years brings to mind numerous changes and technological innovations. Perhaps the most notable changes have been in chicken production, followed by pork and beef. Chicken production has been transformed from a backyard, morning and evening chore operation to a full scale, capital intensive enterprise. To a lesser degree a similar transformation has occurred in the pork production process. Capital intensive, totally confined farrow to finish operations have become common. Beef production methods have also changed, but not as dramatically. Large scale commercial feedlots evolved during the 60's. Feed additives and improved breeding have increased feeding efficiency. These and other changes have not only affected the manner in which beef, pork and chicken are produced, but have also profoundly changed the cost of beef, pork and chicken production. In fact, the conclusion drawn from the production costs presented in this paper is that changing relative costs of beef, pork and chicken have been the dominate cause of dramatic increases in chicken production and consumption relative to beef and pork production and consumption. In the past twenty-five years chicken consumption per capita has increased nearly twice as much as beef consumption and more than twice as much as pork. During the same time period beef production costs tripled relative to chicken production costs and pork production costs doubled relative to chicken production costs.

PRODUCTION COSTS: BEEF, PORK AND CHICKEN

The cost impact of structural/technological change in the beef, pork and chicken production process are reflected by the data in Figures 1 and 2. Cost of production data, profit estimates, breakeven price calculations, etc. such as those presented in Figures 1 and 2 are always difficult to obtain and define and thus should be viewed with caution. However the cost data displayed here have consistent definitions and collection procedures overtime that will allow shifts in the relative costs of production to be validly compared.

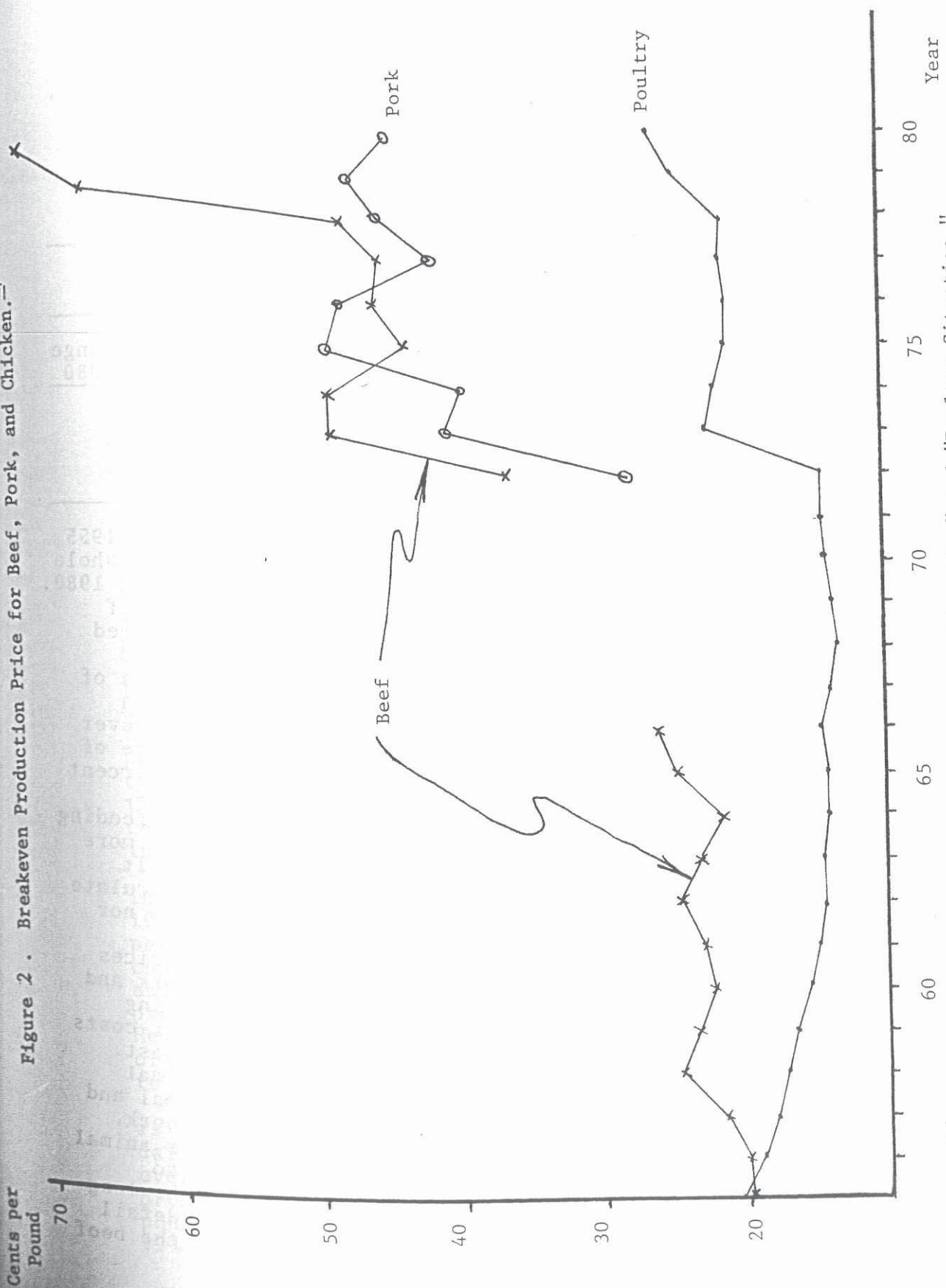
Figure 1 reports the feeding cost per pound of beef, pork and chicken. It should be pointed out that only the feed used in the finishing phase of production, and not the total feed

Figure 1. Feed Costs Per Pound of Gain for Beef, Pork, and Chicken.^{1/}



^{1/} Data collected from "Livestock and Meat Situation" and "Poultry Situation."

Figure 2 . Breakeven Production Price for Beef, Pork, and Chicken.



1/ Data collected from "Livestock and Meat Situation" and "Poultry Situation."

for breeding animals, backgrounding etc. is considered. Likewise in the case of beef only grain concentrate type ration feed costs are considered. Figure 1 points out that the cost of feed rose dramatically for all three meat types in 1973 when grain prices rose sharply. Interestingly however, beef ration costs continued to rise longer and reached a new plateau relative to pork and poultry.

Table 1. Beef, Pork and Chicken Feed Cost Ratios Per Pound of Gain.

Feed Cost Ratio	Year			
	1972	Average 1975-80	1980	Percent Change 1972 to 1980
Beef/Chicken	2.17	2.53	2.30	+ 6.0
Pork/Chicken	1.40	1.51	1.42	+ 1.4
Beef/Pork	1.54	1.68	1.61	+ 4.5

Available data describing feed costs over the period 1955 to 1980 are not complete to analyze ration costs over the whole period. However data are relatively complete from 1972 to 1980. Table 1 indicates that between 1972 and 1980 grain fed beef ration costs rose by some 6 percent relative to chicken feed costs. These comparisons are spot comparisons between two selected years. However, they appear to be representative of the 70's. The limited data contained in Figure 1 depict a relatively stable feed cost situation prior to 1972. However the beef/chicken feed cost ratio increased from an average of 1.6 over the 1955-60 period to 2.17 in 1972; i.e. a 36 percent increase in beef feed cost relative to chicken feed costs.

In summary, Figure 1 provides casual evidence that feeding efficiency in the broiler industry has tended to improve more rapidly in the past than in the beef or pork industry. It must be pointed out however that the budgets used to calculate feed costs do not necessarily reflect least cost rations nor assimilation of all improvements in feeding efficiency.

Figure 2 presents estimated historical breakeven prices (i.e. total cost of production estimates), for beef, pork and chicken. Problems also exist in calculating and comparing the data series depicted in Figure 2. The beef and pork costs per pound include the price of the feeder animal as a cost. Hence any profits or losses in beef and pork feeder animal production are included in the price of the feeder animal and thus also in the cost of producing a pound of beef or pork. Never the less, economic theory suggests that if feeder animal production activities are competitive, profits/losses to producing feeder animals should be driven to zero in the long-run (this theoretical point will be discussed in more detail presently). An additional comparison problem is that the beef

budgets consider only the costs of producing grain fed beef. Figure 2 basically contains the same relationships that were found in Figure 1. All breakeven prices rose sharply in 1973. But, unlike the feed cost case the breakeven prices for beef and pork stabilized immediately along with chicken breakeven prices. This was largely due to feeder animal prices dropping to offset ration cost increases.

Table 2. Beef Pork and Chicken Breakeven Price Ratios

Breakeven Price Ratio	Year			
	1972	Average 1975-80	1980	Percent Change 1972 to 1980
Beef/Chicken	2.56	2.35	2.75	+ 7.4
Pork/Chicken	1.96	2.02	1.70	- 13.3
Beef/Pork	1.31	1.16	1.62	+ 23.7

The ratios of cost of production for beef, pork and chicken present a mixed pattern when the 1980 and 1975-80 average ratios are compared to the 1972 ratio. However, one consistent relation stands out. Pork production costs (breakeven prices) have held the line against both beef and chicken. In viewing Figure 2 it appears beef production costs remained in line with both pork and chicken production costs until 1979.

Despite the lack of comprehensive data over the period from 1955 to 1972, it is clear from Figure 2 that beef production costs per pound have steadily increased relative to chicken. In fact, in 1955 beef is indicated to have had a production cost below that of chicken. Furthermore more in contrasting the percentage changes in relative feed costs (Table 1) and total costs (Table 2) it is evident that increased cost efficiencies of chicken relative to beef have occurred in non-feed costs as well as feed costs.

It is postulated that the beef, pork and chicken production industries have remained relatively competitive throughout the 1955-1980 period. Therefore the general tendency during this period should have been for market prices to approximate the cost of producing beef, pork and chicken. Short-run profits and losses will have existed as the industry adjusted its production to changing input costs, shifts in demand etc. However, in general, profits should have been small and random, or perhaps cyclical because of the biological time lags required to adjust production.

Evidence that profits have been relatively small and random is provided in Table 3. The Table relates the cost of production data displayed in Figure 2 to appropriate market prices existing over the same period. For the twenty six years that chicken production cost data were available the average profit per pound was 1.0 cents. In the case of beef an average profit of .24 cents per pound existed during the twenty one years for

Table 3 Cost, Revenue and Net Returns Per Pound for Beef, Pork and Chicken

Year	Beef			Pork			Chicken		
	Cost	Price	Net Return	Cost	Price	Net Return	Cost	Price	Net Return
1955	20.11	21.17	+1.06		15.19		20.5	25.2	+4.7
1956	19.97	23.72	+3.75		14.82		19.0	19.6	+0.6
1957	21.48	28.32	+6.84		18.29		18.2	18.9	+0.7
1958	24.79	29.01	+4.22		20.25		17.6	18.5	+0.9
1959	23.95	26.72	+2.77		14.64		16.7	16.1	-0.6
1960	22.03	23.33	+1.30		15.96		15.7	16.9	+1.2
1961	22.79	26.30	+3.51		17.60		15.1	13.9	-1.2
1962	24.56	23.43	-1.13		17.24		14.8	15.2	+0.4
1963	23.54	21.12	-2.42		15.71		14.8	14.6	-0.2
1964	21.87	26.73	+4.86		15.73		14.5	14.2	-0.3
1965	24.96	26.74	+1.78		21.54		14.5	15.0	+0.5
1966	26.02	25.32	-0.70		24.06		14.7	15.3	+0.6
1967		25.54			19.80		14.1	13.3	-0.8
1968		27.24			19.57		13.5	14.2	+0.7
1969		29.66			24.08		13.8	15.2	+1.4
1970		29.34			22.71		14.2	13.5	-0.7
1971		32.42			18.45		14.3	13.8	-0.5
1972	36.66	35.83	-0.83	27.99	26.72	-1.27	14.3	14.3	+0.0
1973	48.93	43.89	-5.04	40.41	40.27	-0.14	22.2	24.2	+2.0
1974	48.95	41.03	-7.92	39.56	35.50	-4.06	22.0	21.7	-0.3
1975	43.32	44.61	+1.29	49.10	54.23	+5.13	21.3	26.4	+5.1
1976	45.94	39.10	-6.83	48.02	43.82	-4.20	21.1	23.6	+2.5
1977	45.35	40.39	-4.96	41.25	41.30	+ .05	21.7	23.6	+1.9
1978	48.01	52.34	+4.33	45.13	48.45	+3.32	21.5	26.3	+4.8
1979	66.14	67.68	+1.54	47.71	42.48	-5.23	24.6	26.0	+1.4
1980	71.89	67.04	-4.85	44.27	40.04	-4.23	26.1	27.8	+1.7
		Average	+0.24		Average	-1.18		Average	+1.0

which data were available. Finally the nine years of cost data available for pork indicate an average loss of 1.18 cents per pound.

In general the profit and loss figures reported in Table 3 indicate very small profits or losses. This is consistent with the theory of competitive markets. Sharp, short-run variations in profits and losses have occasionally occurred. Profits and losses approaching 33 percent of the cost of production can be observed in Table 3. But these are the exception and are offsetting in nature.

Given the problems in accurately measuring cost of production over time, a smoothed trend line of competitive market prices, maybe a more accurate reflection of production cost trends than the production data themselves. The fact that production cost trends and market price trends are related is evident from Table 3. Linear correlation coefficients between the cost and price series reported in Table 3 are as follows: Beef - 96.8, Pork - 88.3, Chicken - 96.1.

Quadratic trend functions for the market price series presented in Table 3 are shown below. Quadratic, rather than linear time trends were used because of the general acceleration of price increases for all meats during the 70's. A dummy variable was added to capture the sharp rise in prices in 1973. Values in parenthesis below the parameters are t-values. Graphs of the functions and actual prices are presented in Figure 3.

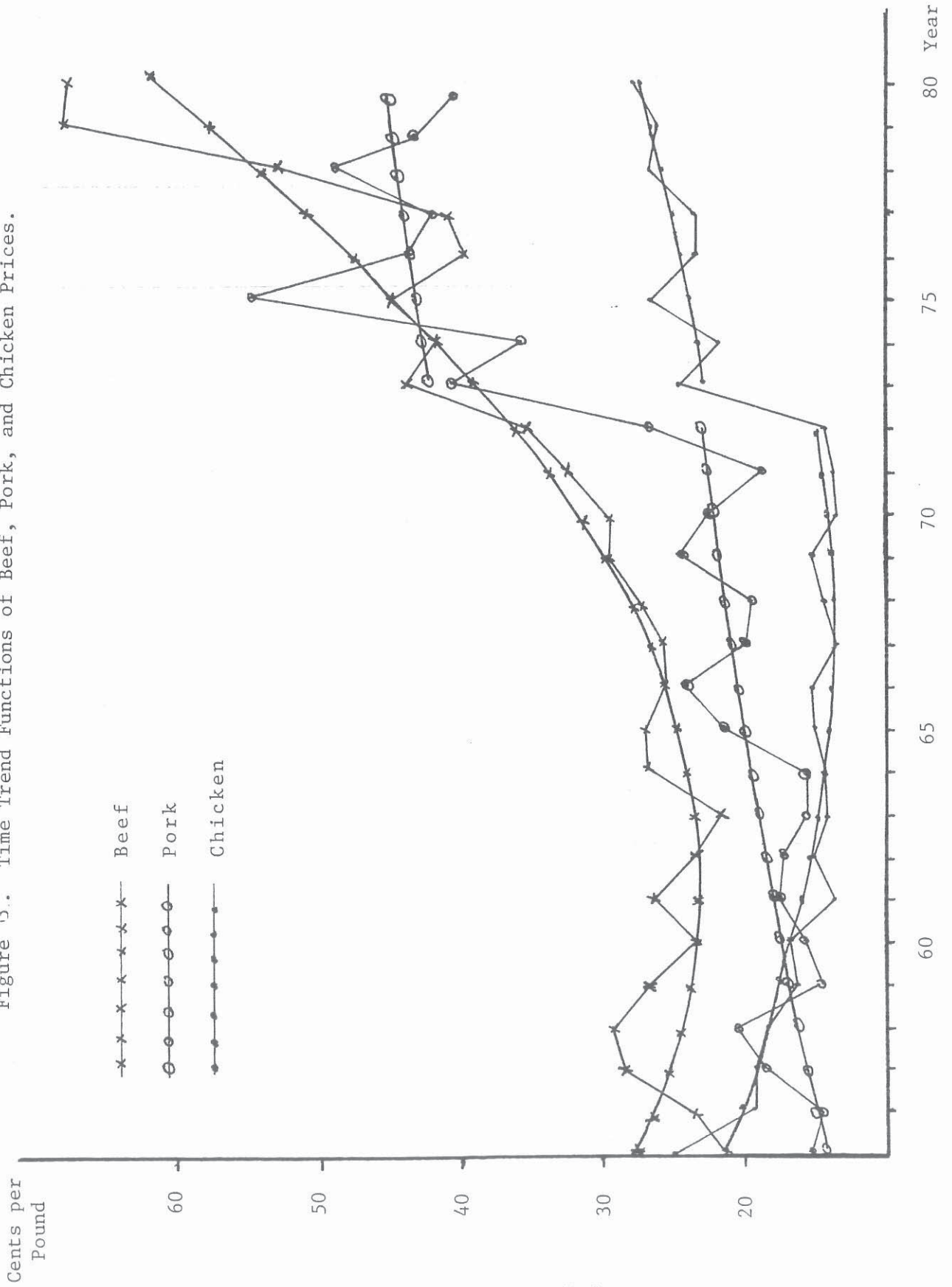
$$\begin{aligned}
 1) \quad \text{Beef Price} &= 427.3 - 13.17 \times \text{Year} + .1074 \times \text{Year}^2 \\
 &\quad (4.48) \quad (4.45) \quad (4.70) \\
 &+ .4116 \times \text{DUM73} \\
 &\quad (.01) \\
 &R^2 = .89 \quad \text{Durbin Watson} = 1.26
 \end{aligned}$$

$$\begin{aligned}
 2) \quad \text{Pork Price} &= -29.44 + 1.065 \times \text{Year} - .0047 \times \text{Year}^2 \\
 &\quad (.34) \quad (.40) \quad (.21) \\
 &+ 18.88 \times \text{DUM73} \\
 &\quad (5.05) \\
 &R^2 = .91 \quad \text{Durbin Watson} = 2.42
 \end{aligned}$$

$$\begin{aligned}
 3) \quad \text{Chicken Price} &= 221.33 - 6.06 \times \text{Year} + .0443 \times \text{Year}^2 \\
 &\quad (7.39) \quad (6.53) \quad (6.16) \\
 &+ 8.19 \times \text{DUM73} \\
 &\quad (6.29) \\
 &R^2 = .93 \quad \text{Durbin Watson} = 2.16
 \end{aligned}$$

Each of the above equations has a reasonably strong R^2 value. The relatively high Durbin - Watson statistics reflect the cyclical price patterns for beef and pork around the fitted trend line. Durbin - Watson values for beef and pork fall in

Figure 3. Time Trend Functions of Beef, Pork, and Chicken Prices.



the inconclusive range of the test. The hypothesis of serial correlation is rejected for the poultry equation. Numerous studies have documented the existence of price cycles for beef and pork. Thus, this topic will not be dwelled upon here. What is postulated here is that the same evidence that supports the existence of price cycles for pork and beef can be extended to indicate profit cycles for pork and beef and random profit years for chicken. Evidence supporting this position is provided by the fact that the residuals of the trended beef, pork and chicken price series are significantly correlated to the net return values reported in Table 3. The correlation coefficients found are respectively; Beef - .10; Pork - .62; Chicken - .44.²⁷ While these are not extremely strong correlations they indicate, especially in the cases of chicken and pork, that a significant relationship does exist between the calculated net return series and the residuals of the respective smoothed price time series. These correlation coefficients also reinforce the hypothesis that smoothed functions of the market price series for products produced in a competitive market accurately approximate the trend in production costs for that product.

Given that the trended price series for beef, pork and chicken reflect each commodity's trended cost of production, equations 1 through 3 support the previous conclusion that the cost of production has been rising faster for beef than for pork or poultry. Table 4 reports the value of the first derivative of the beef, pork and chicken market price trend functions as evaluated at four points in time.

Table 4. First Derivatives of its Beef, Pork and Chicken Market Price Time Trend Functions

Commodity	Year			
	1970	1975	1980	1985
Beef	1.87	2.94	4.01	5.09
Pork	.41	.36	.31	.27
Chicken	.14	.59	1.03	1.47

These derivatives indicate that beef prices have been rising the most rapidly and that the rate of increase in beef prices has also been the highest (i.e. the second derivative is larger than that for pork or chicken). The derivatives reported in Table 4 also indicate pork prices (production costs) have not been rising as fast as chicken prices during the 70's.

COMPOSITION OF PRODUCTION COSTS: BEEF, PORK AND CHICKEN

The preceding discussion has described the changes in production costs for beef, pork and chicken over the past twenty-five years. The composition of beef, pork and chicken production costs in 1981 will now be considered. Special emphasis will be given to analyzing the long-term investment

cost of production versus short-run out-of-pocket expenses. The costs presented will not be calculated in a manner attempting to reflect national average costs. Rather budgets for specific production systems have been used to develop the costs reported here. The costs reported for beef are based upon the combined costs of a 100 head cow/calf operation, a 100 head stocker backgrounding operation which carries calves from weaning to 600 pounds, and costs for feedlot finishing heifers to 950 pounds and steers to 1050 pounds. The pork cost figures reported reflect the costs of a 90 sow, fully confined farrow to finish operation. The chicken costs are based upon a composite set of costs for a hatching egg operation with a capacity for 8,000 layers and a broiler production system with four 15,000 bird houses. It is believed that these budgets reflect typical competitive commercial production systems for beef, pork and chicken. All cost summaries will be presented in cents per pound.

Table 5 reports capital, land, labor and operating costs per pound for beef, pork and chicken^{3/}. Capital and land costs have been computed as either 5, 10 or 15 percent of the total capital and land investment required.

Table 5. 1981 Beef, Pork and Chicken Capital, Land, Labor and Operating Costs Per Pound of Live Weight Produced Assuming Three Rates of Return to Capital and Land Investment.

Meat Type	Rate of Return to Capital and Land		
	5%	10%	15%
	(cents/lb.)		
Beef			
Capital	6.697	13.394	20.091
Land	16.284	32.568	48.852
Labor	8.779	8.779	8.779
Operating	46.131	46.131	46.131
Total	77.891	100.872	123.853
Pork			
Capital	1.750	3.500	5.250
Land	.282	.564	.846
Labor	2.471	2.471	2.471
Operating	46.334	46.334	46.334
Total	50.837	52.869	54.901
Chicken			
Capital	1.392	2.784	4.176
Land	.005	.010	.015
Labor	1.013	1.204	1.204
Operating	21.025	24.999	24.999
Total	23.435	28.997	30.394

Several insights into the nature of the comparative cost structures of beef, pork and chicken are revealed in Table 5.

First, relative to market prices existing in 1981, beef production costs are extremely high, i.e. market prices for beef, pork and chicken averaged approximately 64, 45 and 28 cents per pound respectively during 1981.

Secondly, capital and land costs constitute a much larger portion of the cost of production for beef versus pork and chicken. Table 6 further illustrates this point.

Table 6. Ratios of Capital and Land Costs Versus Out-of-Pocket Costs for Labor and Operation- Assuming a 10 Percent Interest Rate.

Meat Type	Cost		Ratio
	Capital & Land	Labor & Operation	
Beef	45.962	54.910	.837
Pork	4.064	48.805	.083
Chicken	2.794	26.204	.107

Assuming a 10 percent charge for capital and land investment expense, the ratio of capital and land cost to labor and operating cost is .837 for beef, .083 for pork and .107 for chicken, i.e. the ratio of long-term investment costs to short-term out-of-pocket costs is nearly ten times greater for beef than pork or poultry. This relationship causes, among other things, the cost of beef production to be much more sensitive to interest rates (i.e. the rate of payment to land and capital investment) than are pork and chicken costs of production.

A third insightful observation can be made by focusing upon the cost of land used in beef production when a 10 percent interest rate is assumed. At this interest rate land cost constitutes nearly one-third of the cost of beef production. The cost of land in pork and chicken production by comparison is negligible. If land costs are removed from the cost of beef when a 10 percent interest rate is assumed, the cost of beef production per pound is reduced from slightly over one dollar per pound to 68 cents per pound. A cost level of 68 cents per pound is only a few cents above the market price received for beef in 1981. Perhaps more than any other factor, the importance of land as an input in the beef production process relative to its importance in the pork and poultry production process tends to make beef production costs different from pork and poultry. Land, unlike other forms of operating and capital inputs, tends to appreciate in value over time. Hence part of, if not most of, the payment to land is expected in many cases to be covered by the land's appreciation in value. Therefore, when the land input for beef, pork and chicken is "full costed" it is not surprising that the spread between beef production costs and its market price is the widest of the three cost/market price spreads.

A final observation regarding Table 5 is that the costs reported in the Table imply the capital and land investment required to generate a specified gross income in beef production is much greater than that required by pork and chicken. Table 7

has been developed from Table 5 to illustrate this point. Table 7 indicates that the investment level required to

Table 7. Capital and Land Investment Required to Generate One Dollar of Gross Revenue from Beef, Pork and Chicken Production.^{a/}

Meat Type	Investment Per Dollar of Gross Revenue
Beef	71.82
Pork	9.03
Chicken	9.98

^{a/}In calculating this table a 10 percent interest rate and the following meat prices were assumed; Beef - 64¢/lb; Pork - 45¢/lb; and Chicken - 28¢/lb.

generate a dollar of revenue from beef production is some seven to eight times larger than that required for chicken or pork. Hence while it is argued that not all land cost should be covered by the revenue generated from production, it still must be recognized that the large investment for land and other capital required by the beef industry creates a distinct problem. The economic rule and observed practice that a firm should continue to operate in the short-run only as long as they can cover short-term out-of-pocket costs takes on new meaning in relation to Tables 6 and 7. The tables indicate that total costs and out-of-pocket costs are not much different for pork and chicken, but are substantially different for beef. The result is that pork and chicken supplies tend to be cut back very quickly by this economic rule as prices fall. On the other hand according to this rule beef supplies do not respond until prices fall substantially. Hence, in the beef industry as opposed to the pork and chicken industry, longer, more severe periods of losses are usually required to obtain production cut backs that lead to higher prices.

SUMMARY AND CONCLUSIONS

The price trend relations and cost of production data presented here provide significant evidence that over the past twenty-five years greater improvements in production efficiency have occurred in the chicken and pork industries than in the beef industry. This has caused beef production costs and market prices to rise relative to pork and chicken. It is argued that these relative changes in production costs have been the primary cause of changing meat consumption patterns. Fundamental tastes and preferences for beef, pork and chicken appear to have changed very little. Consumers are however dealing with a new and likely permanently different

set of relative meat prices. Their response to this new set of meat prices is primarily responsible for the changes in consumption patterns observed. Producers have produced what is profitable and consumers have ate it.

The problems created in the beef industry by its failure to improve its cost efficiency as rapidly as chicken and pork is compounded by and partially due to the composition of its input costs. The beef industry is a relatively extensive user of land and capital. The chicken and pork industries have transformed themselves into intensive, highly capital efficient industries. As a result their long-term capital investment to short-term operating capital ratios are much lower than beef's. This allows the pork and chicken industries to shut down production operations quickly when market prices fall. In so doing only small losses are encountered since fixed costs upon capital investments are relatively small. In the beef industry, fixed costs upon land and capital investment consitute nearly half of all production costs and short-run termination of production during periods of low prices is not an option for the industry as a whole. This inability of the beef industry to reduce production temporarily in the short-run is further hindered by the longer biological production periods required by beef versus pork and poultry. The ability of the chicken industry to rapidly curtail production, because of its low fixed capital overhead cost, and then rapidly expand production again because of its short biological production period, places it in a commanding position in the meat market. This command becomes stronger and stronger as chicken captures a larger and larger share of the meat market.

FOOTNOTES

1/The pork profit figures maybe somewhat biased by the fact that only nine years of data exist and a four year hog cycle is generally believed to be present. A four year cycle would imply two profitable years followed by two unprofitable years. The nine years of data considered for pork begin with three negative net return years, and ended with two negative net return years. This would seem to imply that three loss phases and two profitable phases of the cycle have been encompassed by the data, thus biasing the average net return figure downward.

2/It is not surprising that a smaller correlation is found between the beef net return series and the residuals of the smoothed time series for beef prices. The net returns reported for beef are in essence feeder returns and not total industry profits, i.e. feeder cattle production is likely of a much different nature than that for cattle feeding. Variation about the trended market price series for beef according to the hypothesis postulated here would be due to the combined profits of both feeder cattle production and cattle feeding. The same problem might be expected to exist in the case of pork where the net returns reported are also just for pork finishing operations. However, in the case of pork, feeder pig production and hog finishing tend to be more closely integrated and a shorter feeder pig profit cycle which is likely similar in length to the finishing profit cycle would be expected.

3/The cost figures reported in Table 5 reflect the relatively high cost of beef production as do the cost figures in Figure 2 and Table 3. The cost figures in Table 5 are not directly comparable to those in Figure 2 and Table 3 due to changes in definition. This is particularly true for beef and pork. The cost figures presented in Table 3 for beef and pork are for the finishing operations only. The costs of feeder animals are entered as their market value. The cost figures in Table 5 are for the entire beef and pork system from breeding to slaughter.

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