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Developing a Producer-Oriented Market Information Delivery System

by

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A TOTAL MEAT DEMAND APPROACH TO FORECASTING AND EXPLAINING BEEF PRICES

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Beef, pork, and poultry are substitute goods in the overall bundle of goods and services purchased by consumers. Numerous studies have confirmed this competitive relationship among the major meats. The typical procedure for dealing with this interrelationship is to estimate the parameters of a set of simultaneous equations representing the individual demand curves for the three meats. This results in a set of demand relationships which may be integrated by one procedure or another into price forecasting models.

Price forecasting models may be sophisticated, as with the large computerized economic models which incorporate exhaustive lists of market factors. Or forecast models may be simple, as with year-to-year projected changes in supplies matched with the appropriate own and cross elasticity estimates. Both the sophisticated and the simple

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models have limitations in education-oriented extension outlook programs. Forecast models for extension must have teachability, flexibility, and accuracy. The sophisticated models, while capable of incorporating simultaneous market relationships, are relatively inflexible or at least are difficult to adapt to changing market situations. These models are too complicated also for use as teaching tools with people having no formal economics or statistics training. The simple year-to-year change models are teachable but present difficulties in dealing with simultaneous relationships and in choosing appropriate base periods from which to project changes.

The total meat approach

The total meat demand approach to price forecasting is both simple in concept and flexible enough to adapt to a changing economic environment. The basic premise is that there is an identifiable consumer demand for meat. This total meat demand reflects a composite demand for all meats: beef, pork, chicken, turkey, lamb, veal, etc. The idea is to consider all close substitutes as a "composite" commodity. This simplifies the cross commodity relationships and is a straightforward, teachable approach to forecasting. The supply of the composite commodity in relation to its demand determines the market price for the composite commodity and simultaneously the price of the individual components. The illustration presented here is based on the assumption that aggregate supply of beef, pork, and broilers in relation to a composite demand for these three meats, determines a composite price

for meat. Simultaneously, the individual prices of beef, pork, and broilers are determined as well. Adding other meats or other proteins to the procedure would neither change the basic concepts nor the methodology.

Aggregation of total meat supplies

The problems of cross commodity relationships are not avoided by the total meat approach; instead, they become problems of aggregation. Questions arise as to the weights to be assigned to the various meats in developing a composite meat supply. The procedure outlined here utilizes a simple summation of USDA estimates of per capita "retail" weights of beef, pork, and broilers. But the objective, regardless of the procedure, is to convert the meats to some equivalent basis that is consistent with the price series to be used in estimating meat demand.

A concern with respect to beef supplies, is the question of fed versus non-fed beef. The price of choice beef does not accurately reflect the price of beef in total, particularly in time of relatively large supplies of non-fed beef. But, even if fed and non-fed supplies are estimated separately, there is a problem in pricing the non-fed component. In this paper, all beef is treated as choice beef, even though the existence of this potential problem is recognized.

Aggregate of composite meat prices

The problems of aggregation of meat prices may raise even more questions than does the aggregation of quantities. Because a simple summation of retail weights is used for total meat supplies, a quantity weighted average of retail prices of beef, pork, and broiler prices is used to represent a composite meat price. Consequently, commodity interrelationships must be treated as a separate step in the disaggregation process to derive individual meat prices. This procedure allows the flexibility of changing own and cross price elasticity estimates implied by changes in total meat supplies and relative market shares.

Composite choice beef prices are weighted by per capita total beef supplies. This measure may overstate the value of beef somewhat in that roughly one-third of the total beef supply is typically made up of non-fed beef. In the mid-1970s, non-fed slaughter made up nearly half of total beef slaughter. But, pricing all beef as choice beef gave more consistent quantity-price relationships for meat in total and among meats than did pricing non-fed beef as ground beef. However, there is still room for refinement in estimating an aggregate beef price.

An added question in the meat price aggregation problem is whether or not to deflate prices and if so, how? No attempt is made here to address the total complexity of that question. The approach presented here is to deflate the aggregated meat price by an index of per capita disposable income. This implies that "real" and "inflation" income

effects on the demand for meat are indistinguishable. If one assumes an aggregate meat income elasticity of one, this procedure adjusts prices for both inflation and real income effects. If different income elasticities were assumed for each meat, the prices would have to be deflated individually and then aggregated.

Total meat demand

The relationships between total retail quantities of beef, pork, and broilers and their income deflated, weighted average prices give a direct measure of total meat demand. Both the income and substitute meat effects are accounted for in the deflation and aggregation procedures. Figure 1 shows the total meat demand relationship for the 1970-80 time period on an annual basis. Aggregate supplies and prices represented in Figure 1 are as follows:

1. $QM = QB + QP + QC$

2. $PM = [(QB/QM)PB + (QP/QM)PP + (QC/QM)PC]/DPI$

where:

QM = Aggregate meat consumption - retail weight

QB = Per capita consumption beef - retail weight

QP = Per capita consumption pork - retail weight

QC = Per capita consumption broilers - retail weight

PM = Composite meat price (deflated by income) - retail level

PB = Choice beef price - retail

PC = Pork price - retail

PC = Young chicken price - retail

DPI = Per capita disposable income - 1972 based index

Figure 1. Total Meat Demand (deflated by 1972 DPI)

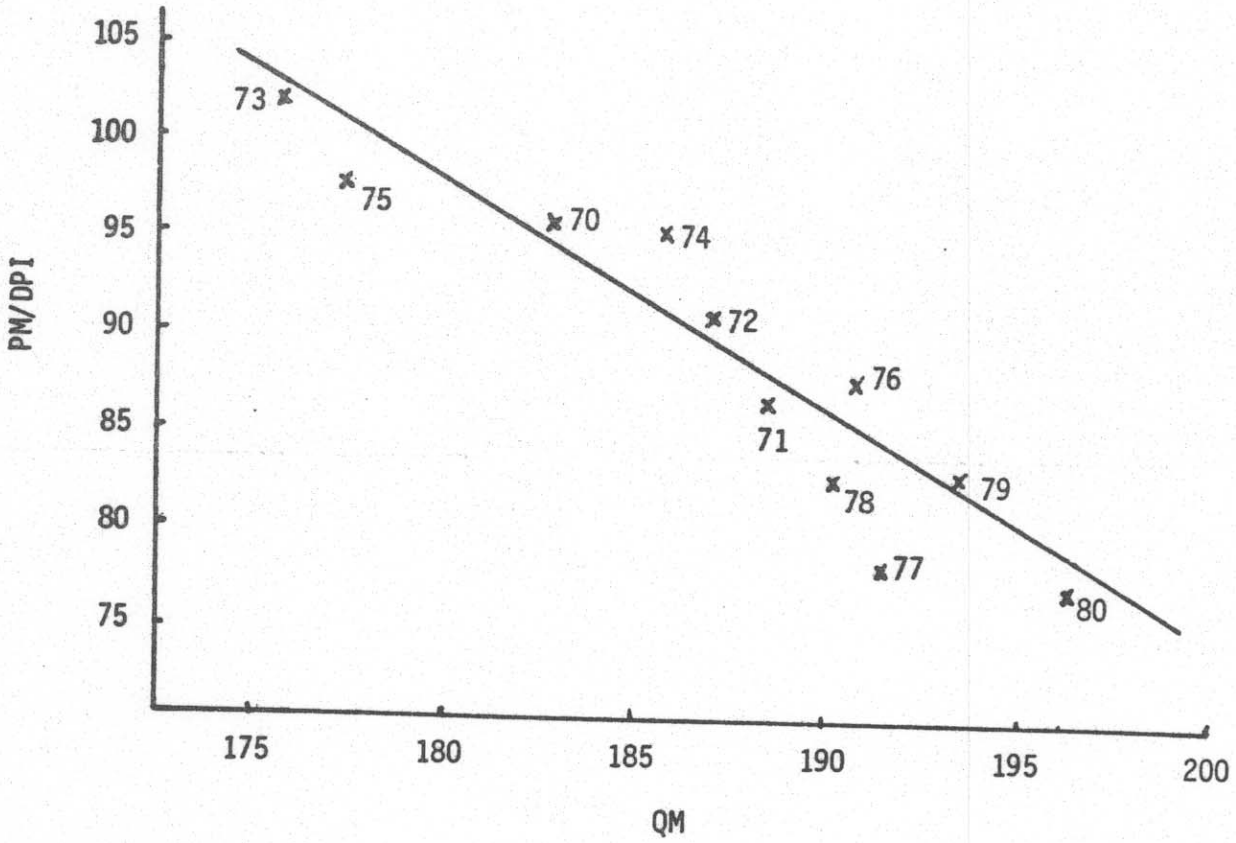
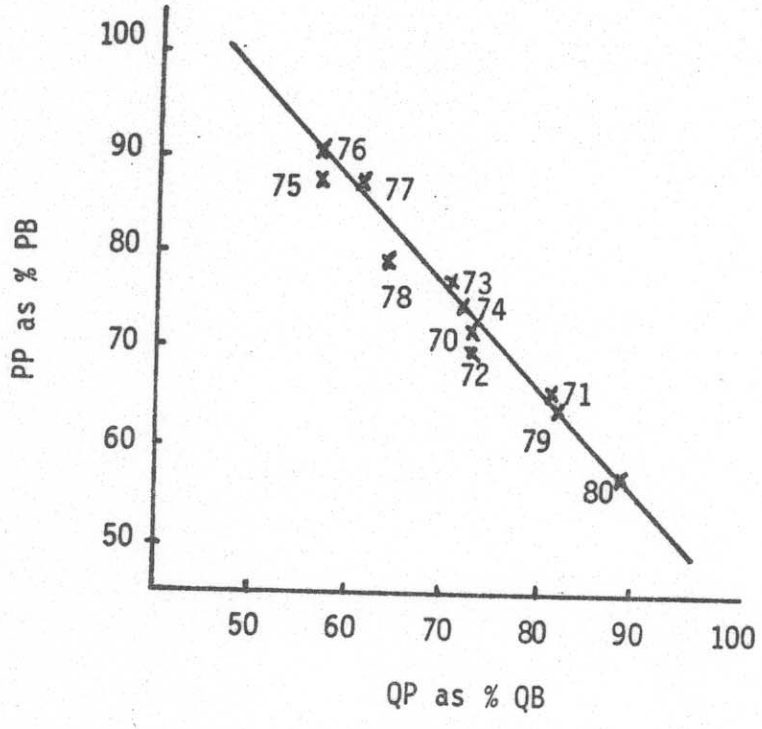


Figure 2. Pork Demand - Beef Demand



The relationship between total meat supplies and composite meat prices traces out a traditional quantity-price pattern which provides a useful teaching tool for use in extension outlook programs. Statistically, the relationship yielded an R^2 or 0.87 with an intercept value of 309.30 and a slope of -1.18. There is no indication in Figure 1 of any fundamental change in the demand for meat in total over the past decade. The elasticity of the demand curve in Figure 1 ranges from 0.49 in 1973 prices and quantities and 0.3 in 1980s.

The simplicity of the total meat demand approach allows the analyst to treat each year individually. In fact, each quarter or each month may be considered as an individual demand situation within the total meat demand context. The analyst may trace recent past demand levels and compare those with the most current data available. The current situation may be compared also with the long-term average. Logical explanations for any current deviation should be taken into consideration. Finally, a judgment is made as to projected future demand levels in relation to current and long-term average levels.

Estimates of future supplies of the individual meats, and consequently total meat supplies, are essential to the forecasting process. However, the emphasis here is on the demand side of the market, which is typically the area of greatest divergence of opinion among market analysts. The analyst using the total meat approach could estimate the deflated composite meat price consistent with his estimates of meat supplies and meat demand level direct from a chart such as Figure 1. For example, a total meat supply estimate of 196 pounds for 1981, assuming

an average meat demand level would result in a composite deflated meat price of about 78 cents for the year as a whole. Current projections for 1981 indicate a weaker demand level and a 73 cents total meat price. This demand weakness, however, has been apparent since the second quarter of 1981.

Relative meat supply-price ratios

A composite deflated meat price is of little value to producers, unless it can be disaggregated into individual prices for beef, pork, and chickens. The relative prices of these meats vary widely so there can be no standard set of weights, which are applicable over time. However, there is evidence that the relative prices among the substitute meats are strongly dependent on their relative supplies. Bullock illustrates that a stable preference structure among competing meats over time will be characterized by a stable relationship between changes in meat supply ratios and their corresponding price ratios (Bullock, 1980). Bullock also concludes that there have been no fundamental changes in the preference structure among beef, pork, and chicken in the past 20 years.

Figure 2 illustrates relationships between beef and pork supply ratios and price ratios in percentage terms. The vertical axis represents retail pork price as a percentage of retail choice beef price and the horizontal axis represents per capita retail pork supplies as a percentage of per capita retail beef supplies. Note that relative retail pork prices have varied from a high of 90 percent of beef prices

in 1976 to a low of less than 60 percent in 1980. Conversely, pork supplies as a percentage of beef supplies varied from a low of less than 55 percent in 1975 and 1976 to a high of nearly 90 percent in 1980. This relationship is consistent with theoretical price-quantity relationships between substitute goods.

Statistically, the relationship yielded an R^2 of 0.97 with an intercept of 1.42 and a slope of -0.94. It is unlikely that the slope of the curve is linear throughout as at some point the marginal value of the increasingly scarce good will likely increase in relation to the increasingly abundant good at something in excess of a constant percentage rate. However, over the data range of the past decade there is little evidence of anything other than a linear relationship.

The analysts using the total meat approach may use a chart such as Figure 2 in projecting price relationships between beef and pork. For example, if the 1981 estimate of per capita retail beef supplies is 80 pounds and the 1981 pork supplies is estimated at 65 pounds, the projected supply ratio will be 0.81 or 81 percent. A pork to beef supply percentage of 81 percent would be consistent with an estimate that pork prices in 1981 will average about 66 percent as high as choice beef prices in 1981. Of course the price estimate used may be adjusted upward or downward on the basis of the analyst's judgment of relative strength in demand for the particular period projected. Current indications are that pork demand is slightly weaker in 1981. Current projections show a retail pork price only 63 percent as high as retail beef prices.

Figure 3. Broiler Demand - Beef Demand

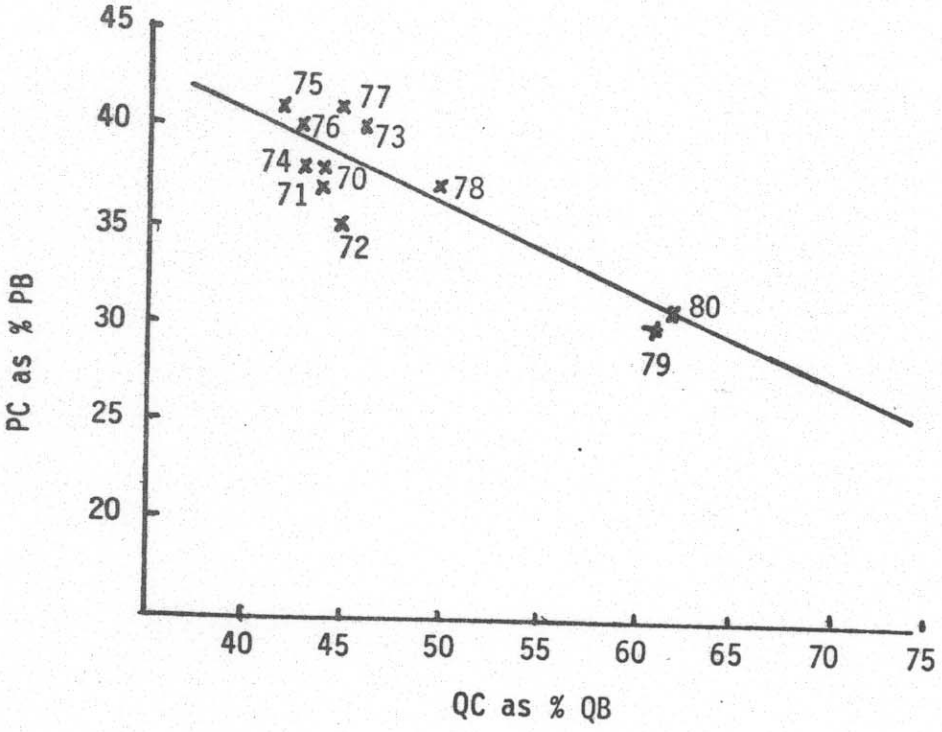


Figure 4. Broiler Demand - Pork Demand

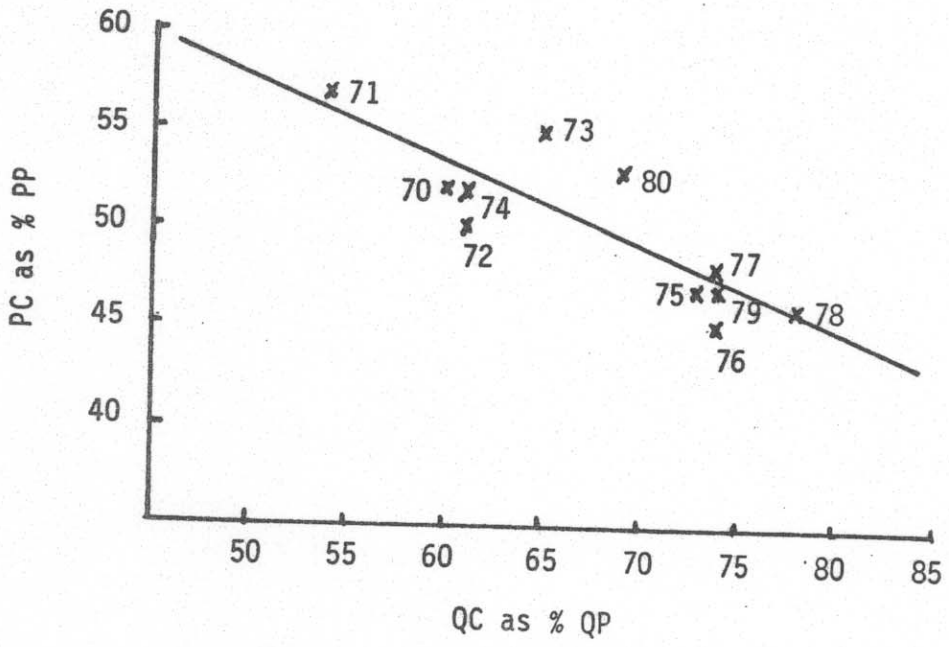


Figure 3 shows a chicken-beef relationship similar to that for pork and beef in Figure 2. The ranges of both relative supplies and relative prices are not as wide as for the pork-beef relationship. In fact, between 1970 and 1977 there was little variation in broiler supplies as a percentage of beef supplies. And, the variability in relative prices, while small as well, seem to be largely random from year to year. But, as broiler supplies increased relative to beef in 1978, 1979 and 1980; retail chicken prices dropped relative to retail beef prices as might have been expected between substitutes. Statistically, the R^2 for the 1970-80 data was 0.71 with an intercept of 0.60 and a slope of -0.47.

A chart similar to Figure 3 could be used to project the relative prices of beef and chicken on the basis of projected beef and broiler supplies. Broiler supplies for 1981 might be projected at about 51 pounds per person retail weight. This 51-pound figure would be 64 percent of the earlier 80-pound estimate of 1981 beef supplies. From Figure 3 this would translate into an average estimate of retail chicken prices at about 30 percent of retail beef prices in 1981. Again, the analyst may choose to deviate from the average. Current projections indicate that chicken prices in 1981 may average about 31% of beef prices, very near average for the decade.

The supply-price relationship between pork and chicken is shown in Figure 4. This relationship is not needed to disaggregate the total meat price but may be beneficial as a consistency check for the two

previous beef relationships. The pork-broiler relationship for the past decade has been similar to that of the comparisons for other meats. Statistically, the relationship yielded as R^2 of 0.70 an intercept of 0.79 and a slope of -0.42. Using previous estimates of pork and broiler supplies for 1981, broiler supplies would be 77 percent as large as pork supplies. A chicken price at just over 47 percent of retail pork price would be implied by this supply relationship. This would be consistent with the previous estimates that pork and chickens would average 66 and 30 percent of retail beef prices, respectively. Current projections are that retail chicken prices in 1981 will average about 49 percent as high as retail pork prices.

Derivation of beef, pork, and chicken prices

Prices of the individual meats may be derived from the aggregate meat price in any order. But, the procedure to this point has centered on prices of pork and chicken relative to beef prices. A more direct approach would be to derive retail beef prices first and then compute prices for the other two meats. Pork prices may be defined as a proportion or ratio of beef prices and likewise chicken prices as a ratio of beef prices. Thus, in Equation 2, (RP x PB) may be substituted for PP and (RC x PB) may be substituted for PC, where RP is the projected ratio of pork to beef prices and RC is the projected ratio of chicken to beef prices. Equation 2 may then be solved for the price of beef that is consistent with the projected composite meat price and price ratios projected using the charts in Figures 1, 2 and 3.

3. PB = (QM x PM)/[QB + (QP x RP) + (QC x RC)]

The derived beef price would then have to be inflated by the projected disposable income index to convert it to a projected retail price of choice beef. The projected retail beef price for 1981 would be about $2.43 per retail pound based on the earlier estimates of meat supplies, meat prices and relative prices; and a 9 percent increase in per capita disposable income from 1981 to 1981.

Substituting the appropriate figure in Equation 2, it yields:

PB = (196 x 73)/[80 + (65 x 0.63) + (51 x 0.31)]

PB = 104.6

The 1972 based disposable income index for 1980 was about 213. A 9 percent increase would result in a 1981 index of 232. The 104.64 deflated beef price would inflate to a $2.43 price in 1981 dollars. The prices of pork and chicken then may be quite easily derived multiplying the appropriate proportion or ratio times the derived beef price. Thus, 1981 pork prices would be 63 percent of retail beef prices, $1.53. And, retail young chicken prices would be projected at 31 percent of retail beef prices, 75¢ for 1981.

The final steps in deriving live prices for cattle, hogs, and broilers involve first subtracting the projected spreads between retail and wholesale or live prices. In the case of livestock, byproduct values must be added to retail meat values and the result converted to live animal weights. A reasonable set of price spreads and byproduct values for 1981 might result in choice steer prices of $66.50/cwt.,

live hog prices of $46.50/cwt., and wholesale broiler prices of 47¢/lb. based on the above projections of retail beef, pork, and chicken prices.

Three quarters of 1981 are already history. The 1981 projections have been revised several times during the year. Current total meat supply estimated are higher than estimates made early in the year. And, total meat demand has been much weaker than expected earlier. The total meat demand approach to forecasting does not insure accuracy in the final result any more than do other forecasting procedures. However, there are several advantages of the total meat procedure: (1) it insures consistency among forecasts for the various meats, (2) it considers total meat demand as well as relative demands among the meats, (3) it is adaptable to a changing economic environment and (4) it is easily illustrated and totally teachable to non-economists.

The total meat approach to explaining demand

Demand is a key concept in any explanation of the fundamentals of price determination and market outlook. Yet, demand likely is one of the least understood terms among users of market outlook information. The total meat approach to forecasting greatly simplifies several aspects of demand for the non-economist. First, a typical point of confusion is in the distinction between changes in the overall demand for a commodity and changes in the quantity demanded. The total meat approach adjusts the price of meat for changes in population and income which are the primary shifters of overall demand. The impacts of changes

in supplies of substitute meats on the demand for any given meat are handled in the aggregation process. Thus, the total meat demand curve in Figure 1 becomes in essence a ceteris paribus demand curve. Deviations of prices and quantities about that curve reflect measurement error or impacts or changes in excluded demand factors such as tastes and preferences. But, the salient point for purposes of explaining demand is the obvious negative relationship between quantities supplied and market clearing prices, i.e., the law of demand.

Deviations about the demand curve in Figure 1 appear to be more or less random with respect to time. Thus, there is no clear indication of shifts in total meat demand over time. However, there are significant deviations about the longer term or average demand relationship for years such as 1974 and 1977. These years represent periods of stronger and weaker demand total meat demand, respectively. The reasons for these deviations are not clear from the total meat demand relationship. However, the preference relationships in Figures 2, 3, and 4 provide some insights into those deviations.

The year of 1974 was the strongest total meat demand year of the decade. But, the preference for pork relative to beef in 1974 was directly on the average preference function shown in Figure 2. Figures 3 and 4 indicate that the preference for broilers relative to beef and pork was slightly below the average levels for the decade. But, overall it appears that the strength in demand in 1974 reflected a stronger demand for all three meats. The year of 1977 was a weak total meat demand year. There is some indication from the preference charts that

beef demand might have been slightly weaker than the other two meats and that broilers might have faired slightly better. But, again, the major impact in 1977 seems to be a weaker demand for all meats.

The total meat demand approach gives no clear indications of any basic change in either demand or preference structures for meats during the past decade. There have been dramatic changes in total meat supplies and in relative supplies of the three meats. And, there have been dramatic changes in meat prices and in relative prices of the three meats. There have been shifts in demands for individual meats, but only shifts that can be explained by shifts in consumer incomes and changing supplies of competing meats. The basic demand and preference structure has remained much the same for the entire decade. Price changes have resulted instead from changes in total and relative supplies. These and other important implications can be explained through the total meat demand approach. And, the explanations can be made in terms that are easily understood by the typical user of market outlook information. This is an important basic strength of using the total meat demand approach in extension outlook programs.

References

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