AN ANALYSIS OF ALTERNATIVE PRODUCTION, PRICE AND INCOME STABILIZATION PROGRAMS FOR LIVESTOCK PRODUCERS IN THE U.S.

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CHAPTER I

INTRODUCTION

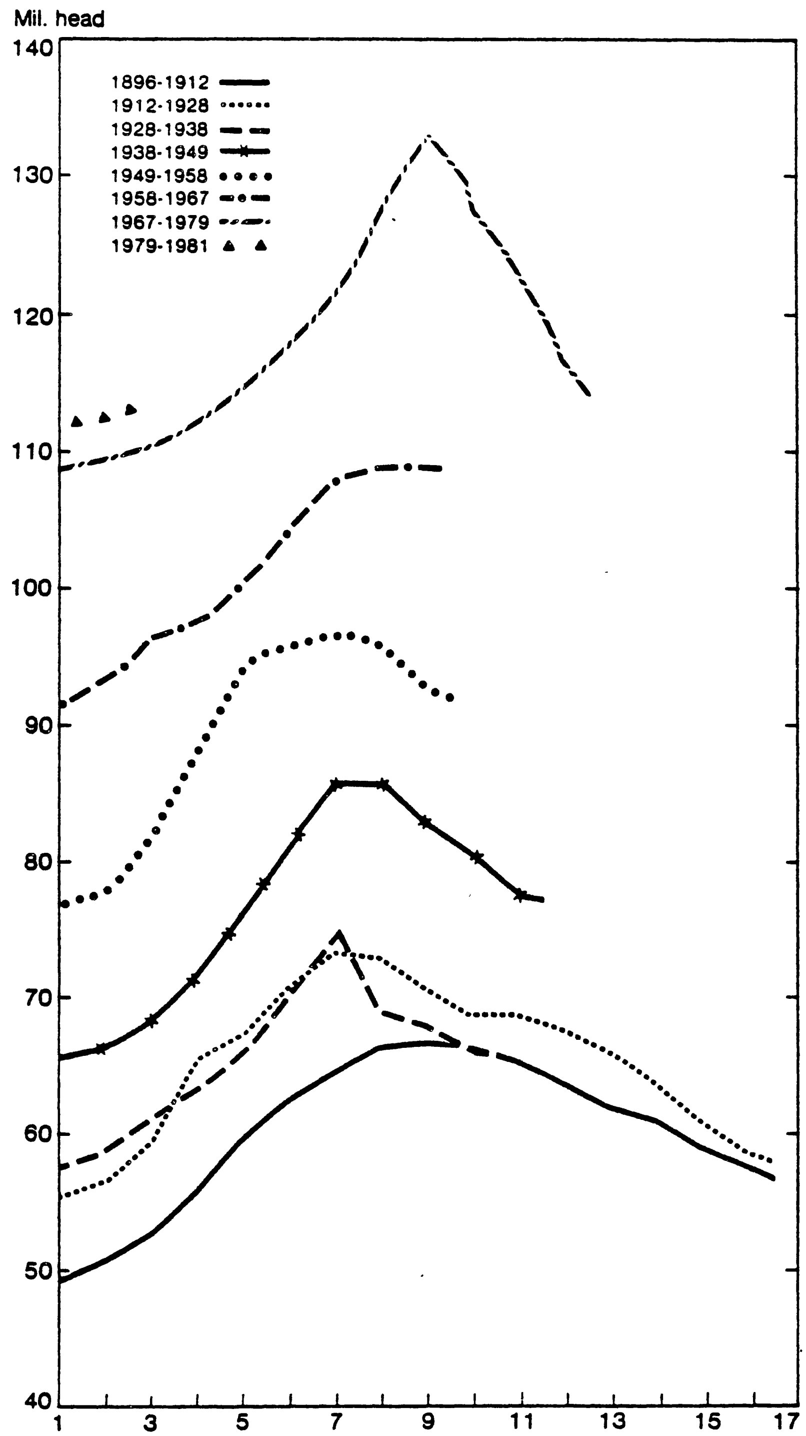
Background and Problem Setting

Price and income instability intensifies as a major problem of U.S. agriculture in the 1970's. In order to cope with the problem, the government established price and income support programs such as target prices, acreage allotments, marketing quotas, payment-in-kind (PIK) and other policy instruments to stabilize the price and income of farmers. Such policies have been primarily aimed at certain commodities in the crop sector with little attention being paid to stabilization programs for the livestock and poultry sectors. Of course stabilization policies for crops will have some indirect effects upon the livestock and poultry sectors and the economy as a whole. Ray and Heady (1972), Breimyer (1975), Breimyer and Rhodes (1975), Ray and Trapp (1977), Robert and Heady (1979, 1980), Salathe, Price and Gadson (1982), Collin and Taylor (1983) and Ray, Tweeten and Trapp (1984) have explored the interrelationships between the feed grain, livestock and poultry sectors and indicated their concern with regard to the impact of the crop commodity policies on the livestock and poultry sectors. They suggested that some kind of stabilization policy needs to be directed at the livestock and poultry sectors. These sectors have traditionally been neglected in government price and income stabilization programs.

However their instability appears to be as great if not greater than that of the crop sector.

Besides the question of income and price stabilization, fluctuating and cyclical prices continually present cow-calf producers with the need to choose between liquidating breeding animals (i.e. selling for slaughter) or retaining breeding animals (i.e. investing in future output). Typically, producers wish that they had more calves to sell during the peak of the price cycle and fewer cows to lose money on during the bottom of the price cycle (Trapp and King, 1978). The persistent pattern of cyclical price behavior causes temporal changes that bring about irregularities in observed prices, observance that leads to income and price instability to livestock and poultry firms, and in some instances, prolonged negative profit margins, especially during the bottom period of the price cycle. Such cycles can be seen in Figure 1 which shows cattle inventory cycles, 1896-1981. The cattle cycle is approximately 10 to 12 years long, while the hog cycle is approximately four to five years long and the chicken cycle is about nine months to one year long.

Price variations observed through time can be described as a mixture of seasonal, cyclical, trend and irregular patterns. In the past, government programs have not attempted to deal with this kind of price and income instability in the livestock and poultry sectors, rather they have focused on crops hence indirectly affecting the livestock and poultry industry as referred to earlier. Breimyer and Rhodes (1975) indicated that a lower loan rate policy encourages the feeding of grain to livestock and poultry by lowering the cost of production for them. However, the government does nothing when the



Source: USDA Extension Service, miscellaneous publication 1430, March 1983.

Figure 1. Cattle Inventory Cycles, 1896-1981

crop supplies are low resulting in high grain prices and low margins for livestock and poultry producers. For example, the recent PIK program or crop commodities caused higher feed prices which were unfavorable to livestock and poultry producers but no compensation was given to livestock and poultry producers.

Emrich (1983) focused on the problem caused by cyclical low profit margins in the cattle industry. He stated that either fed cattle prices have to increase or feed grain prices must decrease if the cattle feeder is to stay in business. Emrich further noted that during the low point in the beef price cycle, some ranchers and feeders have to curtail their operations or in some cases go completely out of business. Increasing numbers of such cases have been seen from 1982 to the present, especially among small ranchers throughout the country. Despite this trend, government programs have continued to focus on grains which are also under economic stress. Government programs designed to help specific segments of agricultural sectors usually injure other sectors that have a strong linkage to those sectors, sometimes to the degree that the overall results may turn out to be unfavorable. Such concern has been expressed in regard to grains and livestock by authors such as Breimyer, Rhodes, Ray, Trapp and Tweeten.

The situation or condition of the livestock and poultry producers will not change unless something is done with regard to instituting government policies aimed at the livestock and poultry industry. It is strongly believed that some kind of alternative marketing and stabilization program for the livestock and poultry industries needs to be established to provide some form of price and income protection to producers without distorting the production and marketing system of the industry. Programs such as deficiency payments, price supports or legislation to regulate the importation of beef and pork may be helpful to the beef and pork producers that have been plagued with chronic disequilibrium, inefficiency and instability in prices, output and low net returns.

The primary goal of this study is to analyze the effects of alternative marketing and stabilization programs for the beef and hog industries in the United States. The focus will be on the efficiency of alternative policies to stabilize price, income and production in the beef and hog sectors without disrupting other sectors in the economy.

Objective

The overall objective of this study is to provide insight regarding the estimated costs and effects of alternative policies to stabilize the beef and hog industries.

The specific sub-objectives are:

1. To propose and analyze alternative national stabilization programs for the livestock industry. One of the proposals developed will be based on the procedure that has been proposed by the Canadian Cattlemen's Association.
2. To evaluate the impact of proposed stabilization programs on the cyclical behavior of beef cattle and hog production and breeding herd inventories and, in turn, the impact on price cycles for beef and pork.
3. To provide estimates of program costs to the government and to determine the effects of the proposed stabilization program

upon the profitability of the cow-calf and brood sow operation.

Review of Literature

In the livestock industry seasonal and cyclical price changes in product prices are superimposed on long term trends that have persisted for years. These cyclical and seasonal output price patterns pose a problem to livestock producers. Large supplies of animals during the peak of the production cycle lead to low prices and margins. Similarly, lower feed costs have reduced the pressure on production cost and as a result, improved profitability for cattle producers, signalling increases in number of cattle inventory for the next season. However, such cases might not happen and reverse is true. The knowledge of all the relationships effecting prices is useful in understanding observed price behavior. To eliminate large fluctuations in prices that cause price instability and uncertainty, stabilization policies for price and income need to be considered in order to improve the ailing beef and hog industries.

Therefore, the literature review consists of two major segments. The first segment will be devoted to literature dealing with obtaining an understanding of the cattle and hog cycle. The second segment will be devoted to literature concerned with the linkages between the livestock sector and feed grain industry. Particular attention will be given to literature dealing with modelling the livestock and feed grain sectors and linkages between them.

The Cattle Cycle, Inventories and Replacement Pattern

By plotting out the average monthly cost per hundred weight of cattle slaughtered from 1921 to 1969 against trend values which had been adjusted for seasonal fluctuation, Franzmann (1971) suggested that the average length of the cattle cycle is approximately 10 years in length and has remained relatively unchanged over the time period he used. He indicated that the consistency of the trend and cycle within the period examined suggests that a reasonable degree of forecasting reliability over time is plausible. He also indicated that the information about livestock prices and production cycles is useful for investors in the cattle industry. Furthermore, it is also useful to researchers to improve the economic models for the livestock industry.

Ikerd (1980) indicated that changes in profit, rather than raising and falling prices resulting from cycles, in production are the key to understanding ups and downs of the cattle business. Thus, in order to combat the cattle cycle phenomena, Ikerd recommends that producers use risk management strategies that shift the use of resources to take advantage of favorable periods associated with the cycle. He specifically suggested three basic strategies for producers to consider in dealing with the cattle cycle. They are: (1) flexible production strategies based on altering the type of cattle enterprise emphasized at different phases of the cycle in order to minimize the risk of loss and increase the potential for profits; (2) long run hedging strategies than can reduce the risk of losses during times when flexible production strategies are not working; and (3) extended ownership strategies, a transaction device within a flexible production strategy.

Trapp (1980) indicated that planned culling and replacement strategies were very important in attacking the cyclical behavior of prices and production of the livestock sector. He developed a general strategy for optimal herd size replacement and culling patterns by computer simulation. He concluded that the average return per cow is effected by the herd size and age structure. He concluded that profit can be improved over a complete cycle by proper timing of culling and replacement that lead to variable herd sizes over the feeder calf price cycle.

Trapp and King (1980), in their search for ways to cope with cyclical cattle prices, suggested a flexible culling and replacement strategy for producers. With regard to replacement rates, they indicated that when prices start to rise after a series of down years the producer should increase the number of replacements and build a young and productive herd to take advantage of rising prices that may last for about five to six years. On the other hand, when prices have apparently "peaked," producers should begin lowering the culling age so as to make room for a younger and more productive cows in preparation for the next upturn in the price cycle. Failure to correctly synchronize the replacements and culling rate will result in losses due to the price cycle.

Tomek and Robinson (1981) indicated that five cattle production cycles were completed within the period 1928 to 1979, averaging about 10 years per cycle. Individual cycles ranged from nine to 12 years in length with each successive cycle at a higher level due to the positive trend in cattle numbers. They also indicated that the upward phase of the cycle is constrained by the biological factor of cattle production.

While the liquidating phase or downward phase, which can either be shorter or longer in contrast, is determined by economic conditions. Such conditions could be price incentives, changes in government programs or severe drought. Thus, they conclude it is more difficult to predict the duration of the downward phase than the upward phase. They also estimated that the hog cycle ranges from three to five years in length.

Gustafson (1983) examined the effect of the poultry sector on the red meat sector and indicated that red meat consumption has varied erratically with changes in various livestock cycles, i.e. less beef and pork will be consumed during the peak prices and more during low prices which is an indication of inefficiencies in allocating scarce resources in livestock production. On the other hand, per capita consumption for poultry has risen continuously for the last decade due mainly to increased efficiency in production, reduced uncertainty in supply and lower prices.

The existence of a cycle can be seen from the pattern that repeats itself regularly with the passage of time. As indicated by Ulrich (1984), cattle cycles apparently have existed for quite some time. He used data from 1896 to 1984 to track the existence of beef cycles and found that the cycle length is not consistent. It was slightly longer in the earlier years of the data than the latter years. The cycle ranged from 17 to 10 years long. Changes in the cycle length could be due to changes in the economic structure of the livestock industry throughout the period. Ulrich also concludes that the pork cycle runs approximately three to four years in length.

In summary, an understanding of livestock cycles is an important factor in determining the survival of the livestock industry. It has been shown that the cycle is not only caused by the biological time lag in livestock production as producers decide to expand or liquidate their herd in response to economic forces, but also is based on government crop commodity programs which indirectly or directly affected the livestock industry. Hence, with such an understanding one can formulate alternative government stabilization programs that are in agreement with livestock producer strategies for dealing with price and production cycles.

Linkages Between Livestock and Feed Grain Sectors and the Modelling Aspect of the Livestock Industry

In the past several decades, numerous studies have been conducted to analyze relationships between the livestock and feed grain sectors, and impacts of crop commodity programs on the livestock sector. Different econometric and simulation models have been developed to analyze these relationships. A variety of policies recommended to improve the livestock and grain industry simultaneously. Thus, the second part of the review of literature will present some of these studies.

Crom and Maki (1965) developed a model of the livestock meat economy and evaluated the model under a variety of market conditions. They developed a simulation algorithm to aid them in evaluating the effect of price and production control as well as changes in marketing margins, foreign trade levels and domestic meat demand. With regard to policy issues of price and output control in the livestock meat economy, they concluded that guaranteed prices for beef and pork would virtually eliminate the price and output cycles in cattle and hogs. On the other hand, changes in marketing margin policy yielded mixed results. The results of their analysis indicated that a variable margin policy is preferable to a fixed margin policy in terms of cyclical stability. Their study found that trade restrictions increased cyclical price variation and raised producer and consumer prices, thus reducing domestic consumption. However, they did not evaluate the relationship or linkage between the livestock and feed grain sectors in their studies.

Ray and Heady (1972, 1974) developed an econometric simulation model that involved two phases. First, a sector model that linked resource use, production, prices, final demand and gross receipts for an individual commodity was developed for livestock, feed grains, wheat, soybeans, cotton and tobacco. The second phase analyzed the impact of alternative levels of government policy on each of the commodities mentioned. They found that an increase in input price generated the highest gross income to livestock producers. This is due to the fact that higher input prices, i.e. feed grain prices, result in lower livestock production and higher prices. Due to the inelastic demand for livestock products gross income to livestock producers rises as production falls. The free market on the other hand leads to lower livestock prices, more production and lower income.

Kennedy (1973) constructed an internally consistent mathematical model that he used to analyze the consequences of alternative hog and pork price stabilization schemes. He included different policy parameters by the government to determine the magnitude and direction of the responsiveness of farmers, packers and consumers to price changes induced by government policy. Three stabilization schemes were analyzed: (1) a deficiency payment scheme which subsidized farmers in time of low slaughter hog prices; (2) a "controlled price ceiling" which set an explicit upper limit on the price of pork; and (3) a "subsidized price ceiling" involving a subsidy to consumers in times of high pork prices. He then compared the outcome of each of these schemes in terms of their contribution to possible policy objectives. The results indicated that if stability of prices is the goal, a controlled price ceiling on pork was preferable. However, if the level of prices was the objective, a subsidized consumer price would be the preferred choice. On the other hand, if stability of farm income is the goal, the deficiency payment can be used to achieve it.

Robinson (1975) expressed his concern with the lack of regard to the effect of well-established grain commodity programs and their obvious influence on the price and production of substitute crops and livestock products. He argued that a stabilizing price policy for grain by itself may not be sufficient to produce stability in livestock output and prices. He cites the fact that fluctuations in livestock prices and production still persisted in the 1960's despite more stable feed costs. Thus, stabilizing the denominator of the livestock/feed grain ratio does not lead to stability in output, but likely will dampen the amplitude of fluctuations in livestock output. Even though Robinson was concerned with the undesirable effect of grain price stabilization policy on livestock prices and production, he did not specifically recommend any stabilization programs for the livestock industry.

Breimyer (1975) expressed concern with regard to farm programs. He believed they were biased toward crop commodities, while neglecting the livestock and poultry sectors. He indicates that a boom in the price of livestock and poultry gives producers of those products some protection due to temporary increases in income. But this protection is inadequate when the livestock price declines are accompanied by increases in input prices as in 1974. Therefore, integrated livestock, poultry and feed grain policies need to be developed in order to protect livestock and poultry producers. Otherwise such risky businesses may drift to become diversified corporations and conglomerates which he judged to be undesirable to the society and the economy as a whole.

Breimyer and Rhodes (1975) looked at the livestock aspects of feed grain policy and indicated the one sided consideration of a two sided issue, in the sense that no stabilization or deficiency payment policies were formulated for livestock and poultry as in crop commodities. They suggested alternative livestock stabilization programs should be developed with the following objectives: (1) to give some stability to operating margins; (2) to reduce the fluctuation of flow of meat and poultry in the markets; (3) to protect export markets; (4) to protect the livestock and poultry sectors from unstable prices of feed grain; and (5) to stabilize the demand for feed grain so as to decrease the shock on grain producers, feed manufacturers and government program operations. A part of their proposal included direct aid to livestock and poultry producers in the form of direct price or income supplements or deficiency payments. Pressure from livestock and poultry producers can be anticipated for deficiency payments, protection from foreign competitors and income tax concessions.

Freebairn and Rausser (1975) estimated the effect of alternative levels of United States beef import on the domestic sector. They considered the effects on retail and farm livestock prices, growth in the beef industry in terms of production levels and cattle inventory, and the effects on welfare of consumers as a whole. They found that the level of beef imports since 1960 has had a modest effect on the total United States livestock sector, and has reduced the retail price of beef. Price declines for beef may be favorable for consumer welfare, but they create a burden to cattle breeders and feeders. Thus, this indicates that one of the policy options feasible to help the livestock producers is an import quota, which has been suggested also by Breimyer and Rhodes earlier.

Martin and MacLaren (1976) evaluated the potential market stabilizing effects and economic benefit that could be achieved through a stabilization program such as deficiency payments for the Canadian pork sector. Thus deficiency payment schemes were formulated. They were price and margin deficiency payments. The price deficiency program established a price support level at 95 percent of the moving average market price over the previous five years while the margin deficiency payment scheme based the support level on net revenue. Thus, if 95 percent of the average price margin in a given period is greater than the actual market price or margin in that period, a deficiency payment is calculated and given. Comparing the stabilizing effects of the price and margin deficiency programs they concluded that margin deficiency payments seem to be the better approach because they give substantially less variation in supply and net income.

Ray and Trapp (1977) used a simulation model to examine the grain-livestock interrelationship and tradeoffs with special emphasis focused on the impact of such relationships on livestock industry. By using data from 1949-76 and moving coefficients of price variation for beef, corn and soybean meal they found a strong positive correlation between feed prices and livestock price variations. They found that changes in feed prices have a substantial effect on livestock income. Thus, due to the fluctuation and riskiness of the livestock industry, they concluded that long term marketing contracts with feedlots or formation of feeding cooperatives by feeder calf producers, may emerge to protect against price and income instability.

Roberts and Heady (1979) used a five commodity livestock and poultry model in conjunction with a national crop simulation model to evaluate the impacts of various government policies upon the livestock and poultry sectors. No definite conclusion was drawn from the study. However, they indicated that consideration of the linkage between the livestock and poultry sector and the crop sector, through the feed grain market, is necessary to study the direct and indirect effects of government policies on United States agriculture.

Arzac and Wilkinson (1979) developed and estimated a quarterly econometric model of United States livestock and feed grain markets, and policy programs. The model performed well in terms of forecasting accuracy and stability. Different market conditions were tested in the simulation runs of the model including corn export, beef import, and government stocks of grain control. The result indicated that an increase in corn exports will increase meat and chicken price at the retail level, while a decrease in beef imports will lead to an increase in the inventory of beef cows and non-fed beef. However, change in non-fed beef import has a very small long run effect on retail prices for meat. They also indicated that government grain stock policy may not be very effective in offsetting price changes due to export fluctuation. Finally, the analysis of the model indicated that corn exports, corn yield and consumer disposable income are more significant than non-fed beef import and corn price supports as a source of fluctuation in retail and producer prices.

Folwell and Shapouri (1980) estimated the structural parameter of the supply and demand structure of the United States livestock economy. They then used their model to evaluate the impact of government, foreign trade, feed grain prices and other economic factors indigenous to the United States economy on the livestock and poultry industries. They found that an increase in beef imports will reduce steer and heifer slaughter and farm price of steers and heifers respectively. But larger reductions occur in the other beef meats, i.e. non-fed beef and cow prices. Meanwhile, if the export of beef, pork and broilers was to increase, the price of each of these products would increase with broiler prices having the highest increase. In addition, feed grain price would be bid up in response to higher livestock prices. On balance, however, increased meat exports and higher grain price would reduce total domestic meat consumption. They concluded that government policy has a positive impact on the livestock and poultry industries either directly or indirectly.

Robert and Heady (1980) again developed an econometric simulation model which incorporated eight sets of policy options to analyze the impacts of selected agricultural policies on the United States livestock sector. The policy options considered were divided into two groups, crop and livestock. They indicated that high grain prices have a larger and more immediate impact on meat other than beef in the early years because of the time it takes beef producers to respond to the changes in prices. The long time delay in beef adjustment responses is primarily due to biological factors in beef production. However, after some time delay, beef production also declines due to higher feed grain prices. Robert and Heady also noted that declines in prices of retail beef can be seen as the importation of beef increases, not only does the price of beef decline, but the price of substitute meats also declines as more beef was consumed. Similar results were reported by Folwell and Shapouri (1980) but of a different magnitude.

Kennedy and Palacios (1980) estimated the cost and effect of government income stabilization programs for British Columbia hog producers. An econometric model including supply and demand relationships and operational characteristics of alternative stabilization schemes was developed and simulated to analyze the impact of different income stabilization schemes. Two schemes were tested: (1) the first scheme involved payments to producers when market price falls below a given floor price in which the floor price is equal to some percentage of a national moving average price; (2) a guaranteed margin approach made up the second scheme. This scheme guaranteed farmers their costs plus same proportion of a five year average margin. Results indicated that the first scheme would contribute to a government goal of income stability. On the other hand, the guaranteed margin would result in a lowering of hog producer income relative to the first scheme.

Robertson (1980) also analyzed the optimal stabilization scheme for Canadian pork industry. However, his objective was to evaluate the usefulness of optimal linear feedback rule in stabilizing the pork industry. Therefore, by constructing a simplified econometric model and simulating different stabilization schemes he was able to evaluate the effect of such schemes on the pork industry. Two experiments were conducted with an objective to stabilize the price received by producers: one objective included a subsidy payment while the other did not include any subsidy payment. With subsidy payment, the result of price stabilization was achieved with less variability.

Ospina and Shumway (1981) studied the impact of corn prices on slaughter beef composition and prices by using an annual econometric model. They indicated that increases in corn price, in general, lead to reduction in quality of beef marketed and a decline in beef prices. Such results tend to agree with Roberts and Heady, and Folwell and Shapouri.

Kennedy and Tang (1982) used simulation techniques to estimate the cost and effect of government income stabilization programs for British Columbia beef producers. They used a mathematical model similar to Kennedy and Palacios and tested similar income stabilization strategies for beef producers. Again two income stabilization programs were tested. The first scheme features the farm income assurance program in which farmers received an indemnity equal to 100 percent of their gross deficit, as determined by how much cost of production exceeds market price. The second scheme involved a guaranteed price scheme in which the government guaranteed a price equal to 90 percent of the average market price over the previous five years plus the difference between the current cost of production over the preceding five years. The finding of the study indicated that the farm income assurance scheme is capable of expanding calf production, raising beef price and producer revenue, and stabilizing producer incomes. Similar conclusions could also be made from the guaranteed price scheme but the scheme was able to reduce income variability even more than the first scheme.

Salathe, Price, and Gadson (1982) introduced a simulation model known as FAPSIM (food and agricultural policy simulator) to evaluate the impacts of alternative legislative proposals and policies on the agricultural sectors. The model seemed to predict the future events with reasonable accuracy. By using the FAPSIM model they analyzed the impact of an increase in corn exports and a decline in beef imports on the livestock industry. They indicated that the initial increase in corn exports caused the price of corn to increase. The impact of such action generally declined the first year for crop variables and after five years for livestock variables. On the other hand, a decrease in beef imports leads to an increase in the price of slaughter steers and a slight increase in the price of beef substitutes. Thus, the finding agreed with those of other authors.

Another simulation model was developed by Collins and Taylor (1983) known as TECHSIM. The model has the capability to analyze the welfare of the economy as a whole resulting from technical changes in agriculture. The simulation model will also permit policy makers to trace the effect of alternative policy instruments on changes in production, prices, resource utilization, farm rents and producers and consumer welfare. They indicated that in terms of the livestock sector, a rise in feed grain prices decreases fed beef production and increases non-fed beef production. Derived welfare measures of technological change can also be estimated through this model. Such estimation can be accomplished by having information on the general equilibrium prices and quantities in the distorted industry before and after the technological change and the change in consumer income. Thus, by using the concept of consumer and producer surplus, they were able to measure the distribution of welfare among the livestock producers, crop producers and consumers. However, they did not explicitly discuss the net welfare effect when one of the policy variables is distorted or changed.

Ray, Tweeten, and Trapp (1984) examined the linkages between commodity programs and the livestock economy, particularly between feed grain and livestock economies. By comparing the degree of price instability for grain and livestock, they were able to analyze the impact of feed prices on livestock output, prices and profit, and the impact of commodity programs on crop and livestock price levels. Several conclusions can be drawn from their study: (1) commodity programs as a whole have been beneficial to livestock producers because they have reduced the variability of grain supplies and prices. However, uncertainty about future programs of policy makers will disrupt both grain and livestock markets; (2) sharp changes in feed prices have significant effects on livestock production and price patterns for many periods into the future. Ray, Tweeten, and Trapp feel that in order to minimize instability in the livestock industry, it is important for policy makers to plan and implement their policy instruments consistently and predictably, and to announce specific programs well in advance.

Summary

The review of literature above gives insights into the nature of previous studies relating to the livestock industry. Much of this literature focused on how different policy variables fared in inducing increased stabilization on livestock prices, income and production. Mixed results were obtained in the studies reviewed. Results from some studies were in agreement, while other studies had entirely opposite conclusions. The literature reviewed indicated that an understanding of livestock cycles and an understanding of the linkage between the livestock and feed grain sectors are essential in formulating livestock industry models.

Crom and Maki conducted extensive research on alternative marketing systems for the livestock meat economy but barely touched any linkages of the livestock industry to the feed grain. On the other hand, authors such as Ray and Heady; Robert and Heady; Ray, Tweeten, and Trapp; Folwell and Shapouri; and a few others evaluated linkages between livestock and grain sectors. They also estimated the relationship of the impact one sector has on the other as different policy variables were introduced. However, they did not include any government deficiency payments to the livestock producers even though price supports for the feed grain sector were considered.

Since the objective of this paper is to analyze alternative stabilization programs through deficiency payment schemes, the studies by Kennedy; Kennedy and Palacios; Kennedy and Tang; and Martin and MacLaren were closely examined. By using the livestock model developed by Ulrich, some of the stabilization schemes introduced by these researchers were tested and further modifications were made to search for a deficiency payment program that stabilized the income, prices received and production for livestock producers.

CHAPTER II

CONCEPTUAL FRAMEWORK

While much attention has been paid to the stabilization of crop commodities, livestock and poultry groups took a variety of policy stances. The most notable and active is that of milk producers who have relied heavily on price supports, marketing orders and cooperative bargaining associations. Other livestock producers basically have taken a free market position with the possible exception of seeking import restriction on meat. On the other hand, feed grain producers have been protected by price support programs, acreage allotments, payment in kind and target prices in order to stabilize crop prices and income as a whole.

Livestock producers and others have begun to question the imbalance between grain and livestock programs. Therefore, there appears to be a need for policy makers to evaluate various stabilization programs for livestock producers in order to provide some stability to operating margins in feeding and producing and, hence, income of beef and hog producers. An additional and related objective of such a program may be to stabilize meat supplies available to consumers and thus improve the welfare of both meat producers and consumers. In this chapter a brief discussion of the methodology and procedure undertaken to analyze the objective of the study put forward in the first chapter will be presented.

Methodology

This study will use a systems approach to estimate the likely cost and effects of alternative price and income stabilization programs that deal simultaneously with beef and hog producer's problems. Mathematical and econometric models of the beef, swine, poultry and meat demand sectors as developed by Ulrich (1984) will be adopted to analyze the stabilization scheme considered. Ulrich's model will be combined with models of the stabilization programs to be analyzed. However, the integrated model developed will be non-optimizing, given that the objective is to determine the cost and effects of alternative stabilization programs rather than to choose the optimal one.

The models developed will attempt to represent the effect of alternative stabilization programs on production cycles and producer decision strategies through:

1. A concept of a typical cow-calf operation and hog production operation which will be formulated to include stocking replacement, prices, quantities and production costs occurring in the absence of any government stabilization scheme. Such a model will be used to attempt to determine typical management decisions under alternative expected prices and firm conditions. It is anticipated that the model developed by Ulrich (1984) can be modified for this purpose.

2. A production decision model which provides production responses by farmers to changes caused by stabilization schemes.

3. A government module that represents operational details for alternative stabilization schemes and the impact of such programs on important policy variables.

Proposed Stabilization Programs for Livestock and Hog Industries

As indicated earlier the objective of this study is to provide insight regarding the estimated costs and effects of alternative policies to stabilize the beef and hog sectors. The primary stabilization program approach analyzed in this study was based on the approach suggested by the Canadian Cattlemen's Association. A stabilization program similar to that proposed by the Canadian Cattlemen's Association was incorporated into the Ulrich simulation model. The effect and influences of such a program in a dynamic meat sector was then analyzed using the model. Modification of the Canadian stabilization programs were subsequently made in order to explore alternative policies that might stabilize the ever-fluctuating livestock industry even better than the Canadian policy.

The proposed Canadian stabilization program for livestock has two components: one component is for cow-calf producers and the other for hog producers. The program requires a firm, legally binding commitment by both federal and state governments to the protection of the red meat sector against market instability. Such programs are designed so that they will not interfere the market access by producers, the production practices to be followed, or the region or area in which production is to be undertaken.

Listed below is a summary of the proposed stabilization program for the Canadian livestock industry.

1. Common Features of the Proposed Stabilization Program: Funding for the basic level of support will be shared equally by the federal government, participating state governments, and the

participating producers. However, the combined contribution of the federal and state governments is not to exceed 6 percent of the gross receipts of participating producers.

2. Cow-Calf Stabilization Program: Support under the cow-calf program is based on the moving average price of national farm market prices for calves in the proceeding ten years (adjusted for inflation). Stabilization payments will be based on a per cow basis. Thus, in any year, if the farm price for calves falls below the moving average price, the payment per cow will be equal to 50 percent of the moving average minus market price multiplied by 90 percent of (4.5 + 5.0)/2, assuming a weaning rate of 90 percent, an equal number of steer and heifer calves and a weaning weight of 4.5 cwt for heifers and 5.0 for steers).

3. Hog Stabilization Program: A guaranteed margin approach is used as a basis of support to hog producers. The support price for a quarter will be equal to cash cost in the current quarter plus 90 percent of the average margin in the same quarter (for the preceding five years). The support payment per cwt will equal the support price for the quarter minus the average market price for the quarter. If the average market price falls above the support price, there will be no payment.

As indicated earlier, modification of the Canadian stabilization program will be made in this analysis. A detailed discussion of such modification will be presented later in Chapter IV along with the results.

Procedures

This study will employ a systems approach to analyze the impact of the alternative marketing and stabilization strategies for beef and hog producers. Many computer packages and languages have been developed for system simulation models in recent years. Richardson and Ray (1975) developed an agricultural policy simulator (POLYSIM) using computer language FORTRAN IV. Since then a number of similar models have been developed by other authors, such as the food and agricultural policy simulation (FAPSIM) by Salathe, Price, and Gadson and a regional feed crop and livestock econometric simulation model (TECHSIM) by Collin and Taylor. Puge (1963) developed a simulation language called DYNAMO in order to facilitate the construction and analysis of the behavior of a large scale system through an industrial dynamic approach. DYNAMO has been used by researchers at Massachusetts Institute of Technology to develop system simulation models of a large scale industry. IBM came out with GPSS (general purpose system simulation), while Rand Corporation developed SIMSCRIPT which is a FORTRAN based language for simulation model. Meanwhile, Pritsker and Regden (1979) developed a simulation language called SLAM (simulation language for alternative modelling) which is an advanced FORTRAN based language. Manetch and Park (1974) introduced a set of simulation subroutines written in FORTRAN which are similar to SLAM and DYNAMO for simulation purposes. Trapp has transformed Manetch and Park's subroutines into BASIC computer language.

The subroutines that were involved in the simulation approach used here include a table look-up function, discrete delay, continuous delay and density functions. All can be used on a microcomputer which uses

BASIC. Ulrich (1984) used the transformed subroutine developed by Trapp to develop a simulation model for the livestock industry. In this study, Ulrich's model will be adopted with some modification to suit the objective of the study.

Simulation: As a Systems Approach to Analyze the Alternative Stabilization Policy Options

The complex system of the livestock-meat economy cannot be analyzed correctly without taking into account other sectors of the economy that have strong linkages to it, either directly or indirectly. Thus, a multi-sector systems model approach is suggested. Anderson (1974) described the systems approach as

> . . . a way of thinking about and looking at systems [connection of interactive and interdependent components] which features conceptualization of a whole systematic structure and a formal modelling phase (p. 4).

Thus, it consists of studying the systems under view and determining their components and interrelationship to each other. In this study, the system that is being considered is both biological and informational. It is biological in the sense that it involves livestock life cycles and production processes. On the other hand, it is informational because it includes the economic framework of supply and demand embodied in livestock production decisions. In other words, the systems approach includes such ideas as the system philosophy, the way of thinking about solving a problem in terms of a systems approach. Systems analysis is a technique used in analyzing the system and, the systems approach itself is the style of managing the system.

In developing the concept of a system, it is useful to classify systems into three broad categories. The first is to distinguish between natural and man-made systems. As an example, a firm is thought of as man made, but the environment in which it operates is a natural system.

A second classification is to separate the system into adaptive or non-adaptive systems. Adaptive systems react to environmental changes in a way that is desirable. Non-adaptive systems do not respond to environmental changes which result in a new system state.

A third classification is to contrast between open and closed systems. An open system is characterized by the absence of feedback loops such that output responses to inputs but inputs are not influenced by the outputs. On the other hand, the closed system is characterized by a feedback loop, in which past actions influence future action. Figure 2 illustrates the difference between open and closed systems.

For our purpose the closed system is the most interesting due to its response to past actions and, thus, its dynamic nature. Two classes of closed systems exist: the first is the negative feedback system which is goal oriented and responds to discrepancies from that goal. The second class is the positive feedback system which generates growth paths such that past actions generate even greater action. Thus, the growth path can either promote further growth or decay. Figure 3 illustrates graphically the workings of a closed system.

Of the two types of closed systems, the negative feedback system is more representative of the livestock system being modeled. The main feedback variable in the livestock industry, given the goal of

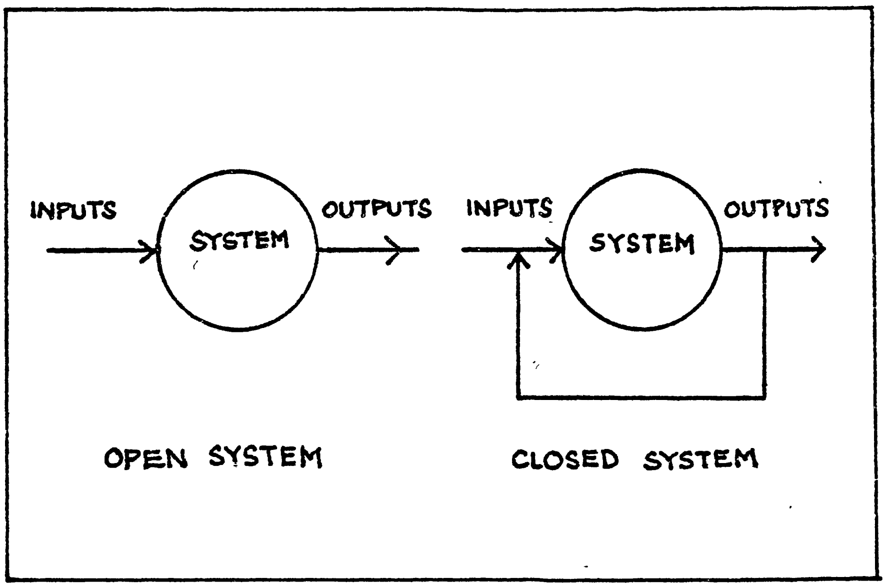


Figure 2. Illustration of the Difference Between Open and Closed Systems

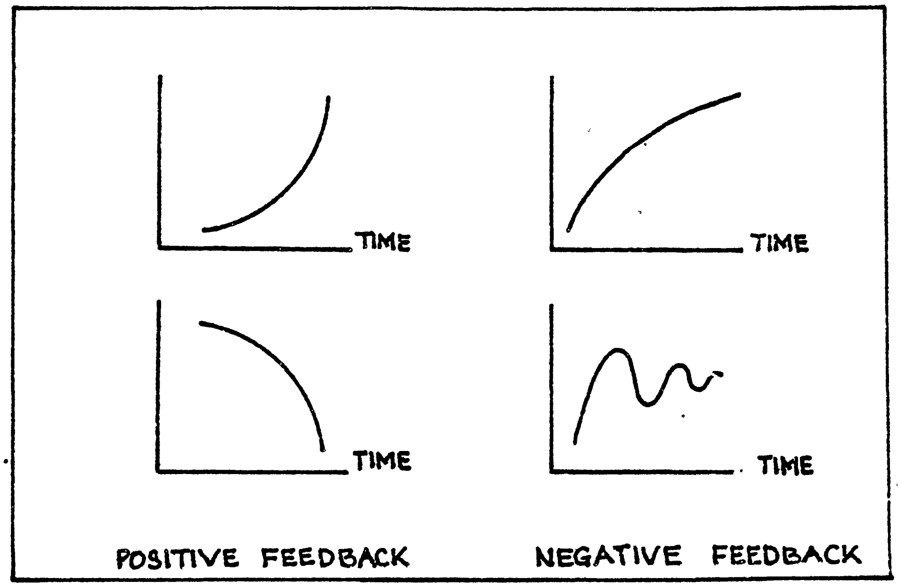


Figure 3. Illustration of the Workings of a Closed System: Positive and Negative Feedback

livestock producers, is to make profit. Thus, any discrepancies will cause producers to alter production to compensate for the differences between their goal and the observed condition.

Having adopted a systems approach as a method to analyze the livestock economy, one has to choose a technique for system analysis in solving the problem by following changes over time of a dynamic model of the system. Several techniques can be listed for this purpose. However, simulation, which is a technique frequently employed by researchers who conducted a "systems approach" or do "systems analysis," was employed in this study. Such a technique will be used to test the effect of specified decision making and government policy option on the behavior of the system modeled.

Various definitions of simulation have been put forward by several authors which basically express the same idea. Naylor (1971) defined simulation as

> . . . a numerical technique for conducting experiments with certain types of mathematical models which describe the behavior of a complex system on a digital computer over extended periods of time (p. 2).

Naylor further indicated that one has to assure that the model of the system has already been formulated and verified before simulation experiments can be performed. It involves setting up a model of the real system in question and then performing experiments on the system.

Hence, simulation is a procedure for step-by-step simulation of structured instructions or equations for computing successive time increments. In doing so this process traces a time path representing the dynamics of the system.

Since this study is non-optimizing, the use of simulation technique seems appropriate in analyzing alternative government income and price stabilization programs. Given the value of initial conditions, parameters and exogenous variables, a simulation is run to represent the behavior of the process over time. Anderson further indicated that simulation gives researchers an ability to construct the model with more flexibility. Simulation is the least confining of modelling approaches. It can accommodate stochastic elements quite easily and directly, and accordingly will often find favor over more restrictive models that may not be able to accommodate stochastic elements whenever refined and versatile modelling is undertaken.

Since a simulation model is supposedly a mimicry of the actual livestock and hog operating systems, the model can be used to develop and test operating policy and instruments before they are implemented in the actual context of the economy. Such a technique, if carefully constructed, will generate a realistic simulation model which will provide an experimental environment for testing hypotheses and decision rules. It will also help to determine the impacts and consequences suggested by alternative sets of objective schemes under a variety of assumed conditions that may be too costly or impossible to experiment with the actual system under study. Such experiments require direct and complete observation of the dynamic behavior of the process of income and price stabilization schemes for the livestock and hog industry. It allows the researcher to observe how the livestock system behaves under the alternative schemes tested.

It also allows the use of "IF" and "THEN" statements in order to monitor the objective of the study, i.e. if a given set of conditions holds then such-and-such consequences will occur. Thus, it will give some kind of estimate of what would happen if a particular scheme were to be adopted by the policy makers. However, the activity of simulation can be deterministic or stochastic in the sense that outcome of the activity can be described complete in terms of input or vary randomly over various outcomes respectively. As indicated earlier, in this study both deterministic and stochastic activity is being employed.

Although simulation is often thought of as a technique to be turned to after all other methods have failed, it has a certain unique characteristic that can be exploited to fit the researcher's objective function within the bound that is desirable.

The Formulation of a Mathematical Model, Data Collection and Computer Programming

Formulation

A model of the livestock and poultry industry is a simplified version of the real world system. It requires a complete understanding and thorough knowledge about the system under study before a valid mathematical or econometric model can be constructed.

Several considerations need to be looked at before formulation of a mathematical model. One of the first steps is to decide the kind of variables to be included in the model. Based on previous studies, experiences and researcher knowledge regarding the problem under study, the researcher can abstract those variables that he thinks important and relevant to the system. He can then present the model in a series of equations. An accurate description of the behavior of the livestock and poultry sectors is required so as to represent the real world situation. However, too complex a model may also create a problem related to programming time, computational time and validation of the model. Hence, it is advisable to keep the model simple yet realistic (Naylor, 1971).

The second consideration involves selection of exogenous and endogenous variables of the system. Exogenous or environmental variables are assumed to be given which affect the system but are not, in turn, significantly influenced by it. Such variables remain constant throughout the simulation run but may be changed between run to determine their impact and implication.

Controlled and non-controlled variables need also to be considered in formulating the mathematical model. "Controlled" variables are those variables that can be controlled by the policy makers which are necessary for the system to carry out its intended function. For example, the desired stabilization payment schemes are determined by policy makers. On the other hand, "non-controlled" variables are those variables that are being affected by controlled variables, such as reaction of producers to the policy parameters. Such reactions are determined by the environment in which the model system exists.

The endogenous variables are the dependent variables and are also known as output variables which are internal to the system. They are generated by system input and/or other endogenous variables within the system (Manetch and Park).

The mathematical model used in this study was developed by Ulrich. A detailed discussion of the system will be presented in the next chapter. Since collection and processing of real world data has already been done by Ulrich, a discussion on collection and processing of data will not be presented here in detail.

Model Validation

In order to determine whether the model is a valid mimicry of the real system being simulated, a model validation test needs to be performed. It requires that both the structural and behavioral relationships in the model be theoretically acceptable and internally correct and consistent in a logical and programming sense. This indicates that the model should be able to predict the real system with reasonable accuracy. Such a process is not an easy task. Naylor, Balintfy, Burdick, and Chu (1966) indicated that if the model did not pass the validation process, then changes must be made in the variables, parameter estimates and the structure of the model. Thus, model validation is a crucial part of the systems modelling which gives an indication of whether the model developed is sound in its mimicry of the real world.

There are several criteria that can be used to establish the validity of the model. Naylor (1971) discussed several approaches to tackle the problem of validity. However, for our purpose two basic approaches seem appropriate to test for validity of the simulation model under study. First, the "multi-stage validation" procedure which consists of three stages as follows.

1. It requires the formulation of a set of postulates or hypotheses to ensure that the models are in accord with relevant theory, and a priori general knowledge about the system and past experiences.

2. To subject the postulate on which the model is based to certain statistical tests where possible.

3. To test the model's ability to predict the behavior of the system under study. This can be done by historical validation and by forecasting.

The second procedure involves testing for "goodness of fit" of the simulation model, that is, the degree of conformity of formulated time series data to the observed or actual data. Such procedures may involve analysis of variance, Chi-square test, factor analysis, non-parametric tests, regression analysis, spectral analysis, Theil's inequality coefficient, etc. For detailed discussion on the above procedure refer to Naylor (1971).

Design of Simulation Experiments

The objective of the experimental design is to see the effect of different parameter levels on the value of endogenous variables and to learn more about the system being investigated. The procedure involves a series of computer runs with different policy parameter options or exogenous variables. This will help researchers to understand and increase their knowledge on what would have occurred in the livestock system under different alternative policy options. For these reasons, several stabilization strategies will be run in order to determine the effect of such policy on producers' decisions, production, income, prices and costs to government in order to implement different stabilization strategies.

Data Analysis and Its Implications

The last step in the simulation procedure involves the analysis of simulated data. The analysis is similar to the analysis of the real world data, but there are some differences. Naylor et al. (1966) indicated that randomness enters in a very complicated form in simulation experiments and, thus, the relationship cannot be stated explicitly. Furthermore, data are derived from a dynamic model and are much more difficult to analyze than static sets of data.

Naylor (1971) suggested several techniques that can be used to analyze simulated data. Such techniques include the analysis of variance, regression analysis, F-test, multiple rankings, multiple comparison, spectral analysis, sequential sampling and non-parametric methods. In this study analysis of variance, regression analysis and spectral analysis will be used to analyze the simulated results.

Implications and conclusions from the study can also be drawn from the analysis of data. Comparison from the status quo condition and the simulated policy option within the context of the model is then carried out to determine the effect and impact of the alternative stabilization policies on the livestock and poultry industry. Therefore, if the model is internally consistent or logically correct, accordingly, it will accurately determine the consequences of a given set of assumptions and policy options.

Summary

This chapter described the methodological procedure taken to develop a systems model of the livestock and poultry industry. Simulation techniques which involve experimenting with a systems model were selected due to its applicability to the objective of the study. Specifically, the objective of the study is not to find an optimal solution, but to evaluate the impact of alternative stabilization schemes on livestock and poultry industries.

The chapter also outlined steps to be taken in performing simulation techniques from formulating the model to the implication of the simulated results. However, some of these steps seem irrelevant in this study because the model has already been developed and verified by Ulrich. Thus, only a brief discussion of those steps will be included in the next chapter.

Chapter III will present in greater detail the systems modelling and estimation.

CHAPTER III

SYSTEMS MODELLING AND ESTIMATION

The model developed simulates beef, pork and poultry production decisions and the resulting nature of the cow and swine herd populations. At any point in time, given breeding herd sizes, weaning weights, birth rates, and feed grain prices, producers' decisions can be simulated. The resulting total meat and chicken production can then be used to estimate prices received for each of these meats.

Eight submodels were formulated to represent the livestock industry system as a whole. Three of these models represent beef, pork and poultry supply, one represents meat demands, and three are support models. They are as follows.

1. Beef Submodel: Culling and replacement decisions are econometrically modeled. From these equations breeding herd size is determined. A physical model is then used to determine the number of calves produced, feeder cattle supplies, and cow, steer and heifer slaughter rates. Biological delays encountered in the production process are modeled physically using simulation "delay" subroutines. An econometric equation is present in the model to simulate the decision as to whether feeder cattle are grain fattened or grass fattened.

2. Hog Submodel: The hog submodel is similar to the beef model. It includes econometric equations to determine the breeding animal

culling and replacement rates, and inventory level. All other variables, including herd size and slaughter rate, are determined by physical simulation. Production time delays are again modeled using a simulation "delay" subroutine.

3. Poultry Submodel: This submodel shows the poultry production component as a function of corn prices and chicken prices. The poultry submodel is a single econometric supply function and was not designed to include any physical and biological structure as is done in the beef and hog sectors.

4. Market Sector Submodel: This submodel computes total production of beef, pork and chicken meat by converting live weights into total meat.

5. Demand Sector Submodel: The demand sector submodel is based on the meat demand model developed by Ikerd. The model generates composite meat prices and composite demand for meat per capita, and subsequently retail prices for beef, pork and chicken.

6. Input or Predetermined Variable Submodel: This submodel provides initial values to the simulation model. The input submodel allows various initial values and exogenous conditions to be changed in order to observe their effect on different endogenous variables. Given the physical nature of the simulation models used to determine production time delays, a rather detailed set of initial livestock population data must be provided. For example, for beef the breeding herd size must be given as well as the number of replacement heifers being held. Numbers of feeder cattle and cattle being fattened must also be given as well as their age distribution or distribution of time left until they are ready to market. Similar information is required

by the pork model. In addition, prices for the past several years that are in the lag structures of the econometric decision models must be given. Lastly, all assumed values and exogenous variables must be provided.

7. Government Program Submodel: Policy maker's stabilization payment strategies for both the beef and pork sectors are introduced in this submodel. This submodel calculates the stabilization payment required and total cost of such payments to the government. It also calculates income generated to producers based on the payment received and the premium producers may have paid for the stabilization fund.

8. Stochastics Submodel: This submodel provides for the inclusion of uncertainty into the model with regard to feed grain prices and the cost of producing heifers and steers. A random normal distribution generator is used for this purpose.

A simplified flow chart representing the components of each of the submodels and the whole system which links them to each other is shown in Figure 4.

The modelling aspect of the simulation technique is based on estimated equations and identities for beef, hog, poultry and feed grain sector submodels. The parameter estimates for each of the equations of the submodels were obtained with ordinary least squares estimation. In the case of any autocorrelation, autoregressive least squares procedures were performed. All the equations in the submodel were verified and estimated by Ulrich in an earlier work. Physical and biological production delay for beef and hog sectors are built into the respective submodel to capture the dynamic properties of the industry.

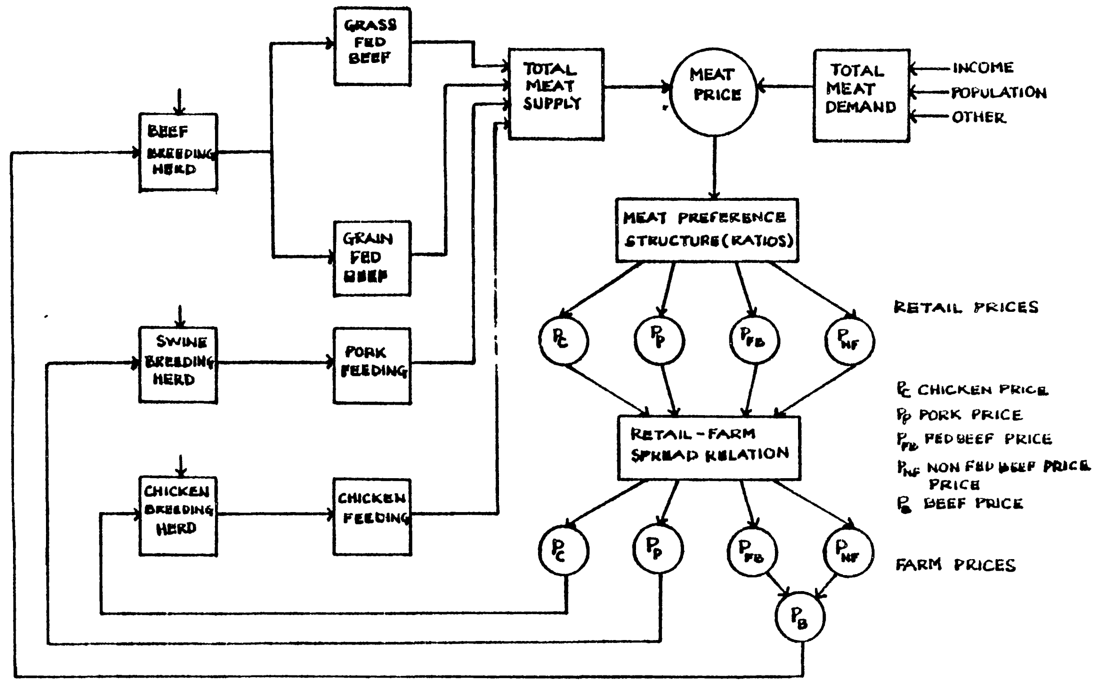


Figure 4. Beef, Pork and Chicken Supply and Demand Model

The submodel for the stabilization schemes can be presented mathematically, hence, no prior estimation of parameters is necessary. It has already been established that the simulation model is non-optimizing but dynamic in nature. Both deterministic and stochastic disturbances will be analyzed in the system for the purpose of comparison. In the sections which follow a detailed discussion of each of the submodels listed above is given.

Beef Sector Submodel

The operation of the beef sector model is keyed upon the number of cows in the breeding herd. Given the breeding herd on hand, decisions on production, replacement and culling levels give the dynamic change in herd size from period to period. The replacement and change in breeding herd equations are estimated econometrically by using ordinary least squares (see Table I). The physical and biological delay data were abstracted from a structure report by Gilliam.

The beef sector submodel traces the beef production process from cow-calf production to slaughter. The producer's responses are based on a profit function for cow-calf operations. The beef price generated from the model plays an important part in determining the response of producers with regard to the retention of replacement heifers for entry into cow breeding herd, grain or grass animals, cow culling and subsequently the amount of beef produced.

The beef sector submodel is shown schematically in Figure 5. Appendix A and Appendix B present the description of the symbols used and variable names and their explanations respectively. The symbols and variable names presented in Appendix A and B will be used in the

TABLE I

ESTIMATED REGRESSION COEFFICIENTS AND SUMMARY STATISTICS FOR EQUATIONS USED IN THE SIMULATION MODEL*

	Beef Production Sector
Replacement Equation	R = 0.1723 + 0.0854 * DUM + 0.00067 * BR(0) (82.13) (21.29) (4.00) R^2 = 0.96
Change in Breeding Herd Equation	DB = 2.207 + 0.258 * BR(0) + 0.107 * BR(1) (6.43) (7.36) (3.00) R^2 = 0.815
	Hog Production Sector
Replacement Equation	H1 = 0.461 - 0.134 * CN + 0.0054 * FP (10.50) (2.38) (1.62) R^2 = 0.25
Cull Sow Equation	H3 = 0.466 + 0.045 * CN - 0.0054 * FP (33.16) (2.66) (5.60) R^2 = 0.72
	Poultry Production Sector
Chicken Production Equation	TC = 4710.88 + 374.15*YR - 903.54*CL + 86.41*CC (13.667) (16.858) (2.73) (2.39) R^2 = 0.977
	Percentage of Fed Equation
Percentage of Calves into High Energy Ration Equation	FF = 84.321 + 2.308*YR - 0.248*FC + 0.58*FB (65.82) (15.23) (15.17) (1.05) R^2 = 96.1

*t-statistic in parentheses. Variable definitions are in their respective equation in the text.

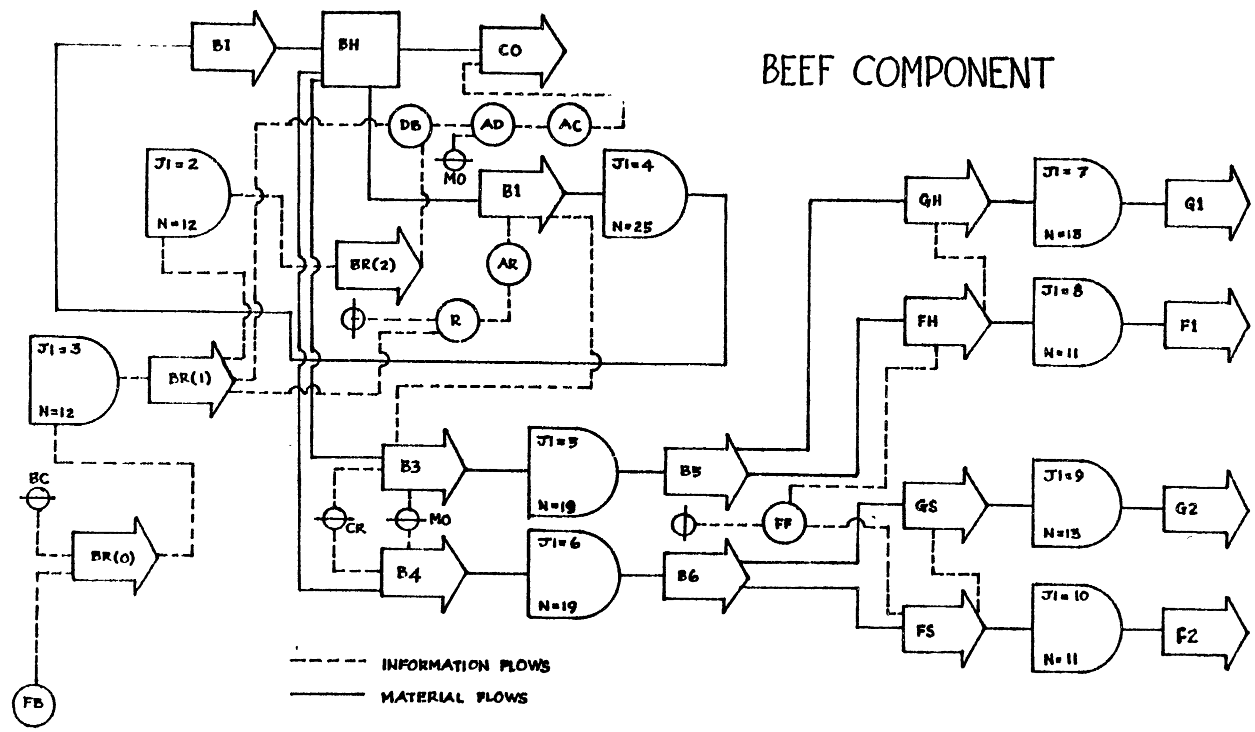


Figure 5. Beef Sector Submodel and Its Component

remainder of this chapter. As explained by the symbology in Appendix A each symbol in the figure has a direct relation to each formula or coded statement in the simulation model. The discussion to follow will present the model functions in notation form identical to that in the computer model.

Heifer Replacement and Breeding

Herd Change Equalities

The replacement equation is based on a profit function. It measures producer response to retain heifers for breeding purposes. The equation also includes a dummy variable to allow for a data definition change that occurred within the time period used.

In general, it is hypothesized that profit is directly related to replacement rates, and inversely related to culling rates. Thus, we would expect the beef breeding herd to expand when replacement rates exceed culling rates and vice versa. The profit series used to estimate the replacement and change in breeding herd equation and culling rates decision was based on the sale of a 400 pound calf. Equations (1) through (3) represent the cow replacement components. The estimated regression coefficients and summary statistics are presented in Table I.

$$BR(0) = FB - BC \tag{1}$$

$$R = b_0 + b_1 * DUM + b_2 * BR(0) \tag{2}$$

$$AR = R/MO \tag{3}$$

where

BR(0) = net profit at time t_0 (current profit) in dollar per hundred weight

FB = farm beef prices ($/cwt)

BC = cost of producing 400 pound calf ($/cwt)

R = replacements/cow

DUM = dummy variable accounting for change in data series

AR = average replacement rate per month

MO = months, 12

b's = regression coefficient

Equation (2) was estimated using annual data. Producers are assumed to base their current replacement decision on current known profit. Since the beef submodel is run using a monthly time frame, to keep the estimated equation consistent with the model, the annual figure must be divided by twelve to obtain average replacement rates per month.

The second equation estimated was a breeding herd size change equation. The breeding herd change equation can be expressed as a function of profit also. Theoretically it was estimated that a one year lag in response to profit changes best described the producers decision to change their breeding herd size. Equation (4) represents the change in breeding herd relationship. The estimated regression coefficient and summary statistics are presented in Table I.

$$DB = b_3 + b_4 * BR(0) + b_5 * BR(1) \quad (4)$$

$$AD = DB/MO \quad (5)$$

where

DB = percentage change in breeding herd (cow number)

BR(0) = profit in $/cwt in the current year

BR(1) = profit in $/cwt lagged one year

AD = average change in breeding herd per month

MO = months, 12

b's = regression coefficients

Again this model, estimated using annual data, must be converted into a monthly time frame by dividing by 12.

As indicated by Ulrich (1984) the data available to describe the culling rate of beef cows is somewhat misleading because of the inclusion of dairy animals into such computation. An alternative to using reported culling data is to deduce the culling rate from the replacement rate and changes in total herd size. Using an identity and simple algebraic manipulation yields the culling rate:

$$DB = R - C \tag{6}$$

$$DB - R = -C \tag{7}$$

$$C = R - DB \tag{8}$$

$$CO = C/MO \tag{9}$$

where

DB = percentage change in breeding herd (cow number)

R = replacements/cow

MO = months, 12

C = culling rate per year (million)

CO = culling rate per month (million)

The breeding herd inventory equation itself is based on the difference between replacements entering the herd and cull cows leaving the herd and it is updated periodically. The breeding herd equation can be presented as:

$$BH = BH + DT * (BI - CO) \tag{10}$$

where

BH = breeding herd (million cows)

BI = replacement heifers entering breeding herd (million herd/year)

CO = cows culled from the herd (million head/year)

DT = solution interval

The variable DT numerically converts the annual rate of culling and replacement to a monthly rate provided the variables used are still in annual term.

Calf Production: Retention for Breeding Herd and Production

Calf production that came out from the breeding herd inventory can be classified into steer calves and heifer calves. The weaning rate (live animals marketed per cow) is determined as an exogenous parameter and set at 87 percent as indicated by the 1980 survey conducted by the Economic Research Service of the USDA and published in the structure report by Gilliam. It is assumed that 50 percent of the current calf crop are heifers and 50 percent are steers. Since there is a difference in the biological and physical development in growth rates and weaning weights between steers and heifers, two different sets of equations are developed for steer and heifer growth.

The steer calving rate can be represented as:

$$B4 = 0.5 * CR * BH/MO \tag{11}$$

where

B4 = steer calves (million head/month)

CR = calving rate in calves per brood cow

BH = breeding herd inventory in million head

Heifer calf production can also be calculated in the same manner as steer calf. However, some of the heifers will be retained as replacement heifers, while some will be placed in the production category. The total heifer calf production and replacement for future brood cow equations can be presented as:

$$B2 = 0.5 * CR * BH/MO \tag{12}$$

$$B1 = AR * BH \tag{13}$$

where

B2 = total heifer calves production (million head/month)

B1 = heifers designated for replacement (million head/month)

AR = average replacement rate per month

BH = breeding herd (million cows)

The heifer calf production equation can be written as:

$$B3 = (0.5 * CR * BH/MO) - B1 \tag{14}$$

where

B3 = heifer calves (million head/month)

MO = months, 12

CR = calving rate in calves per brood cow

BH = breeding herd (million cows)

B1 = heifers designated for replacement (million head/month)

Thus, the total heifer production, B2, can be determined by summing B1 and B3.

It requires approximately 18 months from the time of conception (gestation period of nine months) to weaning weight of 400 pounds. Therefore, it is necessary to delay the flow of calves 19 time periods by using the delay subroutine. Such delays are labeled as J1 = 5 for heifer calves and J1 = 6 for steer calves in the schematic diagram of

Figure 5. The replacement decision is assumed to be made when heifer calves are weaned. Replacement heifers then enter a 25 month delay before entering the breeding herd.

Grain Versus Grass Feeding Calves

Heifers that are not being selected as replacements, along with steers, are placed on feed either as grass fed or grain fed animals after they are weaned from the brood cow at approximately nine months (from birth to weaning age). The heifer and steer outflow from the breeding herd delay (i.e. from time of conception to weaning weight, 18 months) is represented by B5 and B6 respectively in Figure 5.

Historically it has been determined that the proportion of cattle going on high energy grain rations has not fallen below 70 percent. Such consideration was taken into account by Ulrich (1984) so that the model will not get out of normal range of past real world events. The proportion of animals going on high energy grain ration was from the percentage fed equation, FF, which can be presented as follows:

$$FF = b_6 + b_7 * TIME - b_8 * FC + b_9 * FB \tag{15}$$

where

FF = percent of steer and heifers going into feedlot for high energy grain ration as opposed to those fed out on grass

TIME = time variables year

FC = feed cost, averaging price per cwt of a ration of 1500 pounds of sorghum, 400 pounds of cotton seed meal and 800 pounds of hay

FB = farm beef price

b's = regression coefficient

Thus, in order to prevent the estimated equations to get out of normal ranges in the event of abnormally high prices, the above equation was estimated. Therefore, to check the proportion of cattle fed from falling below the 70 percent mark, a routine was developed to slowly step the proportion to any level but it is not to go below the historical 70 percent. The estimated regression coefficient and summary statistic for equation (15) are presented in Table I. For model testing, the proportion of fed cattle needed is 80 percent throughout the experiment.

As indicated earlier, the flow of heifers and steers through the growth process from birth to weaning weight is represented as B5 and B6 respectively. It is necessary for these two variables to be separated into their respective categories of grain fed or grass fed animals. For this purpose we represent the rate of low variable transferring heifers into fat animal as FH and GH respectively for grain fed and grass fed heifers. Similarly, the rate of flow variable transferring steers into grain fed and grass fed fat animals are FS and GS. Such flow of animals through the system can be represented algebraically as:

$$FH = FF * B5 \tag{16}$$

$$GH = B5 - FH \tag{17}$$

$$FS = FF * B6 \tag{18}$$

$$GS = B6 - FS \tag{19}$$

where

FF = proportion of animals going on high energy ration

FH = heifers going into grain feeding scheme

B5 = number of heifers available for fattening

GH = heifer going on grass feeding scheme

FS = steers going into grain feeding scheme

B6 = number of steer available for fattening

Thus, the number of heifer calves placed on grass feeding scheme is defined as the difference between the number of heifers available for feeding programs and the number going to grain feeding scheme [see equation (17)]. Equations (18) and (19) explain the same process for steer calves.

It is assumed that grain fed animals reach slaughter weight faster than grass fed animals. The grass fed calves require approximately 13 months time delay after weaning before they are ready to be slaughtered for market (grain fed animals are assumed to require only 11 months). The fattening period delays for grass fed heifers and steers are represented in the model as J1 = 7 and J1 = 9 for heifers and steers respectively. The rate of flow resulting from the delay in the grass fattening process is represented by G1 and G2 for heifers and steers respectively.

Grain fed calves require approximately 11 months delay time period to reach a market weight. Delay variables represented by J1 = 8 and J1 = 10 account for heifers and steers placed in the feedlot for fattening. The rate of flow resulting from the feeding process to marketable weight are represented by variables F1 and F2 in the simulation model. The entire process of production takes approximately 30 to 32 months time delay from the time of conception to slaughter as a choice beef animal. Figure 6 presents the typical production process from conception to slaughter for beef.

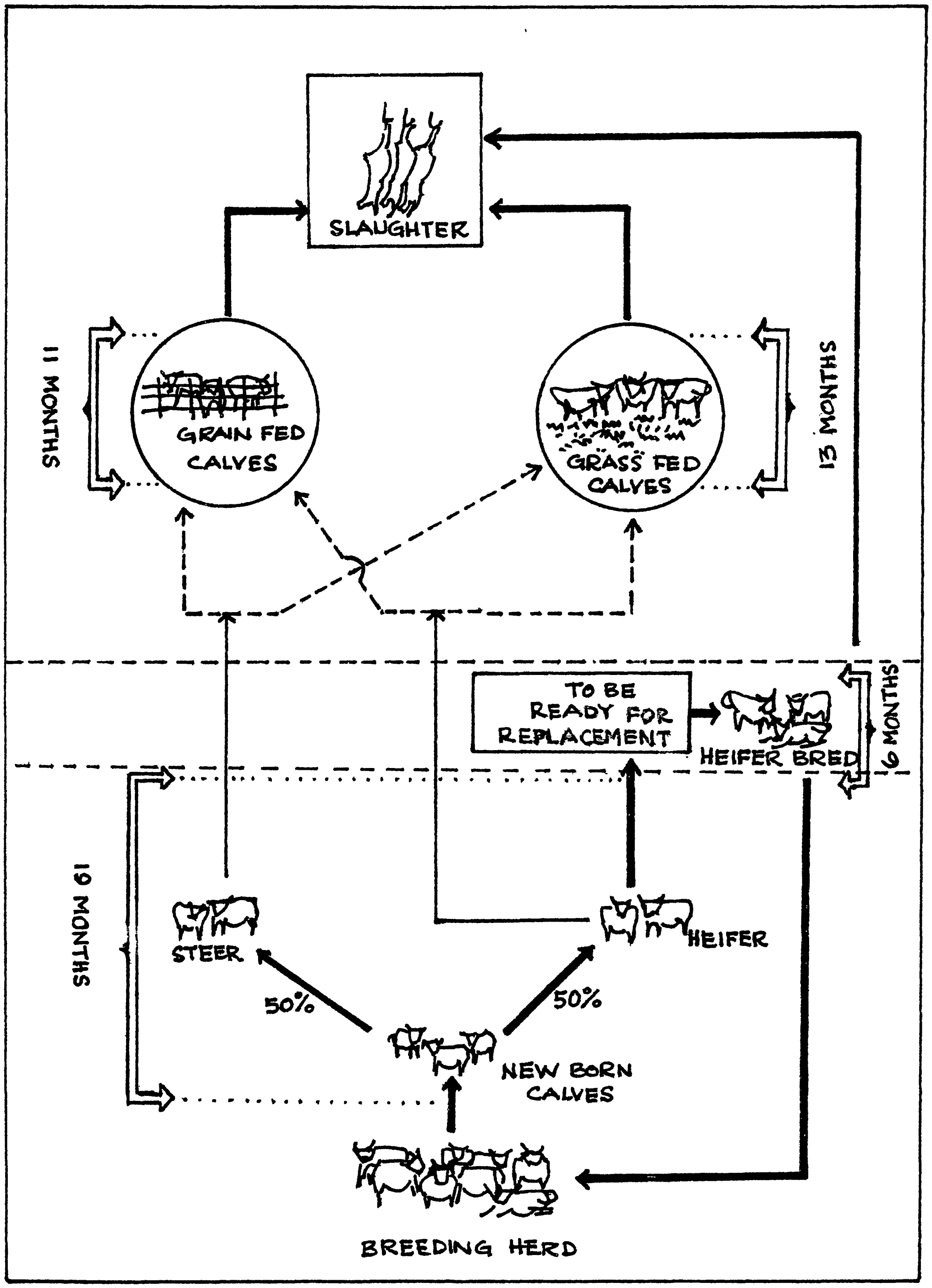


Figure 6. Typical Beef Production Schedule

Hog Sector Submodel

The hog submodel simulates pork production over time by modelling producer's decisions for retention of a gilt pool for breeding herd replacement and culling of the breeding herd. Culling and replacement decisions are modeled as a function of profit that can be obtained from hog production. Thus, the price received for marketed hog and input prices such as labor, capital, feed and land play a very important role in shaping the producer's decision. Corn, which is the main feed used in feeding hogs, accounts for more than 50 percent of the cost of production.

Since the hog enterprise developed for the simulation model is based on an industry model rather than a firm level model, the type of hog production enterprises, such as farrow to finish, feeder pig, or finish operations are being ignored. The analysis is more concerned with industry shares of the meat market and total hog production.

An approach similar to that taken in the beef submodel is taken to determine the amount of pork being produced. It is assumed that hog production is directly dependent on the breeding herd inventory. Thus, increase in the breeding herd will increase hog production while the reverse is true if the breeding herd inventories are decreased. Breeding inventories can be increased by holding more replacement gilts or culling fewer sow. Actions of holding and culling sows can be explained by profits obtained from hog production as indicated earlier.

Based on the above assumption the replacement rate and culling rate equations were estimated using hog prices (farm hog prices received by farmers) and corn prices. Equation (20) shows the rate of replacement per sow.

$$H1 = e_0 + e_1 * CN + e_2 * FP \tag{20}$$

$$H1' = H1/MO \tag{21}$$

where

H1 = replacement rate per sow/year

H1' = replacement rate per sow/month

CN = corn price ($/bushel)

FP = farm level hog prices ($/cwt)

MO = months, 12

e's = regression coefficients

Since equation (20) was estimated using annual data, it is necessary to divide equation (20) by 12 in order to convert it into monthly configuration. The regression coefficient and summary statistics are presented in Table I.

It is hypothesized that hog price is directly related to the replacement rate while corn price is inversely related to the replacement rate; hence, it is assumed that an increase in the hog price would increase profits given that corn price remains constant. This will further give the farmer the incentive to retain more gilts for breeding so as to increase production for the next season. An increase in the corn price will have a reverse effect on the number of gilts held for breeding. In order to obtain the actual number of gilts entering breeding herd, the replacement rate per sow, H1, must be multiplied by the existing swine breeding herd. This can be represented as:

$$H2 = H1' * SH \tag{22}$$

where

H2 = number of replacement gilts (million head/month)

H1' = replacement rate per sow per month

SH = swine breeding herd inventory (million sows)

The culling rate equation can also be estimated by using the hog and corn prices as stated earlier. Such a relationship is represented by equation (23). The regression coefficients and summary statistic are presented in Table I.

$$H3 = e_3 + e_4 * CN - e_5 * FP \tag{23}$$

$$H3' = H3/MO \tag{24}$$

where

H3 = rate of culling per brood sow/year

H3' = rate of culling per brood sow/month

FP = farm pork price ($/cwt)

CN = corn price ($/bushel)

MO = months, 12

e's = regression coefficients

The estimated equation must be divided by 12 to convert into a monthly estimate. The relationship between the culling rate and corn prices is positive, while the relationship of hog prices and culling is negative. It is expected that as hog prices and profits increase the culling rate will decrease, thus increasing the size of breeding herd and consequently the level of future production. Conversely, as the corn price increases, the profit will decrease indicating that the culling rate will increase, thus the level of future production will level off. In order to calculate the number of sows being culled, it is necessary to multiply the culling rate by the breeding herd size as presented in equation (25).

$$H4 = H3' * SH \tag{25}$$

where

H4 = the number of cull sow leaving the breeding herd (million head/month)

H3' = rate of culling per brood sow/month

SH = swine breeding herd (million head)

Figures 7 and 8 present a schematic hog production component depicting replacement and culling decisions that effect the swine breeding herd and production and the hog production schedule respectively.

Given the breeding herd size, the number of pigs produced can be calculated by assuming a pig weaning rate per sow. Ulrich assumes this rate to be 14.4 pigs per year. To convert this to a monthly rate, 14.4 is divided by MO or 12. Hence, hog production rates can be represented as:

$$H5 = (14.4/MO) * SH \qquad (26)$$

where

H5 = number of pigs produced (million head/month)

SH = swine breeding herd (million head)

MO = months, 12

It takes approximately 6 months delay from the time the piglet is born before it is ready to breed or to be marketed as a 220 pound hog. The outflow from such delay in production is represented by H6. The decision to retain breeding animals is assumed to occur when the animals are ready for market. Thus, those animals that go for breeding purposes will go through the H2 path and the hogs that are going to the market for slaughter can be represented as:

$$MH = H6 - H2 \qquad (27)$$

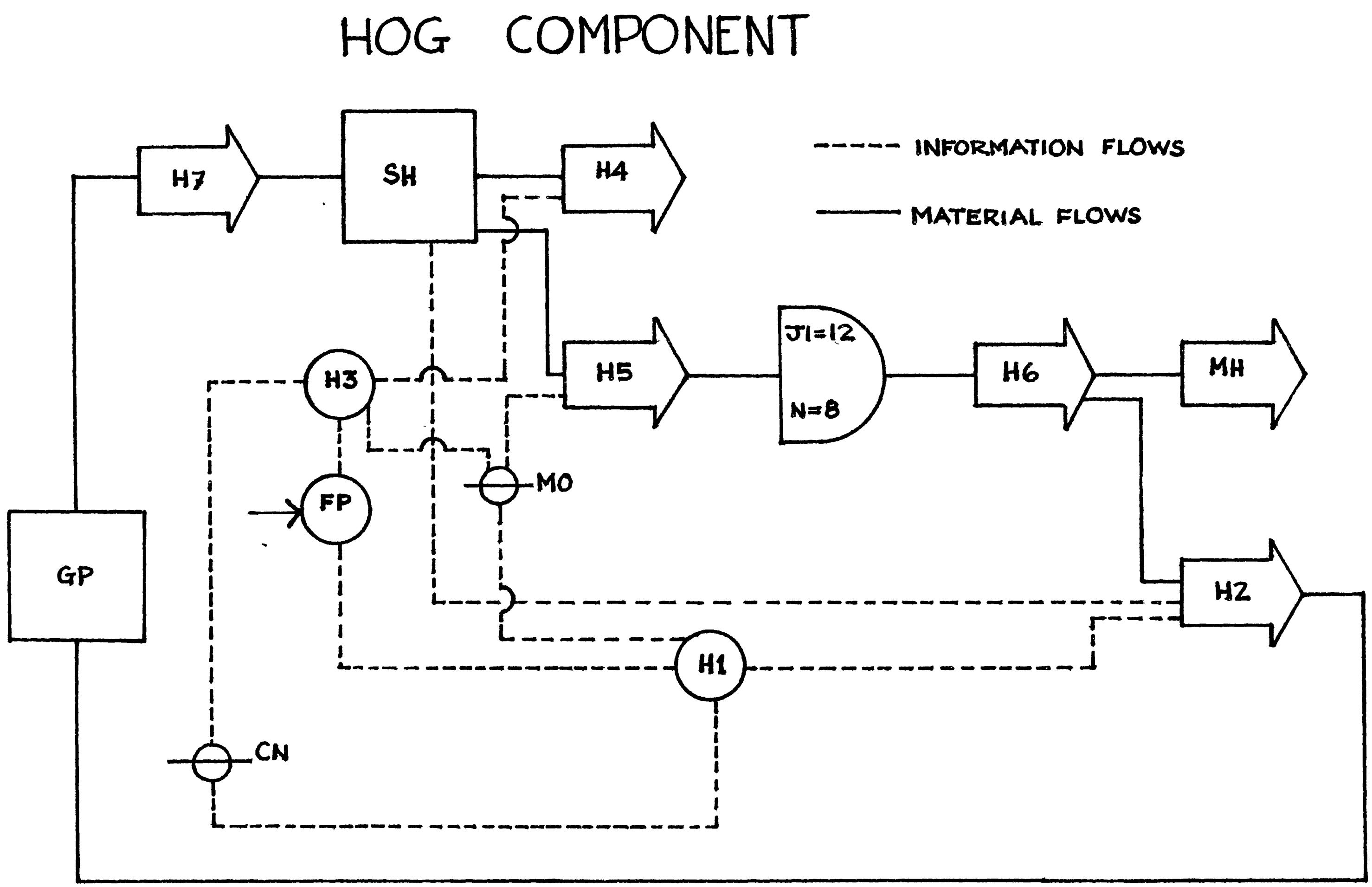


Figure 7. Hog Sector Submodel and Its Component

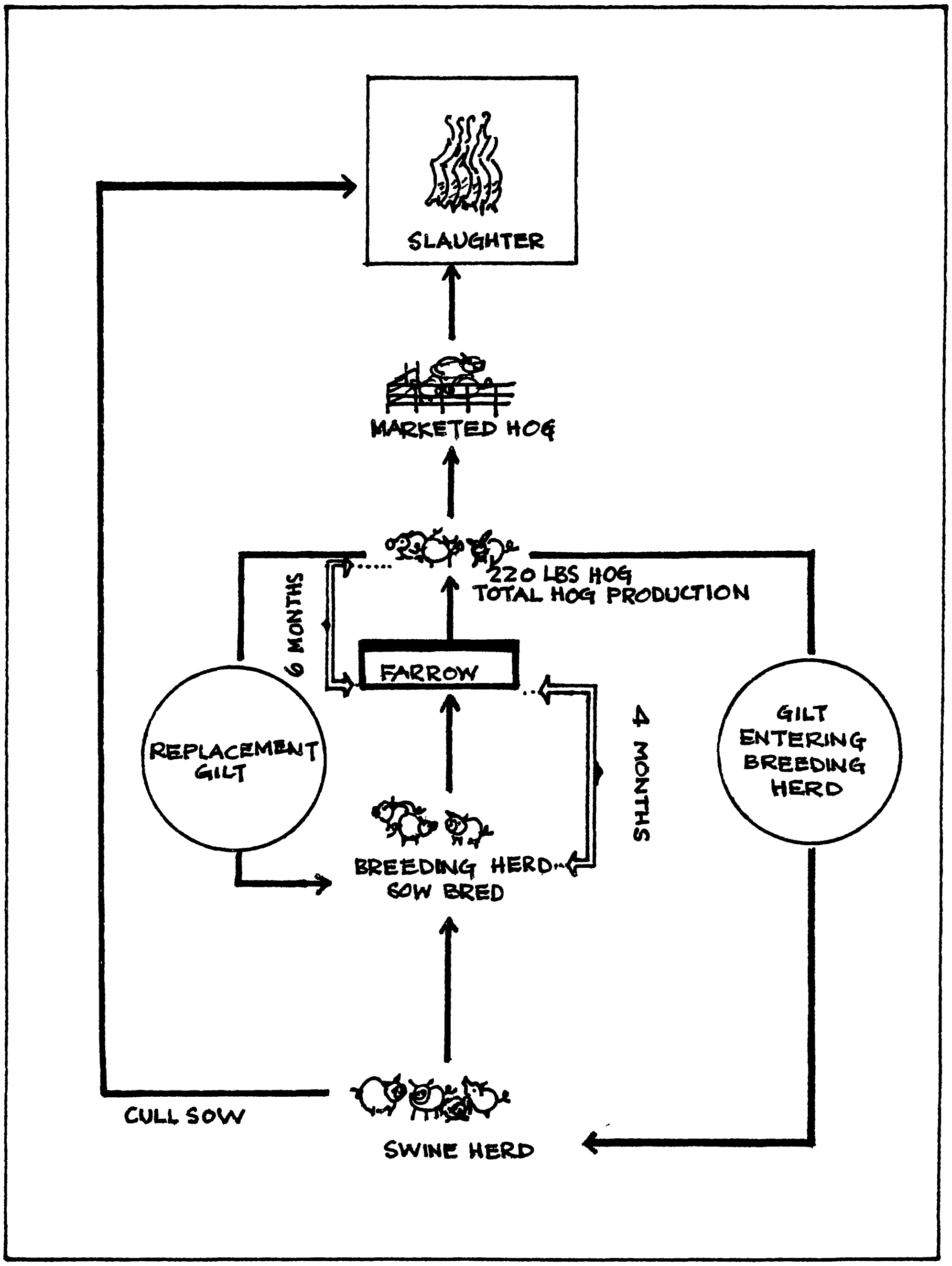


Figure 8. Illustration of Hog Production Schedule

where

MH = marketed hog (million head/month)

H6 = total hog production (million head/month)

H2 = gilts held for replacement (million head/month)

Those gilts that enter into path H2 are held for breeding for an additional month. Such a gilt pool is represented by GP. The outflow from the gilt pool which feed the input side of the swine breeding herd equation is represented by variable H7. Thus we can represent the gilt pool as:

$$GP = GP + DT * (H2 - H7) \tag{28}$$

where

GP = gilt pool (million head)

DT = solution interval

H2 = gilts held for replacement (million head/month)

H7 = gilts entering breeding herd (million head/month)

Given the amount of gilts entering breeding herd and the amount of sows culled, the swine breeding herd equation can be mathematically presented as:

$$SH = SH + DT * (H7 - H4) \tag{29}$$

where

SH = swine breeding herd (million sow)

DT = solution interval

H7 = gilts entering breeding herd (million head/month)

H4 = number of cull sow leaving into breeding herd (million head/month)

Poultry Sector Submodel

The poultry sector submodel consists of the chicken sector and is the most simplified submodel. It is not designed to include physical and biological structures as in beef and hog sectors. Inventories of breeding flocks, replacement rates, culling rates, and growth delays are not taken into consideration in this submodel. The production responses are based directly on chicken prices and corn prices lagged one year. Like the hog production response, corn is the major input. Indirectly, the chicken production response is based on profit obtained from the operation. It is hypothesized that chicken price should have a positive effect while corn price should have a negative effect on chicken production.

The chicken production relationship can be represented as in equation (30). The regression coefficients and summary statistics are presented in Table I.

$$TC = b_0 + b_1 CL + b_2 * CC + b_3 * YR \qquad (30)$$

where

TC = total chicken production in million pounds

CL = corn price lagged one year

CC = chicken price lagged one year

YR = time variable

It has been estimated that the production process for chicken is quite short, approximately three months. However, it is assumed that one year lag time period is required for the producers to adjust their production. This is due to institutional constraint and resource fixity. Thus, if last year's price is favorable, the producers will begin to rebuild their flock for the next year. The reverse applies if last year's price was unfavorable.

It should be noted that the broiler industry in the United States is vertically integrated and producers are under contract for a given production level. Hence, the price fluctuation may not have any significant effect on the decision to increase or decrease production until current contract commitments expire. Figure 9 represents a simplified scheme chicken production component.

The Market Sector Submodel

The market sector submodel provides conversion of fed (grain) and non-fed (grass) beef, cull cows, market hog, and cull sows, into their respective retail red meat categories. Together with chicken, these red meats are defined as the total meat produced in the market. Each animal type listed above must be converted into pounds of dressed meat by a conversion factor. The conversion factors used were obtained from a marketing handbook listing dressing percentages by different livestock type and grade. The variables C1 through C7 represent the conversion factor for each respective animal type. The market sector submodel can be presented mathematically as follows:

$$NF = G1 * C1 + G2 * C2 \quad (31)$$

$$F = F1 * C3 + F2 * C4 \quad (32)$$

$$CB = CO * C5 \quad (33)$$

$$TB = (NF + F + CB) * MO \quad (34)$$

$$TP = (C6 * MH + C7 * H4) * MO \quad (35)$$

$$TM = TB + TP + TC \quad (36)$$

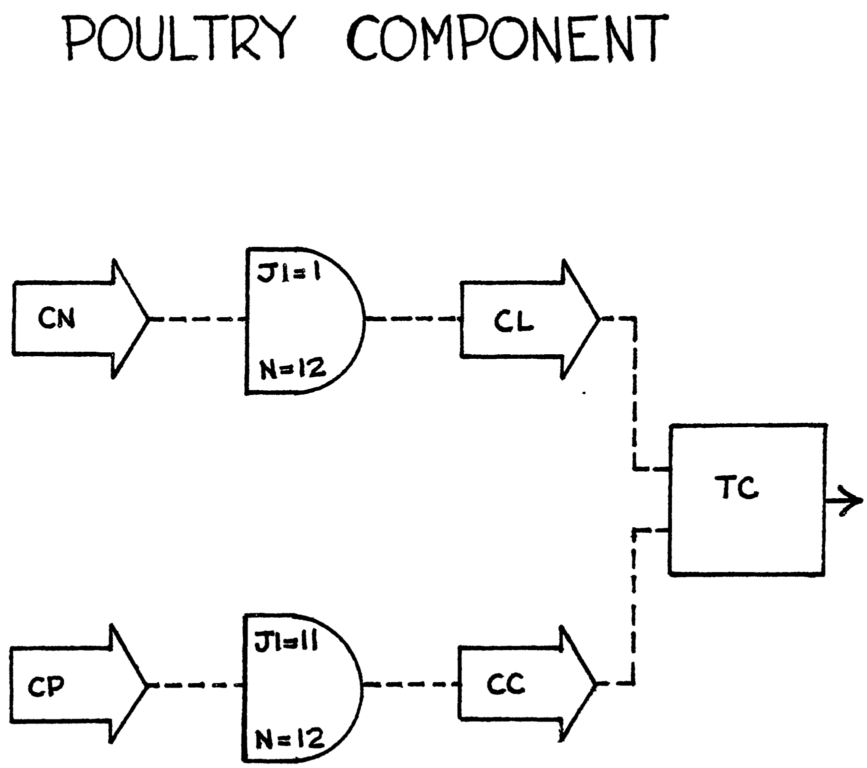


Figure 9. Chicken Sector Submodel and Its Component

where

NF = total non-fed (grass) beef meat (million pounds/month)

F = total fed (grain) beef meat (million pounds/month)

CB = total cull cow beef meat (million pounds/month)

G1 = grass fed heifers (million head/month)

G2 = grass fed steers (million head/month)

F1 = grass fed heifers (million head/month)

F2 = grain fed steers (million head/month)

CO = cull cows (million head/month)

TB = total beef meat produce (million pounds/year)

TP = total pork meat produce (million pounds/year)

MH = market hog (million head/month)

H4 = cull sow (million head/month)

TM = total meat produce (million pounds/year)

TC = total chicken meat produce (million pounds/year)

C1, C2, C3, C4, C5, C6, C7 = dress carcass weight

where

C1 = 520 pounds per G1

C2 = 540 pounds per G2

C3 = 620 pounds per F1

C4 = 650 pounds per F2

C5 = 500 pounds per CO

C6 = 160 pounds per MH

C7 = 180 pounds per H4

MO = months, 12

Figure 10 presents the schematic diagram of the marketing sector depicting the conversion of live animals to meat available for consumption and final demand for meat product.

Grass fed beef animals are to be converted into red meat by using conversion factor C1 and C2 for grass fed heifers and steers respectively. The factors assume live weight of 850 pounds for heifers and 900 pounds for steers, with a 60 percent dressing percentage. These values are based on the average for good grade animals. Thus, C1 and C2 are set at 510 pounds (850 * 0.6) and 540 pounds (900 * 0.6) respectively. Similarly, those heifers and steers that came from the grain feeding scheme into the marketing sector are converted into red meat by using conversion factor C3 and C4 respectively. These factors assume live weight of 1,000 pounds for heifers and 1,050 pounds for steers, with 62 percent dressing percentage. These values are based on the average for choice grade. On the other hand, the conversion factor for a cull cow assumes 1,000 pounds of live weight per animal with a 50 percent dressing percentage, i.e. C5. These values are based on the average for utility, cutter and canner grades for cows. The beef obtained from grass, grain and cull cow are combined to yield total beef production.

In the hog sector, pigs that have been placed in the feed lot to be sold as market hogs are assumed to be sold at 220 pounds. The average cull sow weight was assumed to be 260 pounds. The conversion factors for these animals are C6 for marketed hogs and C7 for cull sows, they reflect a yield of 160 pounds and 180 pounds of retail pork respectively for market hogs and cull sows. The dressing percentage for market hogs (C6) is assumed to be 71 percent which is the average

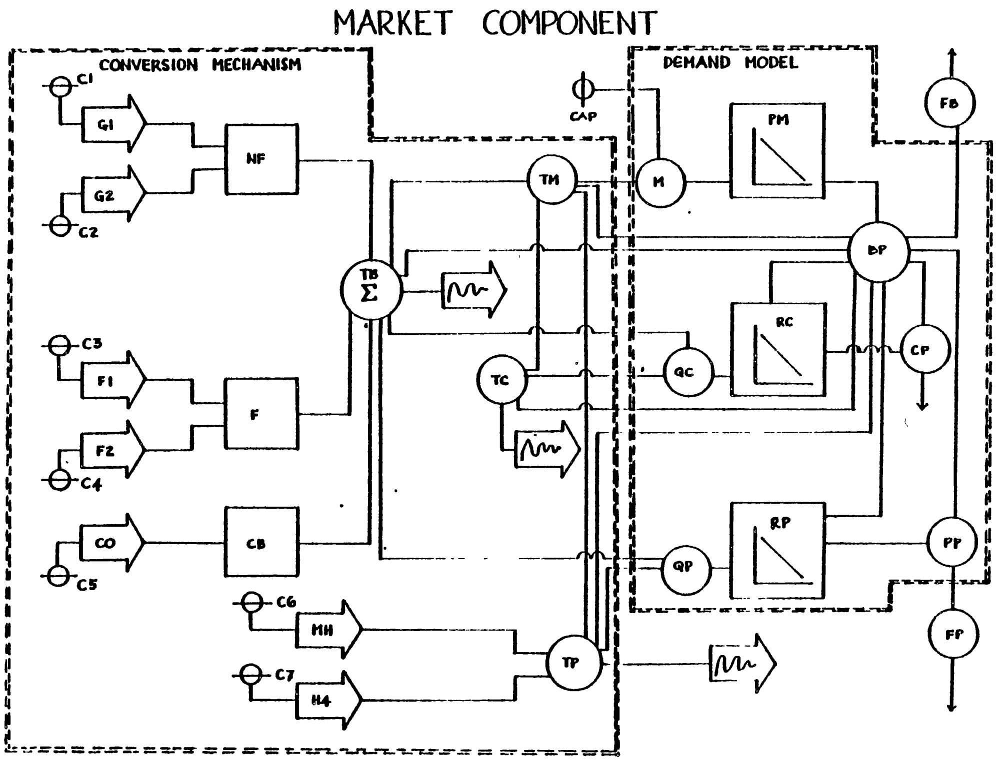


Figure 10. Market Sector Submodel and Its Component

for U.S. grades one through four while the dressing percentage for cull sows (C7) is 69 percent which is the average for utility grades. Total pork production is obtained by summing up the converted weight market hogs and cull sows.

The total chicken production was estimated in annual retail weight directly, thus conversion is not necessary. Total beef and total pork flowing into the market is in terms of monthly production and must be multiplied by 12 to convert them into annual terms. Annual data is needed by the demand model since it was constructed based on annual data and requires annual meat production information to derive prices for the respective meat categories.

Demand Submodel

As indicated earlier the demand model developed by Ikerd (1980) was used to generate retail and farm level prices for beef, pork and poultry. Such price information is used in the overall model as a feedback to the production sectors signalling expansion, contraction or stabilization of the livestock and poultry sectors.

The total meat demand approach was used by Ikerd (1980) with an idea that all meats are close substitutes and form a "composite" commodity. The supply of the composite commodity in relation to its demand determines the market price for the composite commodity and, in turn, simultaneously the price of the individual meat components. Three econometric equations were developed in order to accomplish the total meat demand approach in estimating the retail and farm level prices for beef, pork and chicken. Mathematically, they can be presented as follows:

PM = f(TM) (37)

RP = f(QP,QB) (38)

RC = f(QC,QB) (39)

where

PM = composite meat price ($/pound)

TM = aggregate meat production (million pounds/year)

RP = projected ratio of pork to beef prices

RC = projected ratio of chicken to beef prices

QB = per capita consumption of beef (million pounds/year)

QP = per capita consumption of pork (million pounds/year)

QC = per capita consumption of chicken (million pounds/year)

The relationship between total meat and composite meat price trace out a traditional quantity-price demand schedule represented by equation (37). Since the composite meat price estimated cannot be directly disaggregated into individual price for beef, pork and chicken, equations (38) and (39) were developed in order to estimate the quantity-price relationships between substitute good based on ratios. Equation (38) represents the relationship of pork and beef's price ratio as a function of the pork and beef consumption ratio. Equation (39) illustrates relationships between beef and chicken's price ratio as a function of the chicken and beef consumption ratio. The estimated regression coefficients and summary statistics for the above equation are presented in Table II.

Given the supply/consumption of beef, pork and chicken, the prices of the individual meats can be derived. This can be done by deriving retail beef prices first and then computing the prices for the other two meats. The beef price can be obtained by using the relationship

TABLE II

ESTIMATED REGRESSION COEFFICIENTS AND SUMMARY STATISTICS FOR THE PRICE AND QUANTITY RATIOS EQUATIONS*

Composite Mean Price Equation	PM = 309.30 - 1.18 * TM R_2 = 0.87
Beef and Pork Price/Quantity Ratio Equation	RP = 1.42 - 0.94 * (QP/QB) R_2 = 0.97
Beef and Chicken Price/ Quantity Ratio Equation	RC = 0.06 - 0.47 * (QC/QB) R_2 = 0.71

*The estimated regression coefficient and summary statistics were obtained from Ikerd (1980) article. Variable definitions are in their respective equation in the text.

between the weighted average price of beef, pork and chicken and the total retail per capita supply of these three meats. The weighted average price and total meat supply are defined as follows:

$$QM = QB + QP + QC \tag{40}$$

$$TM = TB + TP + TC \tag{41}$$

$$PM = (QB/QM) * BP + (QP/QM) * PP + (QC/QM) * CP \tag{42}$$

$$PM = (TB/TM) * BP + (TP/TM) * PP + (TC/TM) * CP \tag{43}$$

where

QM = aggregate meat consumption (million pounds/year)

QB = per capita consumption of beef (pounds/year)

QP = per capita consumption of pork (pounds/year)

QC = per capita consumption of chicken (pounds/year)

PM = composite meat prices ($/pound)

BP = retail beef price ($/pound)

PP = retail pork price ($/pound)

CP = retail chicken price (pound)

TM = total meat production (million pounds/year)

TB = total beef production (million pounds/year)

TP = total pork production (million pounds/year)

TC = total chicken production (million pounds/year)

Equations (40) and (41) are equivalent. One is measured in per capita consumption while the other is in total production. The per capita consumption figures were obtained by dividing the total production with population figures.

As indicated earlier, in order to derive price for the individual meat, first we need to derive the retail beef price and then the price for pork and chicken. This can be accomplished by defining pork price as a proportion or ratio of beef prices. Similarly chicken prices can be defined as a ratio of beef price. This can be illustrated as follows:

$$PP = RP * BP \tag{44}$$

$$CP = RC * BP \tag{45}$$

$$RP = PP/BP \tag{46}$$

$$RC = CP/BP \tag{47}$$

where

PP = pork price ($/pound)

BP = beef price ($/pound)

CP = chicken price ($/pound)

RP = projected ratio of pork to beef price

RC = projected ratio of pork to chicken price

Thus, by substituting equations RP and RC into the weighted average price and total meat supply equation (42) or (43), beef price (BP) can be derived. This can be illustrated as follows:

$$PM = (TB/TM) * BP + (TP/TM) * PP + (TC/TM) * CP \tag{48}$$

substituting equations, the estimated values for RP and RC as derived from the OLS estimates of equations (38) and (39) into (48), the following equation is derived.

$$PM = (TB/TM) * BP + (TP/TM) + (RP*BB) + (TC/TM) * (RC*BB) \tag{49}$$

Multiply by TM throughout and factoring out BP:

$$PM * TM = (TB*BP) + (TP*RP*BP) + (TC*RC*PP) \tag{50}$$

$$PM * TM = BP\ [TB + (TP*RP) + (TC*RC)] \tag{51}$$

Solve for BP:

$$BP = PM * TM/[TB + (TP*RP) + (TC*RC)] \tag{52}$$

The derived retail beef price then can be used to determine the retail pork and retail chicken prices as shown in equation (44) and (45). The projected ratio of pork and chicken prices to beef price were generated by the table look-up routine in the simulation model.

The retail prices generated from the above equations can then be used to derive live prices for cattle, hogs and chickens by subtracting the specified spreads between retail and wholesale or live prices. It has been estimated that in the past 20 years the farm level beef price has averaged about 65 percent of the retail beef price while pork prices at farm level have averaged about 60 percent of the retail pork price. Retail prices were used directly in the chicken supply model.

Farm level prices for cattle, hogs and chickens are used as a feedback to the production sectors as a decision criteria for future production levels.

Input or Predetermined Variable Submodel

Predetermined variables are input factors or variables which are determined by factors completely independent of, or external to the system. Such variables include a set of starting conditions and future values for exogenous variables that describe the future environment the model will operate within.

Ulrich (1984) indicated that there are two ways in which the simulation model could be initialized. First, it can be initialized minimally to get the model started in the right direction. The first run is then performed based on the initialized value until an equilibrium solution is found. Using the equilibrium solution the model can be initialized again for the second run. Various sensitivity tests can be conducted to determine model response to exogenous shocks given that a stable equilibrium condition has been defined.

The other initialization option is to use historical values that are consistent through the years and somewhat close to a stable situation. This approach is more difficult but is preferable since there is some basis for using the initial values rather than initializing many levels at zero as in the first option.

Three critical variables that must be initialized at some level before the model can even start are the inventory variables of the beef breeding herd (BH), swine breeding herd (SH) and total chicken (TC) available for consumption. Other variables that are assumed to be fixed values throughout the experiment include the production cost, feed costs, calving rate, carcass weight, income elasticity, population, solution interval, month and proportion of animals going into high energy ration. The value of these variables can be changed in order to determine the effect of such changes on production, prices and income to producers.

Initialization of Inventories

Initial breeding herd inventory values are critical variables for the simulation model. For the analysis done here the beef and sow breeding herd and chicken production levels were initialized at their 1980 levels as follows:

BH = 38 million head brood cows

SH = 6.5 million head brood sows

TC = 13,000 million pounds of chicken

Feed and Production Cost

Feed costs are calculated as the weighted average cost of the feedstuffs used by each livestock type. The feedstuffs considered consist of corn, sorghum, cotton seed meal and hay. Production cost is the cost incurred in producing the livestock and includes all costs. For beef, production cost is based on cost of producing 400 pound calves. For hogs a direct production cost figure was not used. Rather the hog/corn price ratio was used as a proxy for profit. Initial feed and production cost values assumed were as follows:

BC = cost of production of calf, $83.95/cwt

CN = corn price, $2.47/bushel

CL = corn price lagged one year

SGHM = sorghum price, $2.94/bushel

CSM = cotton seed meal, $129.00/ton

HAY = hay, $71.00/ton

CQC = hog/corn price ratio, FP/CN varies according to FP and CN generated from the model

Carcass Weight for Beef and Hog

This is an estimate based on the average dressed or carcass weight of beef and hogs. For beef, it is based on heifers and steers that were fed either on grass or grain and the average carcass weight for cull cows. For hogs, the average dressed weight is based on market grain fed hogs and slaughtered sow weights. The live weights and dressing percentage underlying the assumed carcass weights have been previously discussed.

The assumed carcass weights are as follows:

C1 = 520 pounds for grass or non-fed heifers

C2 = 540 pounds for grass or non-fed steers

C3 = 620 pounds for grain fed heifers

C4 = 650 pounds for grain fed steers

C5 = 500 pounds for cull cows

C6 = 160 pounds for marketed hogs

C7 = 180 pounds for cull sows

Other Exogenous Variables

Other assumed variable values include the weaning rate for the beef breeding herd, population, income elasticity, solution interval and proportion of calves going into high energy ration. The weaning rate is used to determine the actual amount of calves that are actually born and survive to be placed on feed. It is assumed that the weaning rate is approximately consistent throughout the experiment. The population value was used to calculate the amount of per capita consumption of both red and white meat. The aggregated meat prices derived need to be deflated by an index of per capita disposable income so that the "real" and "inflated" income effect on the demand for meat is distinguishable. In our case the income elasticity is assumed to be unitary elastic to adjust for both inflation and real income effects. However, the price would have to be deflated individually and aggregated if different income elasticities were assumed for each meat. The proportion of calves that are fed a high energy ration (grain fed) is assumed to be constant throughout the experiment and held at 80 percent. These values are:

CAP = 226 million (population)

YE = 1 (income elasticity)

CR = 0.87 (calving rate)

FF = 80 percent (percentage of calves into high energy ration)

DT = solution interval

MO = months, 12

Market Demand Model Initialization

The market demand model needs to be initialized to be consistent with the breeding herd inventories specified. The variables involved in the initialization of market demand are total beef (TB), total pork (TP), total chicken (TC) and total meat (TM). The initialization is accomplished with the following equations:

$$TB = BH * [(C1 * CR * 0.87 + C2 * CR) * 0.1 + (C3 * CR * 0.87 + C4 * CR) * 0.4 + C5 * 0.13] \quad (53)$$

$$TP = SH * [(0.395 * C7) + (14.5 - 0.395) * C6] \quad (54)$$

$$TM = TB + TP + TC \quad (55)$$

where

TB = total beef (million pounds/year)

BH = cow breeding herd (million head/year)

TP = total pork (million pounds/year)

SH = swine breeding herd (million head/year)

TC = total chicken (million pounds/year)

TM = total meat (million pounds/year)

Carcass weight:

C1 = 520 pounds for grass or non-fed heifers

C2 = 540 pounds for grass or non-fed steers

C3 = 620 pounds for grain fed heifers

C4 = 650 pounds for grain fed steers

C5 = 500 pounds for cull sow

C6 = 160 pounds for marketed hog

C7 = 180 pounds for cull hog

CR = calving rate

The equations in essence calculate the flow of meat that would enter the market annually if the specified breeding inventories were held at a constant level for an infinite period. Under such condition a stable/steady state flow of animals of various types would eventually evolve.

Total beef is calculated by converting the calculated long-run steady state flows of grass fed steers and heifers, and grain fed steers and heifers and cull cow with their conversion factors respectively.

Total beef equation can be divided into three parts, they are as follows.

1. Calculation of grass fed heifer and steer meat available for consumption.

a. Calculation of Grass Fed Heifers: The product of BH * C1 * CR * 0.87 * 0.1 converts the pounds of beef derived from grass fed heifers. The breeding herd (BH) multiplied by the calving rate (CR) yields the number of calves produced annually. The value of 0.87 accounts for the fact that on the average 13 percent or 0.13 of the heifers will be held back for replacement and slaughtered later as cull cow. Recall that only 50 percent of the calves born are heifer calves and only 20 percent of these calves will be grass fed. Thus among the total calf population only 10 percent or 0.1 heifer calves will be grass fed. The conversion factor, C1, will convert the live weight grass fed heifer into carcass weight available for market.

b. Calculation of Grass Fed Steer: Similarly the product of BH * CR * C2 * 0.1 represents the amount of meat available from grass fed steer. Since none of the steer calves are being held back as replacement, the value 0.87 is not applicable. Again only 20 percent of the steers were placed as grass fed animals which is 10 percent or 0.1 of all the calf population. The conversion factor C2 converts the live weight animal into carcass weight process meat.

2. Calculation of grain fed heifer and steer meat available for consumption.

a. Calculation of Grain Fed Heifers: The product of BH * CR * 0.87 * C1 * 0.4 converts pounds of beef derived from grain fed heifers. Similar explanation can be given as to the conversion of grass fed heifers. However, the value 0.4 needs some explanation. Since 80 percent of the calf population was placed on grain fed scheme (of which 50 percent are heifers and 50 percent are steers) thus only 40 percent or 0.4 of the calf population is heifer calves. Multiplying by conversion factor C3 yields the amount of fed heifer beef available for consumption.

b. Calculation of Grain Fed Steers: Meat derived from grain fed steer can be calculated in a similar way but replacement does not affect steers and therefore the value 0.87 can be ignored. Conversion factor C4 will convert BH * CR * 0.4 into total fed beef available from grain fed steers.

3. Calculation of Cull Animal Meat Available for Consumption: In the normal year, 13 percent of the breeding herd is being replaced/culled. Good grade meat is produced by these cull animals. Multiplying breeding herd (BH) by 0.13 yields the number of cull animals and conversion factor C5 changes the cull cow number into pounds of meat derived from cull cows.

Thus by adding up the red meat from grass fed and grain fed steers and heifers, and cull cows, total beef meat available is obtained.

Total pounds of pork are calculated in the same manner as pounds of beef animals. Recall that two types of hogs leave the hog submodel for processing. These are market hogs (MH) and cull sows (H7).

1. Calculation of Cull Sows Available for Consumption: By assuming normal replacement and culling rates, the pork derived from cull sows can be estimated by the product of SH * 0.395 * C7. Thus by multiplying the swine breeding herd (SH) by the culling rate of 0.395 and the conversion factor C7 the amount of meat produced by cull sow can be determined.

2. Calculation of Market Hog Meat Available for Consumption: Similarly the amount of meat from market hogs can be obtained by multiplying the swine breeding herd (SH) and (14.4 - 0.395). The value 14.4 is the rate of pigs produced per sow per year. Thus, the value 14.4 minus the amount of replacement gilts, 0.395 retained per year per sow, yields the number of market hogs supplied each year. Using the conversion factor C6 the amount of meat from market hogs is obtained.

Therefore, by summing up the meat obtained from cull sow (H4) and market hogs (MH), the total amount of pork meat produced can be estimated.

Pounds of chicken produced annually is directly specified as an initial value. Total meat supply is then simply the sum of pounds of beef, pork and chicken. Meat per capita (M) is calculated by dividing total meat (TM) by the population (CAP). The ratio of pork to beef, chicken to beef and prices for beef, pork and chicken are calculated and are used as initial values. The calculation of such values was discussed earlier.

Once initial meat price values are established the lagged values of the prices needed by the model are initialized as equal to the current solution value. Chicken and corn prices are used to determine chicken production. Since the model is monthly, a 12 period vector must be initialized for each price enabling the model to go back and select a price 12 months prior to the current time. Similarly profit accruing to cow-calf producers in determining the replacement and culling rate needs to be initialized. This is done by taking the difference between price received per cwt and cost of producing a cwt of animal.

Production Delay Initialization

Due to the physical and biological delays in production processes some initialization needs to be made in order to include the delay in the simulation model. This is because breeding herd at time t_0 does not produce a consumable product until some future time period. Therefore, in order to prevent any distortions in price signal in the demand model, physical and biological delays are initialized consistently with the inventory values of breeding herd of cows and sows, and total chicken supply. In essence it is assumed a constant breeding herd has been producing a steady flow of output for as long as need to fill the cohorts of the delay models. Values used to fill these delays are the same as those used to initialize the available meat supply variables in the demand models.

1. Beef Production Delay: The initialized beef replacement delay is approximately 25 months. Such delay initialization is essential in order to keep the population of replacement heifers and to assure a steady flow of replacement heifers in the future and, consequently, the amount of meat available for production.

2. Hog Production Delay: Similarly the hog production delay required 10 months to produce hog at a marketed weight of 220 pounds. It is essential to initialize the production delay as to keep the population of replacement sows and a steady flow of replacements into the breeding herd in the future. Thus this will insure the steady flow of meat to the public.

3. Chicken Production Delay: Total chicken production does not have any specific delay period. The amount of chicken supply (TC) will be used as an initialized value. Chicken production does not have a specific delay period. The amount of chicken supply (TC) will be used as an initialized value.

Stochastic Subroutine

The purpose of the inclusion of stochastic elements in the simulation model is due to the fact that the livestock and poultry industries are not purely deterministic. The industries are frequently involved with variables that they cannot control. Thus, by introducing stochastic elements in the simulation model, it will help to capture the uncertainty aspect of production in livestock and poultry industries. For this purpose a random number generating function is used to generate stochastic elements.

The stochastic elements used apply to the cost of producing 400 pound calves and corn prices. These two variables are very important variables influencing farmers' production decisions and, subsequently, the amount of meat to be produced in the system. Based on sample standard deviations estimated over the period 1958 to 1983 for both the cost of producing 400 pound calves and corn price, a normally distributed random variation was generated about the assumed 1980 beef production cost and corn price available.

Generation of the desired random variables was achieved with a subroutine. The subroutine requires as input the desired mean and variance. The subroutine is configured to generate normally distributed random corn prices and beef production costs. The BASIC language statements and variable definitions of the subroutine are listed below.

```
EXCN = 2.47                                   (56)
STCN = 0.354                                  (57)
EXBC = 83.95                                  (58)
STBC = 4.24                                   (59)
W8 = 0                                        (60)
FOR K = 1 to 12                               (61)
W7 = RND(1)                                   (62)
W8 = W8 + W7                                  (63)
NEXT K                                        (64)
CN = STCN * (W8 - 6) + EXCN                   (65)
```

IF CN > 2.824 THEN CN = 2.824 (66)

IF CN < 2.116 THEN CN = 2.116 (67)

BC = STBC + (W8 - 6) + EXBC (68)

IF BC > 88.19 THEN BC = 88.19 (69)

IF BC < 79.71 THEN BC = 79.71 (70)

SGHM = -0.013 + 0.938 * CN (71)

CM = 8.997 + 57.79 * CN (72)

HAY = -2.472 + 24.15 * CN (73)

RETURN (74)

where

EXCN = historical mean value of corn price ($/bushel)

STCN = standard deviation of corn price ($/bushel)

EXBC = historical mean value of cost of calf production for 400 pound calf ($/cwt)

STBC = standard deviation of cost of calf production ($/cwt)

CN = corn prices ($/bushel)

BC = cost of producing 400 pound calf ($/cwt)

SGHM = sorghum price ($/bushel)

CM = cotton seed meal price ($/bushel)

HAY = hay price ($/ton)

Equations (56) to (59) are the historical mean values and standard deviations for corn and the cost of producing a 400 pound calf. These values are used to generate the random corn prices and production costs of a 400 pound calf. Equations (60) through (64) generate the basic random numbers from which the desired distribution is obtained. The RND(1) variable in equation (62) generates a uniformly distributed value between 0 and 1 and is a function internal to the computer. By summing a series of such random variables the central limit theorem indicates that a standard normal variable is created. This value is then taken times the specific standard deviation. The resulting value is added to the mean [equation (65) and (68)] to generate the desired random variable. For the purpose of this model the random variable values generated were restricted to within one standard deviation of the mean. This is done to eliminate any large extreme values that the stochastic process might occasionally generate. In other words, a true normal distribution is not felt to be reflective of the corn price and beef production cost distribution at the extreme upper and lower ends of the distribution. Hence the distribution was truncated.

Components of Continuous Simulation Model

Recall that both cattle and swine production processes involved considerable amount of delay time in biological growth, especially in the gestation delay and feeding process. A beef replacement heifer requires a nine month gestation period followed by another 14 to 18 months growth delay before it can be bred as a breeding animal. For those calves that would be placed on feed, it would require approximately nine to 10 months of growth from birth to weaning and another 11 to 13 months of growth before reaching slaughter weight, depending on the feeding scheme (that is, grain or grass fed) and the rate of daily grain per animal. Similarly, hog production also requires a considerable amount of time. It takes approximately four months of gestation time and six months from birth to marketing weight or entry into the breeding herd. Thus the simulation procedures for the livestock industry require a step-by-step solution or structured instruction for computing successive time increments, thereby tracing a time path representing the dynamics of a system.

As indicated earlier, the simulation modelling technique used to represent the animal population in the livestock industry are those of continuous systems modelling. The techniques fall into three main categories, including stock/flow models, table look-up routines and time delay models.

Stock/Flow Model. There are three types of equations used in the continuous systems model stock/flow relationships. The first type is called the level or stock equation. This equation is made up of a stock variable which is dependent upon its own previous level and the rate of addition (inflow) and subtraction (outflow) to stocks between the previous time period and the current time. Level/stock variables are also known as state variables because they give the state of the system. A level equations could be presented as follows:

$$LEVEL = LEVEL + DT * (IN - OUT) \tag{75}$$

example:

$$BH_c = BH_p + DT * (BI - CO) \tag{76}$$

$$SH_c = SH_p + DT * (H7 - H4) \tag{77}$$

$$GP_c = GP_p + DT * (H2 - H7) \tag{78}$$

where

LEVEL = the level variable

DT = solution interval

IN = inflow rate unit per time

OUT = outflow rate unit per time

BH, SH, GP, BI, CO, H7, H4, H2 = defined earlier

BH, SH, GP = level or state variables

BI, H7, H2 = inflow variables

CO, H4, H7 = outflow variables

subscript c and p = current and previous level respectively

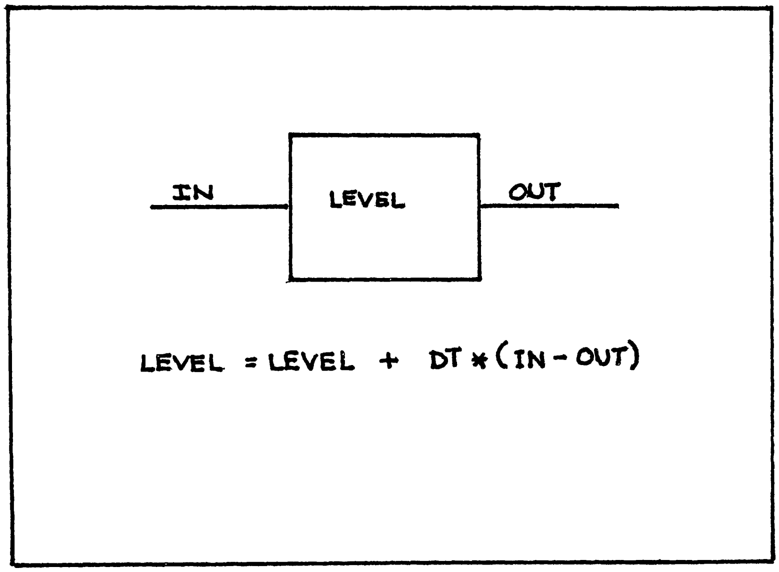
Figure 11 presents a schematic flow diagram of a level variable, i.e. state variable. At any point in time the current level is the level of the previous time measured plus the net flow since the level was last measured.

The second type of equation is the flow equation. The net flow is represented by (IN - OUT). The solution interval DT represents the change in time (delta time) since the last observation. The inflow and outflow variables are always in terms of rates, or unit per period of time. Hence, if the time interval is one-half period the net inflow for one period (IN - OUT) must be halved to reflect the net inflow for one-half a period. DT performs this operation. In essence, equation (75) represents the numerical integration of a continuous net flow equation. The numerical approximation of the integration of the rates of flow generated from the cumulative sum of the net rate of flows is assumed to be the state of the system.

Further discussion of the rate equation concept is warranted. They describe a flow of material through the system which can either be in terms of real good or information which occurs over time rather than at a point in time. Unlike the level variable, the flow variable measures some physical unit per unit of time rather than the quantity or stock of material itself. The rate equation could be presented as:

RATE IN = 50 (79)

RATE OUT = LEVEL (80)



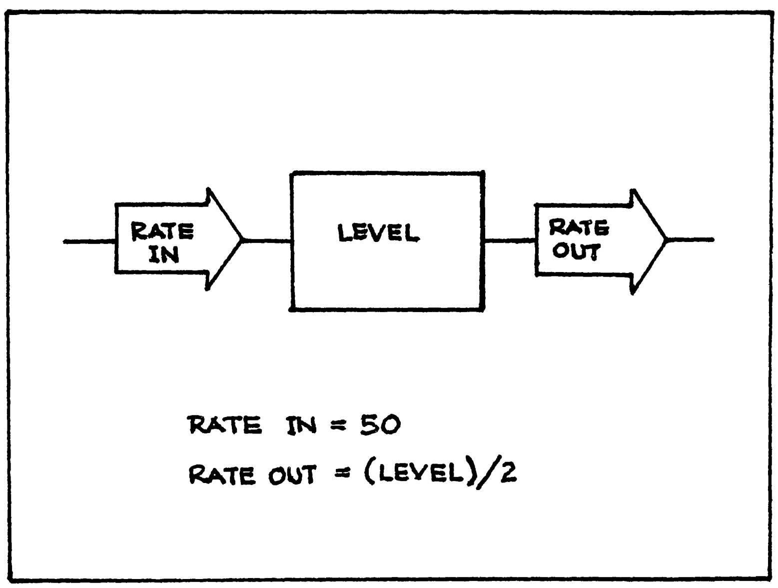


Figure 11. Illustration of a Schematic Flow of a Level Variable

example:

$$DB = a_0 + a_1 * BR(0) + a_2 * BR(1)/100 \quad (81)$$

$$AD = DB/MO \quad (82)$$

$$AC = AR - AD \quad (83)$$

$$CO = AC * BH \quad (84)$$

where

BH = level variable

AD, AC, AR, DB = rate variable, a flow variable

From the above example the average change in breeding herd per month (AD) is RATE IN which is the function of change in breeding herd. The RATE OUT could be represented by the number of culled cows per month (CO) which is a function of the average culling rate (AC) and the value of the level variable, breeding herd (BH).

Notice that the level variables are the integrals of their corresponding rate variables as in equation (75). Knowledge of the relationship between the rate function and the corresponding level variables is very useful in analyzing system behavior, especially in the model verification process. Figure 12 represents three common rate functions and their corresponding level variables. A spike rate when integrated will yield a step function level variable. However, if the rate variable is a step function, when integrated it will generate a ramp function for the level variables. A ramp function for the rate variable, when integrated, will transform into an exponential function for the level variable.

The third type of equation in a simulation model is the auxiliary equation. Auxiliary equations are used to develop model structure. The function generation subroutine, also known as table look-up

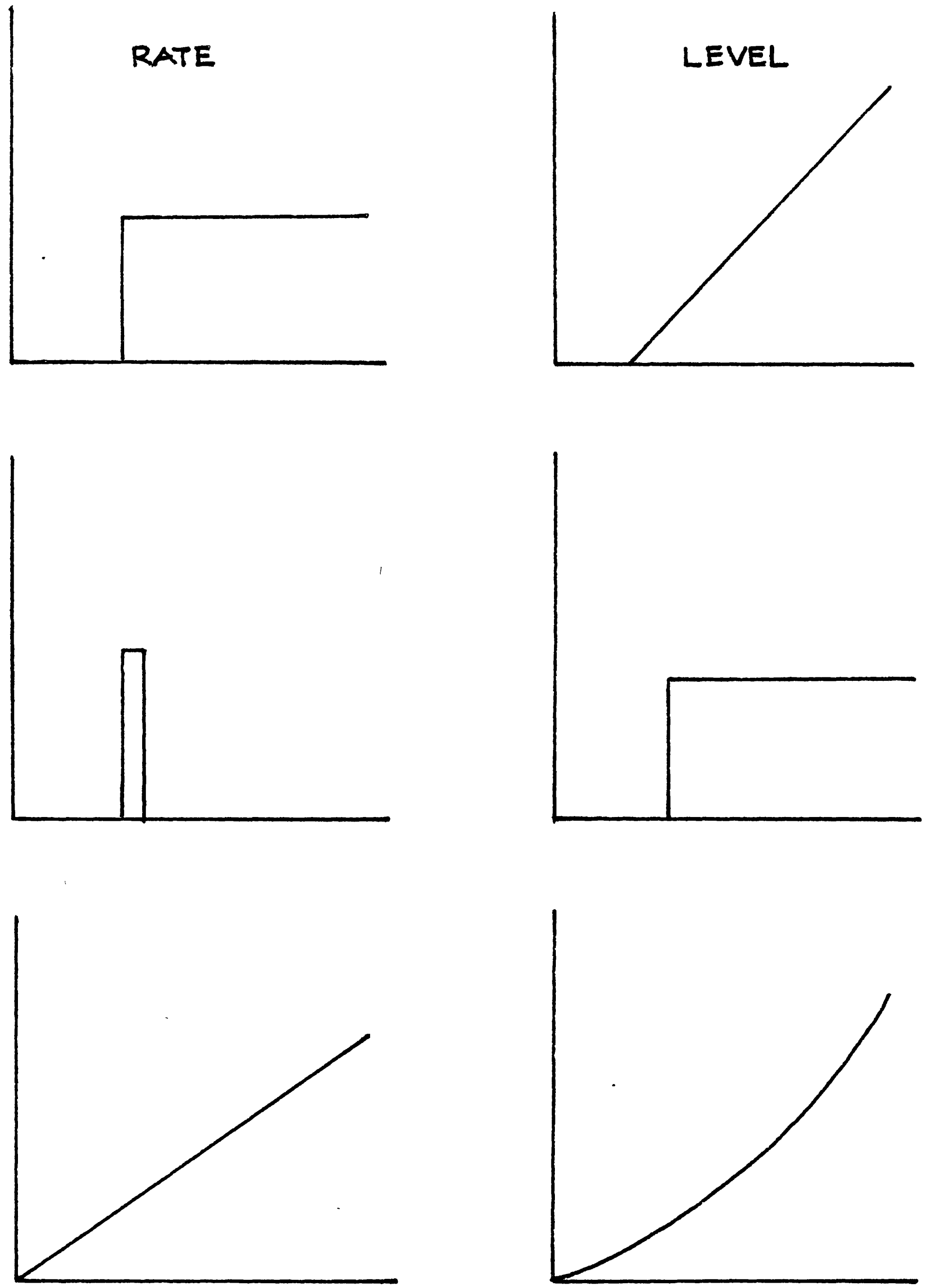


Figure 12. Illustration of Rate Functions and Their Corresponding Level Variables

function, and the delay subroutine are two fundamental auxiliary subroutines used in the simulation model developed here.

<u>Table Look-Up Subroutines</u>. The function generator or table look-up subroutine is a set of equations or instructions for creating a function that may be known visually but not mathematically. It can be divided into two types. One is an explicit function such as SIN, COS, TAN and EXPONENTIAL which have a specific pattern or shape. The other is non-explicit, it can take any shape or form. For our purposes the non-explicit function is being used. The look-up function will trace out the demand relationship of quantity of beef, pork and chicken in their respective prices over some interval specified in the table look-up function subroutine. The program instructions or equations used for the function generator are defined as follows:

```
210 IF (X - SX) < 0.0 GO TO 240                                  (85)
220 IF (X - SX - NI * DX) < 0.0 GO TO 280                        (86)
230 GO TO 260                                                    (87)
240 Y = D(1)                                                     (88)
250 GO TO 310                                                    (89)
260 Y = D(NI + 1)                                                (90)
270 GO TO 310                                                    (91)
280 XD = X - SX                                                  (92)
290 I = INT(1 + XD/DX)                                           (93)
300 Y = [XD - (I-1) * DX] * [D(I+1) - D(I)/DX + D(I)]            (94)
310 RETURN                                                       (95)
```

where

X = independent variable

SX = smallest independent variable defined

NI = number of intervals on X axis

D(I) = dependent variable array

Y = (selected) dependent variable value

XD = distance from the smallest X value to the desired X value

DX = size of increments on X axis

Figure 13 demonstrates the workings of the table look-up function generator. Assume the D(I) array range is D(1) through D(4) and Y, which is the desired value of the function, will be equal to some point within the domain of the dependent variable corresponding to the independent variable (X) mapped by the table. NI in this case is three. Assume that a value is desired for Y that corresponds to X as depicted in Figure 13. Note that equation (85) in the subroutine checks to determine that the independent variable does not fall outside the axis range. If it does, Y is given a value equal to D(1) or D(4), i.e. all Y values associated with any X below SX will be set equal to D(1) and if X lies outside the upper range, Y will then take on the value corresponding to the largest defined X. Statement 220 thus tests for an X value outside the upper defined range.

As an example, in Figure 13, if the independent X is located between the smallest X which is SX and the largest X which is X4, linear interpolation is used to find the dependent variable value Y corresponding to the X value. Statement 280 through 300 accomplished this task. The linear interpolation can be performed for as many X values as desired to generate a function.

Time Delay Models. Time delays in a systems mode may be modeled as discrete or continuous delays. Continuous delays are characterized by a variance associated with their delay length. They are defined by

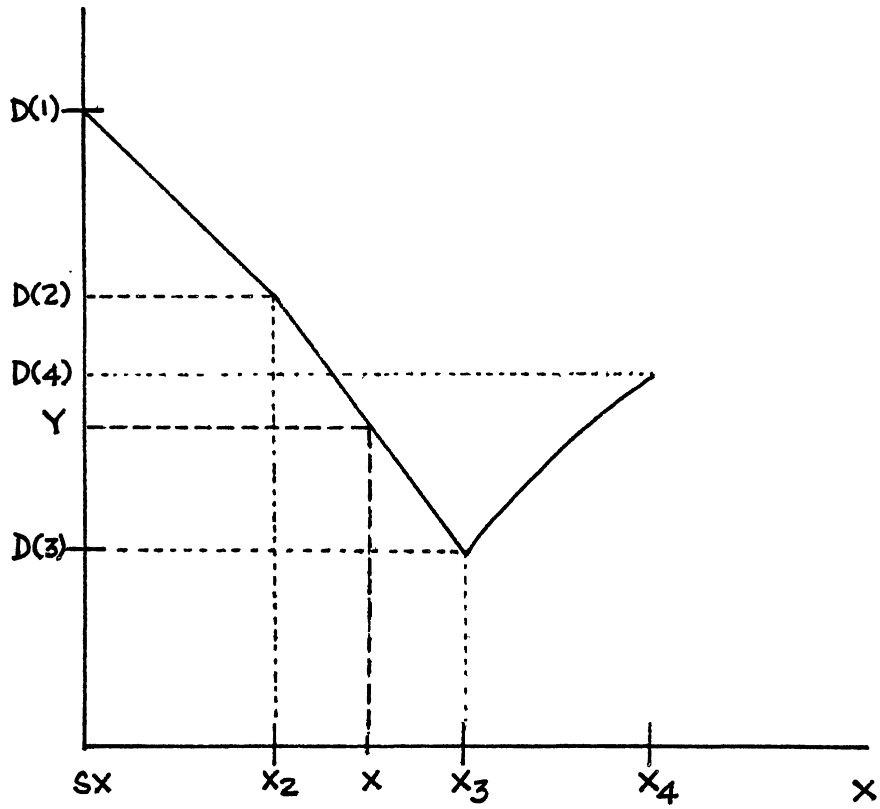


Figure 13. Illustration of the Working of the Table Look-Up Function

an expected length parameter and "order" variable. The order variable characterizes the variance of the delay. The higher the order of the delay the less variance exhibited and the more normally distributed the variance becomes. Figure 14 depicts continuous delay of various orders.

The second type of delay routine is the discrete delay. This is the type of delay routine used in this study. With discrete delays there is no variance or distribution associated with the delay length. A discrete delay subroutine that was developed by Manetch and Park was adopted for the simulation model developed here. A discrete variable delay has inputs of current period values and generates as output lagged values of the variable. Thus, what goes in comes out exactly N time periods later. Figure 15 shows an example of discrete delay. The discrete delay programming is as follows:

```
20 VOUT = VT(J1,1)            (96)
30 FOR I = 2 TO N             (97)
40 VT(J1,I-1) = VT(J1,I)      (98)
50 NEXT                       (99)
60 VT(J1,N) = VIN             (100)
70 RETURN                     (101)
```

The above discrete subroutine moves material through time blocks such that the first material in the delay routine is the first material that comes out. The above routine can be explained as follows. Line 20 [equation (96)] determines the amount of material that should be leaving the delay process which is the first step to be taken. The variable VOUT represented the material flowing out the process. VOUT assigned a value equivalent to the first element in the delay process

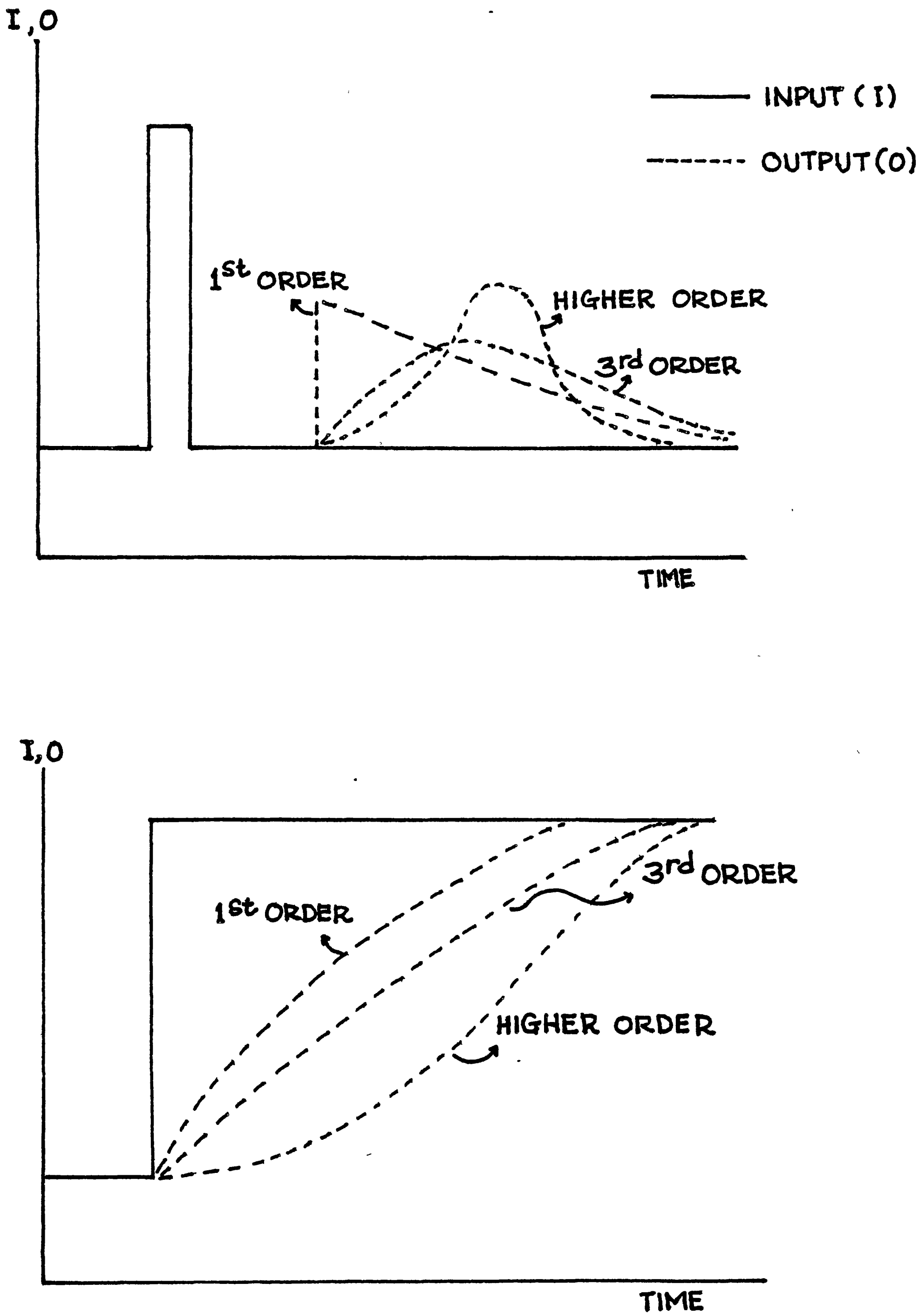


Figure 14. Continuous Delay of Various Order

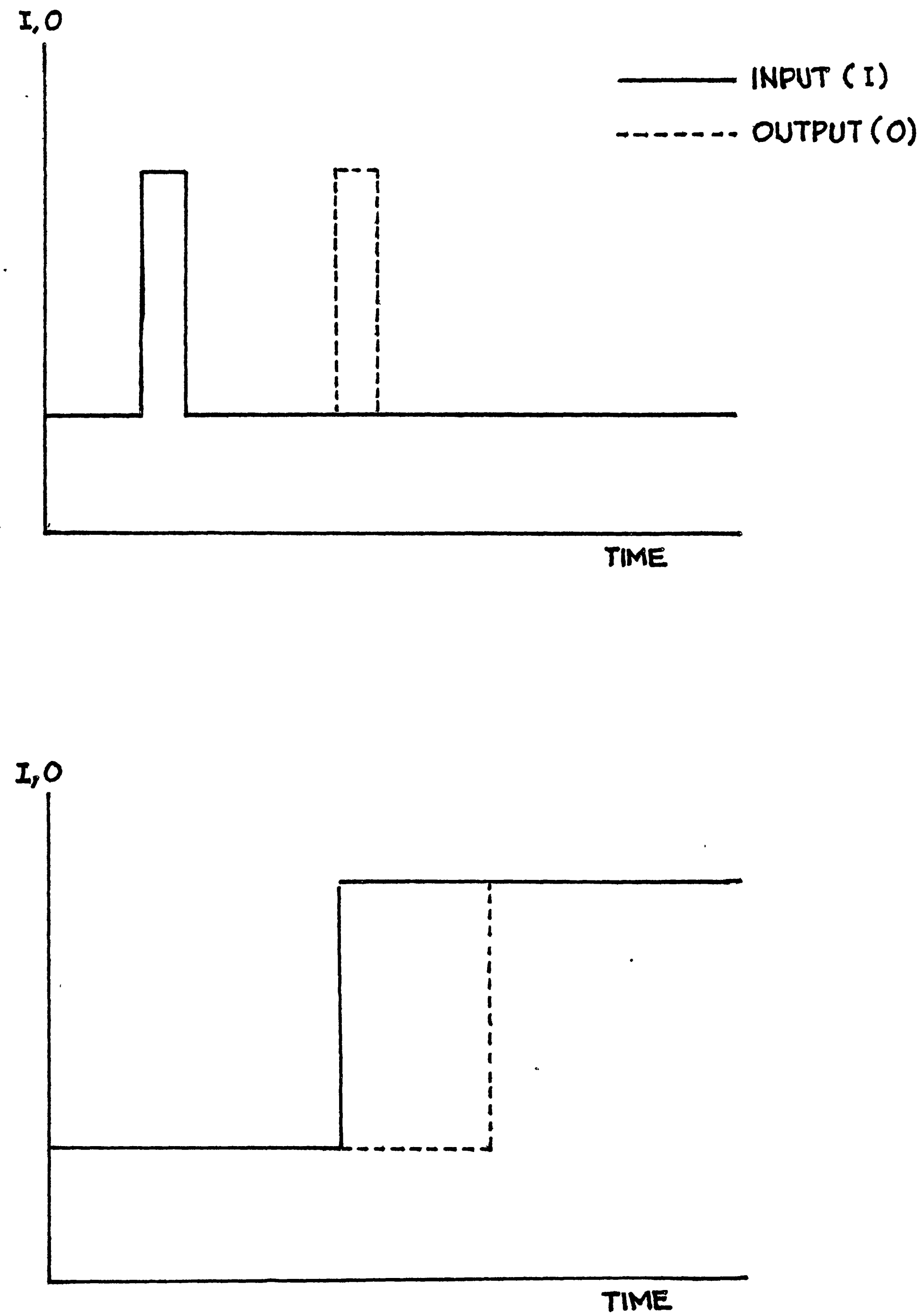


Figure 15. Illustration of Discrete Delay

J1. The second step is to move the material from each time period to the next time block. Line 30 through 50 will accomplish the second step. Line 60 takes the value for the material coming in and places it in the last block of the delay process such that it will be the last value out, which is consistent with the first-in first-out inventory method.

Deficiency Payment and Subsidy Scheme

Under the hypothetical simulation stabilization program, several proposed schemes for cow-calf and hog stabilization programs, as discussed in Chapter II, were formulated. Basically, the payment schemes modeled follow closely to the stabilization scheme formulated for the Canadian stabilization programs. Modifications were made to the basic Canadian scheme in order to explore the objective of this study. A detailed discussion of the payment schemes and their results will be discussed in Chapter IV.

Model Verification and Validation

Verification and validation of a model involves determining the level of agreement between results obtained from the model with those from the real system being simulated. Verification refers to mathematical correctness of the model in the sense that it must perform mathematical operations as intended. This is done by checking that conservation of flow is maintained and delays are correctly defined. Validation, on the other hand, refers to the model specification, that is, the model should generate results that correspond to the real world behavior.

The verification and validation of the livestock industry model to be used for this study has already been done by Ulrich (1984). He indicated that the model did perform according to expectations and it is verified. In this study the section of model verification and validation will not be discussed. Those interested can refer to Ulrich (1984) for a detailed discussion.

Summary

The above discussion summarizes the formulation of a mathematical model relating to the livestock and poultry industries and their interrelationship. Several submodels that make up the whole system have been presented. Within each of these models the basic relationships among endogenous variables, controllable variables and exogenous variables of the system are defined. Each submodel is designed so as to trace the effect of selected control variables on production, prices received produce income and demand for each of the meat categories (beef, pork and chicken).

Government income and price stabilization schemes are the primary control variables considered. They are implemented through direct support payments to producers of beef and hog so as to stabilize their ever fluctuating prices and incomes. The impact of such support payments on production decisions is analyzed through the feedback effect of the stabilization payment on the producer's profit function for beef and hogs.

Stochastic disturbances represented the uncertainties surrounding the economic activities of livestock producers injected by means of normally distributed random in the cost of production. Delay and table look-up generation function subroutines are used to simulate biological delays and the demand schedules for meat.

CHAPTER IV

MODEL SIMULATION AND ANALYSIS OF RESULTS

The objective of this chapter is to present and analyze alternative stabilization/deficiency payment schemes with regard to their effect on stability in prices, income, production and government costs. Different simulation runs were performed with different stabilization or deficiency payment schemes. The schemes and the results of the runs will be presented in this chapter. The stabilization or deficiency payment schemes considered are presented briefly as follows.

Scheme #1 is based on the basic simulation model and is run without any payment scheme. This scheme is used as a basis of comparison with the simulation run for different stabilization payment schemes. Hereafter scheme #1 will be referred to as the "base" scheme.

Scheme #2 is based on the stabilization payment scheme as suggested by the Canadian Cattlemen Association, i.e. payments for the beef sector are based on an index of moving average prices, while payments for the hog sector are based on a "guaranteed margin" approach. Hereafter scheme #2 will be referred to as the "price/margin" scheme to reflect the fact that payments for beef are based on moving average prices and payments for pork on guaranteed margins.

In scheme #3 payments are based on guaranteed profits for both the beef and hog sector, i.e. payments are equal to the amount of losses indicated by a production cost formula. Hereafter scheme #3 will be referred to as the "profit/profit" scheme reflecting the fact that profits are guaranteed for both beef and pork.

In scheme #4 payments are based on the opposite of the stabilization payment scheme as suggested by the Canadian Cattlemen Association, i.e. the payments for the beef sector are based on a "guaranteed margin" approach while the payments for the hog sector are based on indexed moving average prices. Scheme #4 will be referred to as the "margin/price" scheme.

In scheme #5 payments are based on indexed moving average of profit over 10 years for the beef sector and direct profits for the hog sector, i.e. it is similar to scheme #3 (1.2 profit/0.98 profit). Thus, if either the indexed moving average of profit for beef or direct profit for hogs is negative, payment will equal to the amount of losses indicated. Scheme #5 will be referred to as the "MA profit/profit" scheme.

Two different options were tested for both the beef and hog sectors for each of the schemes mentioned above. They are as follows: Option 1 is the stabilization or deficiency payment scheme without taxes being included in the scheme. Option 2 is the stabilization or deficiency payment scheme with taxes being included in the scheme.

The taxes referred to are taxes charged to help defray the cost of the stabilization payment scheme. The exact nature of these taxes will be discussed in detail later. Feedback of the stabilization payments and taxes from these two options will be included into the profit equation for the beef sector and replacement and culling equations for the hog sector in order to trace the effect of such payments and taxes on production, prices and income.

Descriptions of the two options can be presented as follows.

Beef Sector

Equations (102) and (103) mathematically present the two options discussed above for the beef sector.

$$BR(0) = FB - BC + SB \tag{102}$$

$$BR(0)' = FB - BC + SB - TXB \tag{103}$$

where

BR(0) = profit with stabilization payment feedback but no taxes (option 1)

BR(0)' = profit with stabilization payment feedback and with taxes (option 2)

FB = price received for beef at the farm level ($/cwt)

BC = cost of producing a 400 pound calf ($/cwt)

SB = stabilization payment ($/cwt)

TXB = taxes incurred by beef producers ($/cwt)

Equation (102) represents the profit function for option 1, where the stabilization payment is taken as part of the income or price paid to or received by producers. It is added to the profit function to see the effect of stabilization payment on income, prices and production. Since the replacement rate equation, R, and change in breeding herd equation, DB, are functions of profit, any changes in profit due to stabilization payments can be traced by the change in R and DB and consequently the production, prices and income of the producers.

Similarly equation (103) represents the profit function for option 2, where the stabilization payment is added and taxes are subtracted from the profit function. It is assumed that the stabilization payment is part of producers income and taxes as part of the expenses incurred over the years.

Hog Sector

For the hog sector, the two options can be presented as follows:

$$H1 = 0.461 - 0.134*CN + 0.0054*(FP + SP) \quad (104)$$

$$H3 = 0.466 - 0.045*CN - 0.0053*(FP + SP) \quad (105)$$

$$H1' = 0.461 - 0.134*CN + 0.0054*(FP + SP - TXH) \quad (106)$$

$$H3' = 0.466 - 0.045*CN - 0.0053*(FP + SP - TXH) \quad (107)$$

where

H1 = hog replacement equation with stabilization payment feedback and no taxes (option 1)

H3 = rate of sow culling equation with stabilization payment feedback and no taxes (option 1)

H1' = as in H1 but with tax feedback (option 2)

H3' = as in H3 but with tax feedback (option 2)

CN = corn price ($/bushel)

FP = hog farm price ($/cwt)

SP = stabilization payment ($/cwt)

TXH = taxes incurred by hog producers ($/cwt)

As in the beef stabilization payment program, the hog payment is also taken as an addition to price received by producers and taxes as expenses incurred by producers. Unlike the beef stabilization payment, the hog sector stabilization payment is not incorporated into the profit function, PIEH, because profit is not used as a variable in the hog production simulation model. Thus, in order to measure the effect of such payments and taxes on income, prices and production, the payment is incorporated into the hog replacement, H1, and culling equations, H3, through the price effects. Both of these equations have farm hog price as one of their independent variables.

General Simulation Experiment Considerations

Since 10-year moving averages for price and profit were being used as a basis of stabilization payment for scheme #2 (0.5 price/0.9 margin) and #5 (0.9 MA profit/1.0 profit), the stabilization payment and taxes could only be implemented after the tenth year of simulation. In order to be consistent with the other stabilization payment schemes, stabilization payment and taxes incurred will only be implemented onward from the eleventh year in all runs. The results for each of the schemes will be computed based on years after the eleventh year.

Two different simulation period lengths were considered, i.e. a 10-year and 90-year period length was tested. The purpose was to compare the effect of stabilization payment options 1 and 2 on prices, production, income and government cost between short and long time periods.

Both the beef and hog sectors were run simultaneously with interaction for both option 1 and option 2.

The discussion of the results will be based on several critical variables of interest. These variables are listed below.

Beef Sector

(i) direct profit without stabilization payment ($/cwt):

PIEB = FB - BC + 6.05

(ii) profit with stabilization payment added ($/cwt):

BR(0) = FB - BC + SB + 6.05

(iii) gross income with program payments ($/cow):

GIB = FB * 4.275 + PYCOW

(iv) net income with program payments ($/cow):

NIB = [BR(0)] * 4.275 + PYCOW

(v) stabilization payments ($/cow):

SPB = based on the stabilization payment scheme

(vi) total beef production (million pounds):

TB = total beef production

(vii) price received at farm level ($/cwt):

FB = price of beef at farm level

(viii) cost to government due to stabilization payment (million $):

CGOV'TB = BH * PYCOW

The cost of government is based on 100 percent participation of producers.

where

BC = cost of production of a 400 pound calf

PYCOW = payment per cow ($/cow)

4.275 = average weaning weight of heifer and steer calf with 10 percent mortality rate

6.05 = break even profit ($/cwt)

BH = beef breeding herd (million head)

The 6.05 value which appears in definition (i), (ii) and (iii) deserves some comment. The profit variable used for beef in the model are only a proxy of the true profit of beef production. While it hopefully reflects changes in beef profit over time it may not reflect the true average level of profit. Indeed the variables used indicated direct profits to beef over time were negative. By using percentage change in the breeding herd equation, which is a function of current and lagged profit, the profit level, as defined here, results in a stable breeding herd size that can be calculated:

$$DB = 2.027 + 0.258 * PROFIT + 0.107 * PROFIT_{-1} \quad (108)$$

Set DB = 0 and assume lagged profits equal current profits and solve for PROFIT:

$$0 = 2.207 + 0.365 * PROFIT \quad (109)$$

$$0.365 * PROFIT = -2.207 \quad (110)$$

$$PROFIT = -6.05 \quad (111)$$

Therefore the value 6.05 is added to the profit figure to place it on a normalized profit basis where zero profit is thought of as generating no change in the beef supply.

This same basic concept is also used to define a normal profit level for hogs, i.e. zero profit implies stable production. Variables used to report the results for the hog sector are the following.

Hog Sector

(i) direct profit without stabilization payment added ($/cwt):

PIEH = FP - ACC

(ii) profit with stabilization payment added ($/cwt):

PPYH = PIEH + SPH

(iii) gross income with program ($/cwt per year):

GIH = SPH + FP

(iv) net income with program payments ($/cwt):

NIH = FP - ACC + SPH

also equivalent to profit with payment

(v) stabilization payments ($/cwt):

SPH = depend on the stabilization payment scheme

(vi) total pork production (million pounds):

TP = total pork production

(vii) price received at farm level ($/cwt):

FP = price of hog at farm level

(viii) cost to government due to stabilization payment (million $):

CGOV'TH = SPH * 2.2 * 14.4 * SH

The cost to government is based on 100 percent participation.

where

SH = swine breeding herd (million head)

2.2 = average weight of matured hog in cwt

14.4 = average number of pigs produced per year per brood sow

Since the stabilization payment value SPH is based on a $/cwt of slaughter, stabilization payment SPH needs to be multiplied by the number of pigs produced per year times their slaughter weight in hundreds of pounds, i.e. 2.2. Pigs produced per year is equal to the number of brood sow, SH, times pigs per sow per year which is 14.4.

Description of Stabilization or Deficiency Payment Schemes and Its Results: For Option 1, Tenth and Ninetieth Year Run

Scheme #1 (Base)

This scheme was based on a basic livestock simulation model developed by Ulrich. No stabilization payment scheme was included in the model. The results generated from this scheme will be used as a basis for comparison to the simulation runs that include the different stabilization payment schemes discussed earlier.

Two options were run for scheme #1 (base). The first option was without any random generator function being included to generate randomness of input costs. The second option included a random generator function in the simulation runs. It is assumed that the inclusion of a random generator function will take into account stochastic disturbances that represent uncertainty surrounding the economic activities. It should be noted that stabilization payment schemes #2 (0.5 price/0.9 margin) through #5 (0.9 MA profit/1.0 profit) were run with the random generator function operating.

Simulation Results for Scheme #1 (Base)

Beef Sector for 10- and 90-Year Averages. Comparison between the random and non-random options can be seen clearly from Tables III and IV, and Figures 16, 17, 18 and 19. Figures 16, 17, 18 and 19 present the beef production and price received over 25 and 100 years respectively. As indicated in Table III, the values of the level of profit, gross income, net income, and prices were slightly lower on the

TABLE III

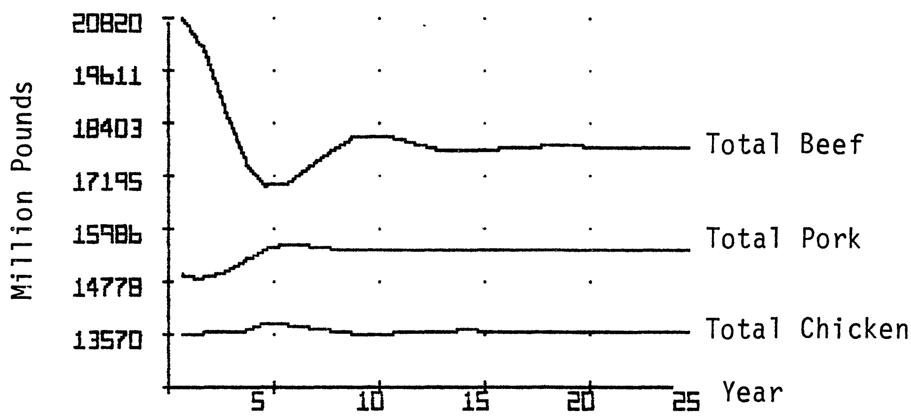
SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #1 FOR BEEF SECTOR, RANDOM AND NON-RANDOM 10-YEAR AVERAGE, OPTION 1

Variables	Non-Random (10-Year Average)	Random (10-Year Average)
Level of Direct Profit		
$/cwt per year	-0.096	0.46
standard deviation	2.206	5.225
Level of Gross Income		
$/cow per year	332.665	335.351
standard deviation	8.854	16.019
Level of Net Income		
$/cow per year	-0.409	1.968
standard deviation	9.429	22.335
Level of Stabilization Payment		
$/cwt per year	0	0
standard deviation	0	0
Level of Production		
million pounds per year	17,909.040	17,766.340
standard deviation	369.492	540.219
Level of Price Received		
$/cwt per year	77.816	78.445
standard deviation	2.071	3.747
Cost to Government		
million dollars per year	0	0
standard deviation	0	0

TABLE IV

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #1 FOR BEEF SECTOR, RANDOM AND NON-RANDOM 90-YEAR AVERAGE, OPTION 1

Variables	Non-Random (90-Year Average)	Random (90-Year Average)
Level of Direct Profit		
$/cwt per year	-0.007	-0.065
standard deviation	0.191	4.654
Level of Gross Income		
$/cow per year	332.999	333.094
standard deviation	0.788	14.740
Level of Net Income		
$/cow per year	-0.030	-0.277
standard deviation	0.815	19.896
Level of Stabilization Payment		
$/cwt per year	0	0
standard deviation	0	0
Level of Production		
million pounds per year	17,895.941	17,809.024
standard deviation	30.191	409.684
Level of Price Received		
$/cwt per year	77.894	77.917
standard deviation	0.184	3.448
Cost to Government		
million dollars per year	0	0
standard deviation	0	0



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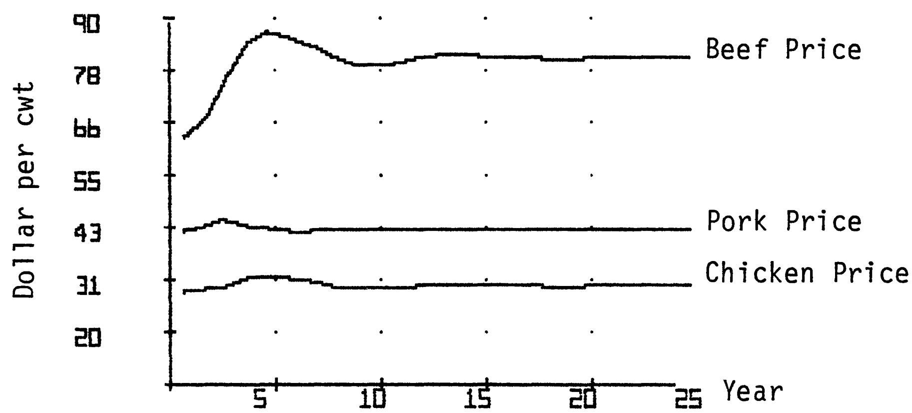
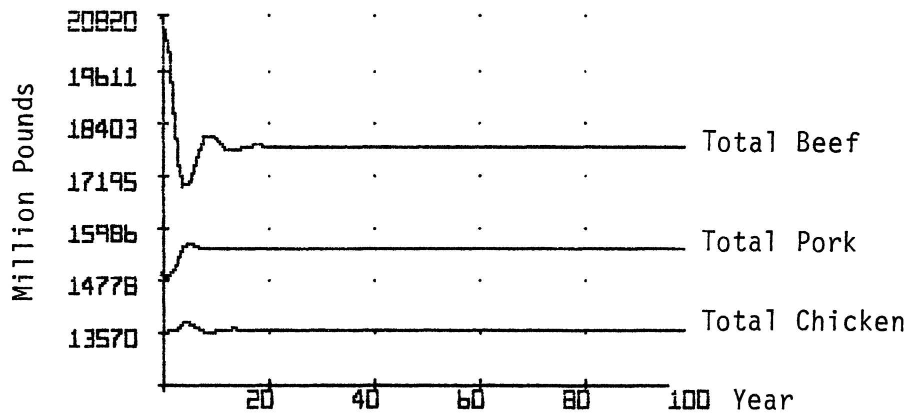


(b)

Figure 16(a). Beef, Pork and Chicken Production Without Random Generating Function for Scheme #1, Option 1, Over 25 Years

(b). Beef, Pork and Chicken Prices Without Random Generating Function for Scheme #1, Option 1, Over 25 Years



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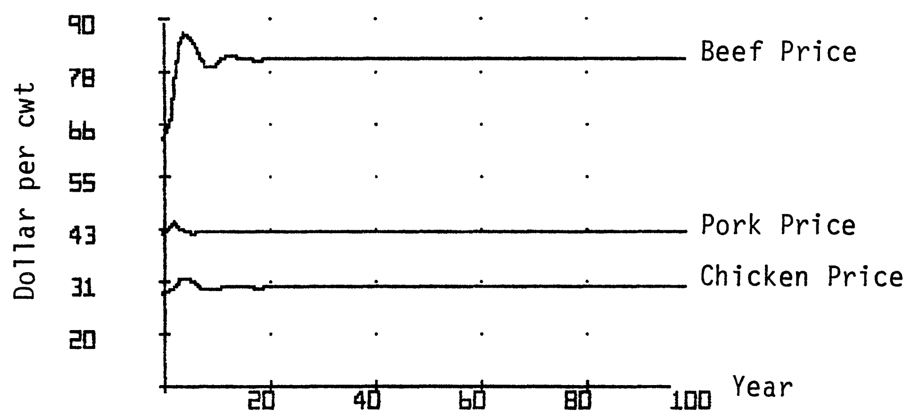
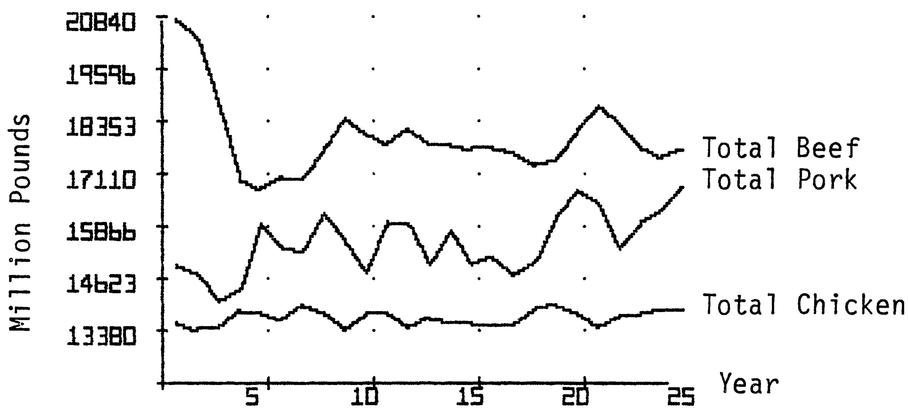


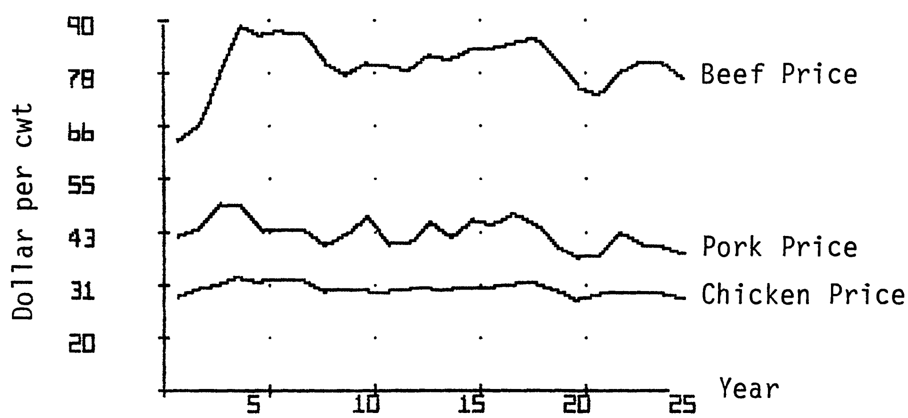
(b)

Figure 17(a). Beef, Pork and Chicken Production Without Random Generating Function for Scheme #1, Option 1, Over 100 Years

(b). Beef, Pork and Chicken Prices Without Random Generating Function for Scheme #1, Option 1, Over 100 Years



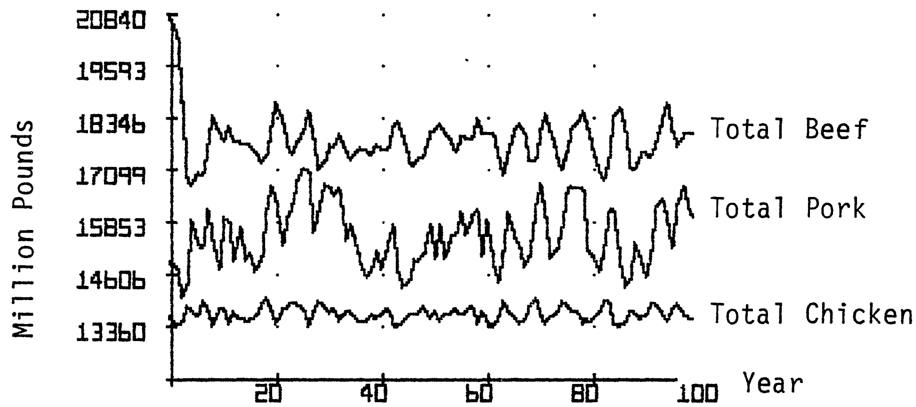
(a)



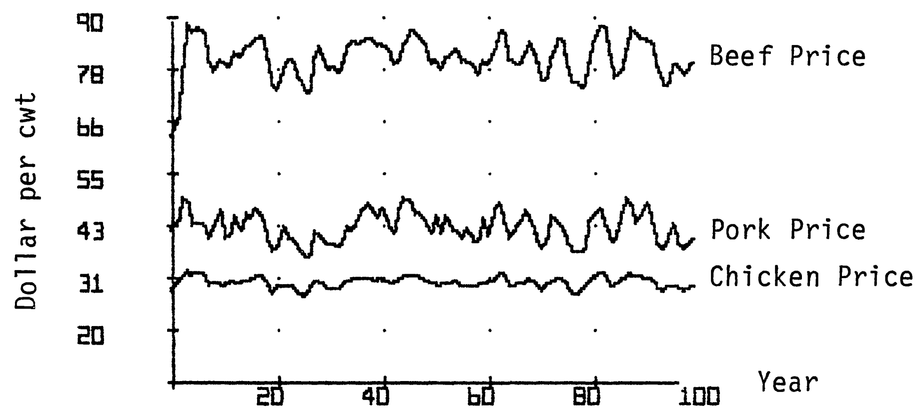
(b)

Figure 18(a). Beef, Pork and Chicken Production With Random Generating Function for Scheme #1, Option 1, Over 25 Years

(b). Beef, Pork and Chicken Prices With Random Generating Function for Scheme #1, Option 1, Over 25 Years



(a)



(b)

Figure 19(a). Beef, Pork and Chicken Production With Random Generating Function for Scheme #1, Option 1, Over 100 Years

(b). Beef, Pork and Chicken Prices With Random Generating Function for Scheme #1, Option 1, Over 100 Years average for non-random options over the 10-year period considered. Similarly the absolute variability was much lower for the non-random option as shown by the standard deviation. This is an indication that the non-random option was more stable than the random option. However, the production figure was higher for the non-random option with slightly lower absolute variability.

From Figure 17 it can be seen that the instability in the non-random option only occurred between period 1 and period 20. After period 20 the model had reached a long-run equilibrium condition. It can be assumed that after period 20 the variability of all variables is approximately zero.

Differences observed between the mean values for the random and non-random runs, given the variance present in the model are interpreted as insignificant and due to randomness and the period observed. For the 10-year average the random option generates approximately twice as much variability as the non-random option, as shown by the standard deviation on profit, gross income and net income. This is partly due to the fact that the non-random option model was able to stabilize the production and price at a faster rate as compared with the random option model which did not show any sign of stabilizing during the 90 years simulated (see Figures 18 and 19).

The average income and price over the 90-year simulated period were slightly higher for the non-random option, although in both options profit and net income were negative. On the other hand, gross income and production were slightly lower for the non-random option. In general, absolute variability over the 90-year period considered was much lower for the non-random option as expected. Table IV presents the comparative results for the non-random and random options averaged over 90 years for beef. Figures 17 and 19 graphically represent the non-random and random options for production and price received over 100 years. The figures indicated that variability of non-random option over the 90-year period was mostly due to the variability in the tenth to the twentieth year of the time tested.

Hog Sector for 10- and 90-Year Averages. As in the beef sector, similar estimated effects can be seen for the hog sector for both the random and non-random options. As indicated in Table V, the non-random option generates slightly lower values for level of gross income and prices but slightly higher values for level of profit and production over the 10-year average. The absolute variability as shown by the standard deviation was much lower for the non-random option in every aspect. This can also be seen in Figures 16 and 17. The instability of the non-random option subsides after six to eight years when the model reaches a long-run steady state equilibrium. Variability thereafter was approximately zero as in the beef sector.

Similarly the average profit over 90 years for both options as shown in Table VI were negative and could be considered zero for the non-random option. Prices for pork and production of pork were slightly lower for the non-random option. However, the absolute variability, as shown by standard deviation, was much lower for the non-random option. Thus a state of stability could be achieved with the non-random option, while variability and uncertainty still prevail for the random option as shown by Figures 18 and 19.

If one examines Figures 16 and 17 closely it can be seen that absolute stability of production, price, income and profit occurred

TABLE V

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #1 FOR HOG SECTOR, RANDOM AND NON-RANDOM 10-YEAR AVERAGE, OPTION 1

Variables	Non-Random (10-Year Average)	Random (10-Year Average)
Level of Direct Profit		
$/cwt per year	0	0.148
standard deviation	0.351	4.918
Level of Gross Income		
$/cwt per year	41.788	42.122
standard deviation	0.002	3.154
Level of Net Income		
$/cwt per year	0	0.148
standard deviation	0.351	4.918
Level of Stabilization Payment		
$/cwt per year	0	0
standard deviation	0	0
Level of Production		
million pounds per year	15,548.335	15,534.436
standard deviation	189.836	719.045
Level of Price Received		
$/cwt per year	41.788	42.122
standard deviation	0.351	3.154
Cost to Government		
million dollars per year	0	0
standard deviation	0	0

TABLE VI

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #1 FOR HOG SECTOR, RANDOM AND NON-RANDOM 90-YEAR AVERAGE, OPTION 1

Variables	Non-Random (90-Year Average)	Random (90-Year Average)
Level of Direct Profit		
$/cwt per year	-0.000096	0.075
standard deviation	0.005	19.896
Level of Gross Income		
$/cwt per year	41.789	41.826
standard deviation	0.005	3.209
Level of Net Income		
$/cwt per year	-0.000096	-0.075
standard deviation	0.005	4.526
Level of Stabilization Payment		
$/cwt per year	0	0
standard deviation	0	0
Level of Production		
million pounds per year	15,547.716	15,621.875
standard deviation	1.215	734.629
Level of Price Received		
$/cwt per year	41.789	41.826
standard deviation	0.0055	3.209
Cost to Government		
million dollars per year	0	0
standard deviation	0	0

only after the fortieth year and onward for both the beef and hog sectors. Tables VII and VIII present the summary of the average of every other tenth year period for the beef and hog sectors respectively. Thus without any stochastic disturbances to account for any uncertainty surrounding the production process and management strategy, total stability is achieved within approximately 40 years. Such a condition does not represent the actual environment condition surrounding the livestock industry. Thus any program with the objective of stabilizing the livestock industry when tested with the non-random model will not result in a realistic analysis due to the fact that the model will stabilize itself. In order to combat this problem and to measure the effect of different stabilization payment programs on the livestock industry, stochastic disturbances were introduced through a normal random number generating function and historical trend of randomness incorporated into the corn (CN) price and cost of production (BC) variables used in the model. As indicated in Chapter III these two variables made up approximately 90 percent of the production cost encountered by producers. The generated stochastic disturbances are assumed to measure the uncertainty surrounding the livestock industry.

As indicated earlier the discussion of stabilization payment schemes #2 (0.5 price/0.9 margin) through #5 (0.9 MA profit/1.0 profit) will be based on the results obtained from the simulation model runs with the random number generator function. This approach provides a method to realistically study the impact of different stabilization payment schemes on the cyclical behavior of production, prices and income of the livestock industry. The remainder of this chapter

TABLE VII

SUMMARY OF THE ESTIMATED EFFECT OF STABILITY OF SCHEME #1 ON PRODUCTION, PRICES, INCOME AND PROFIT FOR BEEF SECTOR FOR EVERY OTHER 10-YEAR AVERAGE, OPTION 1

Variables	First 10 Years	Second 10 Years	Fourth 10 Years	Sixth 10 Years	Eighth 10 Years	Tenth 10 Years
Level of Direct Profit						
$/cwt per year	-2.211	-0.126	0.005	0.003	0.003	0.003
standard deviation	8.031	2.206	0.005	0.0	0.0	0.0
Level of Gross Income						
$/cow per year	324.201	332.665	333.045	333.037	333.037	333.037
standard deviation	33.395	8.854	0.024	0.001	0.0	0.0
Level of Net Income						
$/cow per year	-9.452	-0.409	0.022	0.015	0.015	0.015
standard deviation	34.331	9.429	0.023	0.001	0.0	0.0
Level of Stabilization Payment						
$/cwt per year	0	0	0	0	0	0
standard deviation	0	0	0	0	0	0
Level of Production						
million pounds/year	18,264.931	17,909.040	17,893.298	17,893.569	17,893.573	17,893.573
standard deviation	1,343.323	369.492	0.880	0.041	0.0	0.0
Level of Price Received						
$/cwt per year	75.837	77.816	77.905	77.903	77.903	77.903
standard deviation	7.812	2.071	0.006	0.0	0.0	0.0
Cost to Government						
million dollars/year	0	0	0	0	0	0
standard deviation	0	0	0	0	0	0

TABLE VIII

SUMMARY OF THE ESTIMATED EFFECT OF STABILITY OF SCHEME #1 ON PRODUCTION, PRICES, INCOME AND PROFIT FOR HOG SECTOR FOR EVERY OTHER 10-YEAR AVERAGE, OPTION 1

Variables	First 10 Years	Second 10 Years	Fourth 10 Years	Sixth 10 Years	Eighth 10 Years	Tenth 10 Years
Level of Direct Profit						
$/cwt per year	0.351	0.0	0.0	0.0	0.0	0.0
standard deviation	0.969	0.351	0.01	0.0	0.0	0.0
Level of Gross Income						
$/cwt per year	43.138	41.788	41.788	41.788	41.788	41.788
standard deviation	0.969	0.351	0.001	0.0	0.0	0.0
Level of Net Income						
$/cwt per year	0.351	0.0	0.0	0.0	0.0	0.0
standard deviation	0.969	0.351	0.0	0.0	0.0	0.0
Level of Stabilization Payment						
$/cwt per year	0	0	0	0	0	0
standard deviation	0	0	0	0	0	0
Level of Production						
million pounds/year	15,358.595	15,548.335	15,547.629	15,547.612	15,547.613	15,547.613
standard deviation	369.993	189.836	0.188	0.001	0.0	0.0
Level of Price Received						
$/cwt per year	42.138	41.788	41.788	41.788	41.788	41.788
standard deviation	0.969	0.351	0.001	0.0	0.0	0.0
Cost to Government						
million dollars/year	0	0	0	0	0	0
standard deviation	0	0	0	0	0	0

TABLE IX

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #1 FOR BEEF SECTOR WITH RANDOM EFFECTS, OPTION 1

Variables	10-Year Average	90-Year Average
Level of Direct Profit		
$/cwt per year	0.46	-0.065
standard deviation	5.225	4.654
Level of Gross Income		
$/cow per year	335.351	333.094
standard deviation	16.019	14.740
Level of Net Income		
$/cow per year	1.968	-0.277
standard deviation	22.335	19.896
Level of Stabilization Payment		
$/cwt per year	0	0
standard deviation	0	0
Level of Production		
million pounds per year	17,766.340	17,809.024
standard deviation	540.219	409.684
Level of Price Received		
$/cwt per year	78.445	77.917
standard deviation	3.747	3.448
Cost to Government		
million dollars per year	0	0
standard deviation	0	0

TABLE X

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #1 FOR HOG SECTOR WITH RANDOM EFFECTS, OPTION 1

Variables	10-Year Average	90-Year Average
Level of Direct Profit		
$/cwt per year	0.148	-0.075
standard deviation	4.918	19.896
Level of Gross Income		
$/cwt per year	42.122	41.826
standard deviation	3.154	3.209
Level of Net Income		
$/cwt per year	0.148	-0.075
standard deviation	4.918	4.526
Level of Stabilization Payment		
$/cwt per year	0	0
standard deviation	0	0
Level of Production		
million pounds per year	15,534.436	15,621.875
standard deviation	719.045	734.629
Level of Price Received		
$/cwt per year	42.122	41.826
standard deviation	3.154	3.209
Cost to Government		
million dollars per year	0	0
standard deviation	0	0

summarizes the estimated effects of four alternative stabilization payment programs.

Scheme #2 (Profit/Margin)

Stabilization Payment Scheme for Beef Sector. The support price for the cow-calf program is based on an index of moving average prices, BMA, for calves which is defined as the national average market price for calves in the preceding 10 years adjusted for inflation. Payment will be based on the number of cows in the herd but first will be calculated on a per cwt of calf basis and then converted to a per cow basis. Thus, in any year that the market price (FB) for calves falls below the indexed moving average price, the payment per cwt of calf will be equal to 50 percent of the indexed moving average minus the market price. Thus, if the market price is above the BMA, no payment will be made. Mathematically, the scheme can be presented as follows:

$$SPB = 0.5 * (BMA - FB) \tag{112}$$

$$\text{IF } SPB \leq 0 \text{ THEN } SPB = 0 \tag{113}$$

i.e. FB > BMA, NO PAYMENT

$$PYCOW = [0.9 * (4.5 + 5.0)/2] * SB \tag{114}$$

where

SPB = stabilization or deficiency payment ($/cwt)

BMA = 10 year farm level beef price moving average ($/cwt)

FB = farm level beef price ($/cwt)

PYCOW = stabilization payment (per cow basis)

The values 4.5 and 5.0 are the assumed weaning weights (in cwt) for heifer and steer calves respectively. The payment per cow (PYCOW) is based on the average weight of these two animals. The value 0.9 is the assumed percentage of animals weaned and sold with the assumption that there is a 10.0 percent mortality rate.

From the above equations, if the farm beef price (FB) is above the 10-year moving average of the farm beef price no payment will be made to producers. Producers will receive the market price without any restriction on ceiling prices. On the other hand, if FB is lower than BMA, then 50 percent of the difference will be paid to producers as a stabilization payment. In order to calculate total payment per cow, SPB is multiplied by the conversion factor discussed in Chapter II. In cases where FB is equal to BMA, no payment will be made. As indicated earlier, a 10-year moving average of price was used to calculate the stabilization payment for beef sector, thus the program and payment will only start after the tenth year of the simulation run.

Stabilization Payment Scheme for Hog Sector. Under scheme #2 (0.5 price/0.9 margin) stabilization payments for hog producers are based on a "guaranteed margin" approach. Support price for a quarter will be equal to cash cost in the current quarter plus 90 percent of the margin of the same quarter of the preceding eight years. The margin of any quarter is equal to the national average market price for the quarter minus the national average cash costs in the quarter. The determination of the stabilization payment in any quarter is based on market price and support price. Thus, in any quarter that the market price falls below support price, the stabilization payment per cwt will be equal to the support price for the quarter minus the average market price for the quarter. The above stabilization payment can be presented as follows:

$$PIEH = FPq - ACCq \qquad (115)$$

$$SUPHq = ACCq + (0.90 * HMAq) \tag{116}$$

$$SPHq = SUPHq - FPq \tag{117}$$

$$\text{IF } SPHq \leq 0 \text{ THEN } SPHq = 0 \tag{118}$$

i.e. FPq > SUPHq, NO PAYMENT

$$\text{IF } SPHq > 0 \text{ THEN } SPHq = SPHq \tag{119}$$

where

PIEH = margin for any quarter ($/cwt)

FPq = farm hog price for the quarter ($/cwt)

ACCq = average cash feeding cost for the quarter ($/cwt)

SUPHq = support price for the quarter ($/cwt)

HMAq = eight year moving average of HMq for the same quarter ($/cwt)

SPHq = stabilization payment for the quarter ($/cwt)

For the above equations, payment will only start after 10 simulated years in order to be consistent with the beef sector. For reporting purposes the quarterly payments are converted into an annual figure by summing up the four quarters in each year.

Since no cost of production variable exists for pork in the model, the average cash cost in the quarter was estimated by using the following equation:

$$ACC = 0.4673 + 16.729 * CN \tag{120}$$

where

ACC = average cash feeding cost ($/cwt)

CN = corn price ($/bushel)

Equation (120) was mathematically deduced from the culling and replacement equations in a manner similar to that previously explained for beef. It was assumed that when the culling rate was equal to the replacement rate the industry was in equilibrium with average revenue equal to the cost of production, hence average total cost equals average total revenue which in turn equals the farm price for hogs. If the replacement rate equation is set equal to the culling rate equations and FP, the farm price is taken to represent cost per unit, cost per unit can be solved for as a function of corn price (CN). The derivation of average total cost of production estimates can be presented as follows:

$$H1 = 0.461 - 0.134 * CN + 0.0054 * FP \quad (121)$$

$$H3 = 0.466 + 0.045 * CN - 0.0053 * FP \quad (122)$$

Equate equations (121) to (122) and solve for FP:

$$0.461-0.134*CN+0.0054*FP = 0.466-0.0045*CN-0.0053*FP \quad (123)$$

$$0.0107 * FP = 0.005 + 0.179 * CN$$

$$FP = (0.005 + 0.179 * CN)/0.0107$$

$$FP = 0.4673 + 16.729 * CN$$

where

H1 = replacement rate per sow/month

H3 = rate of culling per brood sow/month

CN = corn price ($/bushel)

FP = farm level hog price ($/cwt)

Simulation Results for Scheme #2 (0.5 Price/0.9 Margin)

Beef Sector for 10- and 90-Year Averages. Beef stabilization payments under scheme #2 (0.5 price/0.9 margin), on the average, were relatively insignificant. The average payment per year was only $0.82/cwt per year over the first 10 years of the stabilization payment scheme being implemented. This is an indication that the market price during the tested years on average were above the 10-year moving average (BMA).

Table XI presents the results of scheme #2's (0.5 price/0.9 margin) average over 10 and 90 years. The results in Table XI indicated that the level of profit over the 10-year average was slightly negative for direct profit but positive for profit with payment. The average level of stabilization payments of $0.82/cwt per year was significant enough to generate positive profits with payment versus without payments. Similarly the direct profit and profit with payment over the 90-year period also follow the same pattern as the 10-year average but with slightly higher values. Thus, the stabilization payment of $0.84/cwt per year on average was able to generate positive profit.

The level of net income with payment was $2.22/cwt per year on average over the 10-year period considered with an absolute variability of $22.30/cwt per year. This level of variability represents a reduction of only approximately $0.04/cwt per year from scheme #1 (base) which has no stabilization payment (see Table III). The net income generated over the 90-year period was negative on average and fell to $-0.70/cwt per year from the 10-year average. However, the absolute variability of the net income as shown by standard deviation was reduced by approximately 21 percent from the 10-year average which is an indication that in the long run the net income was slightly more stable.

In terms of the level of production, the average level of production over the 10-year period after the stabilization payment

TABLE XI

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #2 FOR BEEF SECTOR, OPTION 1

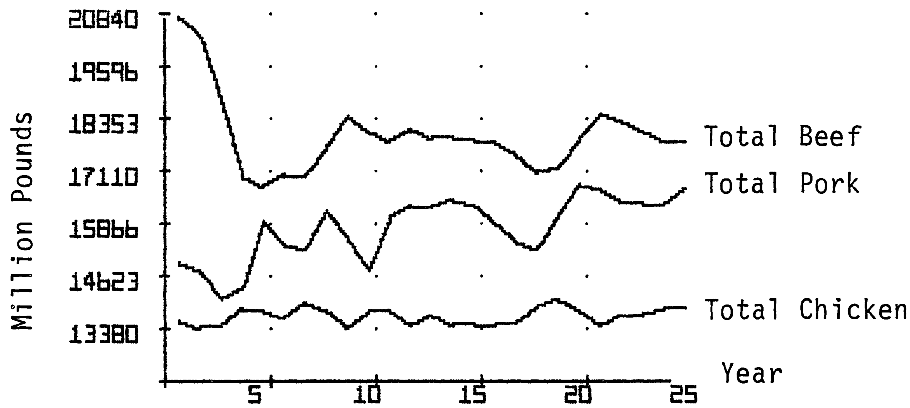
Variables	10-Year Average	90-Year Average
Level of Direct Profit		
$/cwt per year	-0.306	-1.001
standard deviation	5.278	4.608
Level of Profit with Payment		
$/cwt per year	0.493	0.164
standard deviation	5.164	4.072
Level of Gross Income		
$/cow per year	335.630	332.655
standard deviation	13.461	12.748
Level of Net Income		
$/cow per year	2.215	-.698
standard deviation	22.296	17.589
Level of Stabilization Payment		
$/cwt per year	0.824	0.838
standard deviation	1.069	0.996
Level of Production		
million pounds per year	17,712.256	17,788.207
standard deviation	602.067	425.685
Level of Price Received		
$/cwt per year	77.686	76.976
standard deviation	3.257	3.624
Cost to Government		
million dollars per year	122.348	125.059
standard deviation	158.607	149.412

scheme has been implemented was slightly lower as compared with the average over 90 years, i.e. an increase of approximately 76 million pounds/year on average over the 90-year period. However, the price received moves in the opposite direction to the production. The price received on average was $77.69 and $77.97/cwt per year for the 10- and 90-year periods respectively.

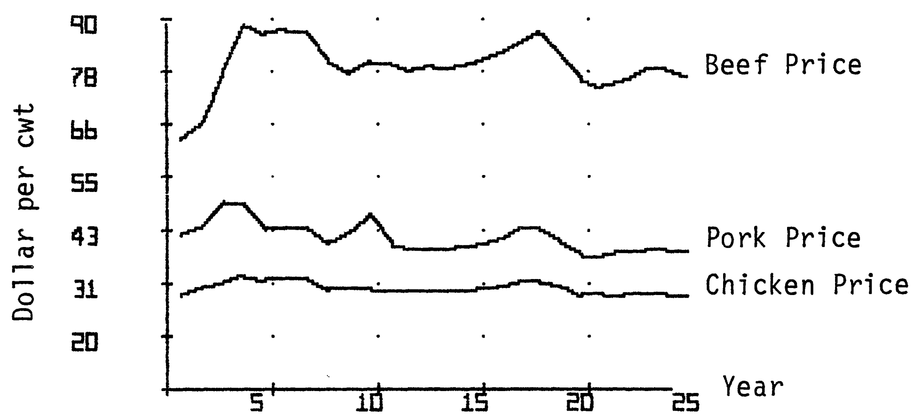
On average the 90-year period does generate a stabilizing effect on income and production as compared with the 10-year period. The absolute variability of production, as shown by standard deviation, over the 90-year period versus 10 years was reduced by approximately 30 percent or 176.4 million pounds/year. On the other hand, the market price variability was slightly higher on average for 90 years versus 10 years by $0.37/cwt per year.

Since the purpose of this study was to search for stabilization payment schemes that would stabilize producers' income, production and prices received, it is concluded that scheme #2 (0.5 price/0.9 margin) did not adequately fulfill this requirement. This can be seen from Figures 20 and 21 which present the production level and prices for beef over 25 and 100 year periods respectively. The figure shows that the production and prices received by producers still fluctuate very similarly to the patterns seen in Figures 18 and 19 for the base run in scheme #1 (base) over the period tested.

Hog Sector for 10- and 90-Year Averages. Hog stabilization payment programs were run simultaneously with the beef stabilization payment scheme. Table XII presents the estimated effect of the stabilization payment program for the hog sector for 10- and 90-year periods. On the average the level of direct profit (HM) was



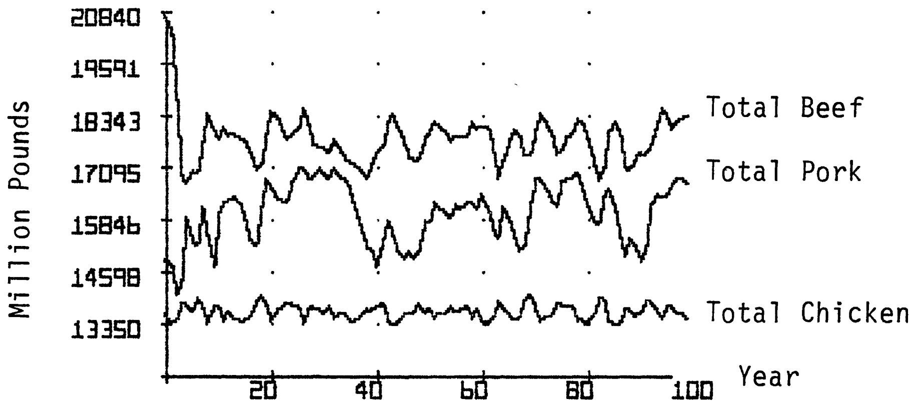
(a)



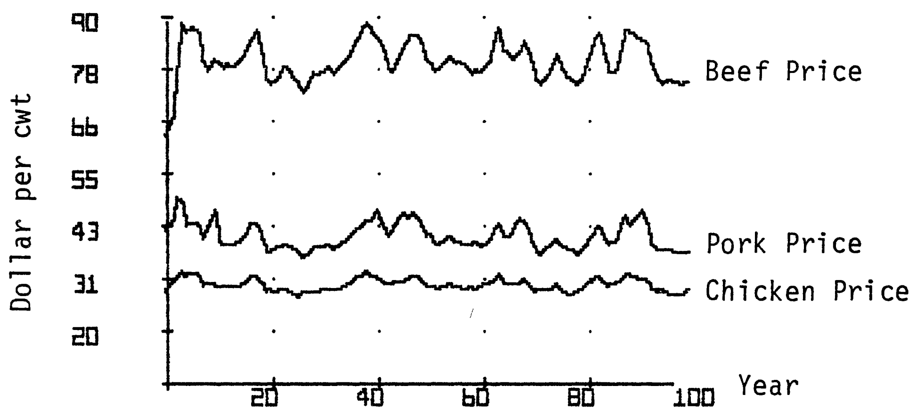
(b)

Figure 20(a). Beef, Pork and Chicken Production for Scheme #2, Option 1, Over 25 Years

(b). Beef, Pork and Chicken Prices for Scheme #2, Option 1, Over 25 Years



(a)



(b)

Figure 21(a). Beef, Pork and Chicken Production for Scheme #2, Option #1, Over 100 Years

(b). Beef, Pork and Chicken Prices for Scheme #2, Option 1, Over 100 Years

TABLE XII

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #2 FOR HOG SECTOR, OPTION 1

Variables	10-Year Average	90-Year Average
Level of Direct Profit		
$/cwt per year	-2.218	-2.101
standard deviation	5.801	4.414
Level of Profit with Payment		
$/cwt per year	0.307	0.019
standard deviation	2.808	2.461
Level of Gross Income		
$/cwt per year	42.281	41.919
standard deviation	2.838	2.703
Level of Net Income		
$/cwt per year	0.307	0.019
standard deviation	2.808	2.461
Level of Stabilization Payment		
$/cwt per year	2.525	2.120
standard deviation	4.084	2.599
Level of Production		
million pounds per year	16,099.932	16,136.187
standard deviation	1,003.309	640.773
Level of Price Received		
$/cwt per year	39.756	39.799
standard deviation	3.906	2.552
Cost to Government		
million dollars per year	561.946	475.402
standard deviation	910.036	587.664

negative with a value of $-2.22 and $-2.10/cwt per year for both the 10-year and 90-year average respectively. However, when payments are added, positive net income is generated for both periods. The net income with payments generated was much higher on average over the 10-year period with a value of $0.31/cwt per year as compared with $0.02/cwt per year on average over the 90-year period, or a reduction of almost 94 percent or $0.29/cwt per year. Comparatively the scheme without stabilization payment, i.e. scheme #1 (base), also generates negative profit on average over 90 years but positive profit in the shorter period of 10 years.

Although the 10-year average generates higher net income with payment as compared with the 90-year average, the 90-year average period generates a more stable income as indicated by the standard deviations of $2.46 and $2.81/cwt per year for the 90- and 10-year averages respectively.

The level of production (TP) per year was slightly lower on average for the 10-year period. The 10-year production average was almost 36 million pounds/year less than the 90-year average. The standard deviation was reduced to 640.8 million pounds/year over the 90-year period as compared with 1003.3 million pounds/year over the 10-year period, the implication being that the stabilization effects of the scheme take time to occur over a relatively longer period after the implementation of stabilization payment.

Similarly the price received (FP) was more stable over the 90-year period as indicated by a reduction of the standard deviation of price from $3.91/cwt per year for 90 years to $2.55/cwt per year for over 10 years. Reduction of variability of production and prices could be achieved over the 90-year period after the implementation of the stabilization payment scheme. However, as shown in Figure 21, the scheme was not able to dampen the fluctuation in production and prices for both the beef and hog sectors.

Summary on Cost to the Government for Both Beef and Hog Sectors for Scheme #2 (0.5 Profit/0.9 Margin)

Overall the cost to government to implement stabilization payment programs as described in scheme #2 (0.5 profit/0.9 margin) for the hog sector was five times larger than for the beef sector. On average the cost to the beef sector over the 10-year period was slightly lower than the 90-year period, but the opposite was true for the hog sector. This could be due to higher stabilization payment (SPH) incurred for the hog sector over the 10-year period on average. Total cost to government would have been $639.2 (122.3 + 516.9) million per year and $600.4 (125.0 + 475.4) million per year on average for both beef and hog sectors over 10- and 90-year averages respectively.

In general the program costs were relatively small, but so to were the results. The beef program costs as a percent of the gross value of beef produced were about one percent, while the pork costs were about eight percent of the gross value produced. Thus the "guaranteed margin" approach used for hog would appear to be more expensive and perhaps more effective than the indexed moving average price approach used for beef.

One of the hypothesized negative outcomes of the subsidy provided through scheme #2 (0.5 profit/0.9 margin) did not occur to any degree.

It was hypothesized that the increased profits generated by the payment would stimulate beef and pork production. In turn this would drive market prices for beef and pork down and lead to a very expensive program. This did not happen. To some degree pork production did rise as shown by the 90-year average.

One reason the hypothesized response of simulated production may not have occurred to the degree expected or representative of reality may be due to the fact that the price response parameter used describe historic producer responses to price changes when no stabilization programs were in effect. The use of these parameters in this model implicitly assumes that producers will respond to subsidized prices in the same manner that they have to non-subsidized prices. This may not be the case. It would appear logical to hypothesize that producers would react less to price decreases if they know subsidies will be given to offset them. Likewise, firms can expend during periods of rising prices with no fear that later on they may encounter larger losses if prices fall. This study has not attempted to quantify any differences in producers' responses to price and/or profit with or without stabilization programs.

Scheme #3 (Profit/Profit)

Stabilization Payment Scheme for Beef Sector. Scheme #3 (1.2 profit/0.98 profit) is based on guaranteed profits for both beef and hogs. In this scheme, if profit is negative, the support payment will be equal to 1.2 the amount of negative profit. However, if the profit is positive, no payment will be made. Such a scheme can be presented as follows:

$$BR(0) = FB - BC + SPB \tag{124}$$

$$\text{IF } BR(0) < 0 \text{ THEN } SPB = 1.2 * |-BR(0)| \tag{125}$$

$$\text{IF } BR(0) \geq 0 \text{ THEN } SPB = 0 \tag{126}$$

where

BR(0) = profit with stabilization payment ($/cwt)

FB = farm beef price ($/cwt)

BC = cost of production of 400 pound calf ($/cwt)

SPB = stabilization payment ($/cwt)

From the above equation if producers incurred a loss in any period, the stabilization payment issued will be 1.2 times the amount of losses. In order to measure the effect of the stabilization payment (SPB) on the beef producers' responses, the profit with payment variable [BR(0)] was used in all decision equations, i.e. culling and replacement equations. Since it was assumed that stabilization payments are a part of income to producers, it is appropriate to use BR(0) as a decision variable and as a feedback variable in the model.

Stabilization Payment Scheme for Hog Sector. Similarly stabilization payment for the hog sector under scheme #3 (1.2 profit/ 0.98 profit) was also based on the profit function. The payment can be represented as follows:

$$PIEH = FP - ACC \tag{127}$$

$$\text{IF } PIEH < 0 \text{ THEN } SPH = 0.98 * |-PIEH| \tag{128}$$

$$\text{IF } PIEH \geq 0 \text{ THEN } SPH = 0 \tag{129}$$

where

PIEH = margin for hog sector ($/cwt)

FP = farm level hog price ($/cwt)

ACC = average cash feeding cost ($/cwt)

SPH = stabilization payment for hog producer ($/cwt)

The value 0.98 was used to calculate the stabilization payment for hog producers because in most cases a positive profit was generated by the hog sector. Thus a stabilization payment was based only on 98 percent of the negative margin. The profit or margin for the hog sector does not include stabilization payment as in the beef sector.

It should be noted that the values of 1.2 and 0.98 were chosen in this scheme for calculating the stabilization payment because these coefficients generated more stable prices and production for both the beef and hog sectors than several other combinations tested.

Simulation Results for Scheme #3 (1.2 Profit/0.98 Profit)

Beef Sector for 10- and 90-Year Averages. Table XIII presents the results for 10- and 90-year averages and their standard deviation for the beef sector. The level of direct profit was much lower than the level of profit with payment [BR(0)]. Profits without payment were negative over the first 10 years of the program. Profit decreased further to -4.99 over the long run 90-year period. Stabilization payments of $4.80 and $6.02/cwt were paid on the average over the 10-year and 90-year periods respectively. These payments cause profits with payments added to be positive over both the 10-year and 90-year periods.

The net income per cow with payment averaged $9.28/year over the first 10 years of the scheme, but was reduced to $4.50/cow per year over a 90-year average for the scheme. This is a reduction of almost 51 percent in net income. But the scheme did generate much more

TABLE XIII

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #3 FOR BEEF SECTOR, OPTION 1

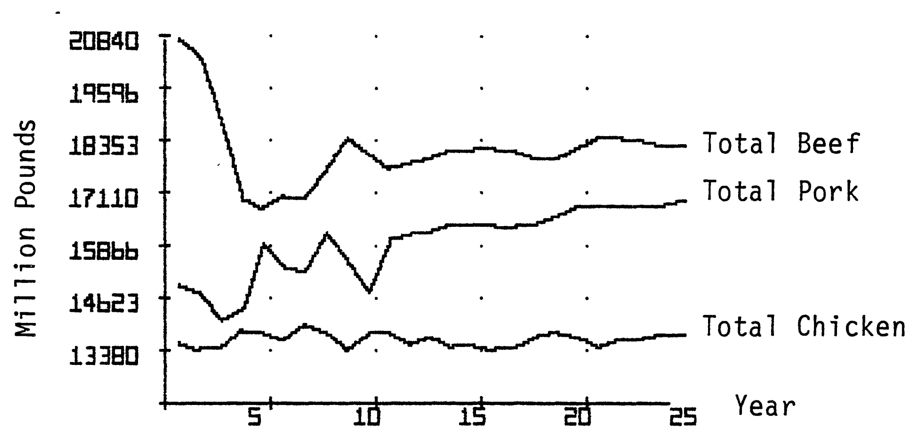
Variables	10-Year Average	90-Year Average
Level of Direct Profit		
$/cwt per year	-2.627	-4.996
standard deviation	3.249	3.043
Level of Profit with Payment		
$/cwt per year	2.054	1.041
standard deviation	4.490	1.244
Level of Gross Income		
$/cow per year	342.668	337.837
standard deviation	18.208	7.758
Level of Net Income		
$/cow per year	9.280	4.495
standard deviation	19.986	6.763
Level of Stabilization Payment		
$/cwt per year	4.798	6.017
standard deviation	4.963	1.487
Level of Production		
million pounds per year	18,017.908	18,105.868
standard deviation	255.933	200.201
Level of Price Received		
$/cwt per year	75.358	73.009
standard deviation	1.737	1.630
Cost to Government		
million dollars per year	723.687	905.086
standard deviation	744.347	224.339

stability in net income over the 90-year period versus the 10-year period as indicated by the standard deviation of $6.76/cow per year over 90 years as compared with $19.99/cwt per year for over 10 years.

The level of production on average was slightly higher at 18105.868 million pounds per year for over 90 years as compared with 18017.908 million pounds per year for the 10-year average. However, the absolute variability as shown by standard deviation moved in the opposite direction over the 10- and 90-year averages. The standard deviation was 255.9 million pounds per year over 10-year period, as compared with 200.2 million pounds per year over 90 years. Overall the variability of production was much lower for scheme #3 (1.2 profit/0.98 profit) as compared with scheme #2 (0.5 price/0.9 margin), scheme #1 (base), and other stabilization payment schemes yet to be considered. Figures 22 and 23 present graphically the production over 25- and 100-year periods for scheme #3 (1.2 profit/0.98 profit).

The price level moves in the opposite direction compared with the production for 10- and 90-year averages. The average price level is $75.36 and $73.01/cwt per year over 10- and 90-year periods respectively. This is a reduction of about $2.35/cwt per year over the 90-year period versus the 10-year period. However, the variability in terms of the standard deviation of market prices in both cases were approximately the same at $1.74 and $1.63/cwt per year for over the 10- and 90-year periods. Again this standard deviation is much lower than the standard deviations for the other four schemes considered in this study.

Hog Sector for 10- and 90-Year Average. Table XIV presents the estimated effect of the stabilization payment scheme for the hog



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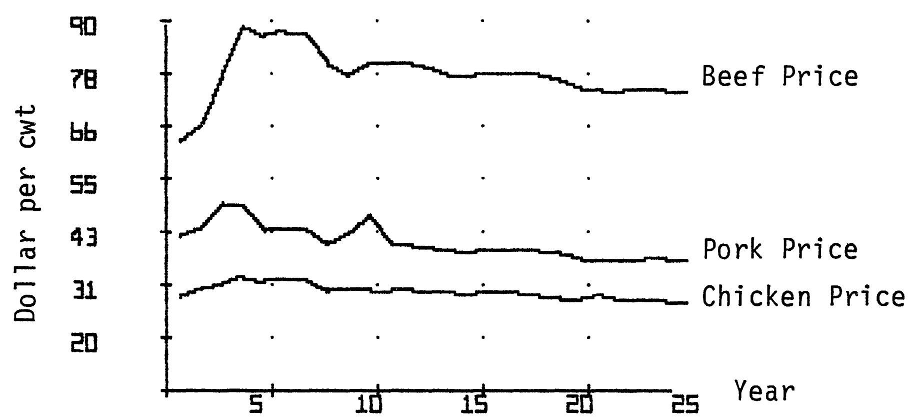
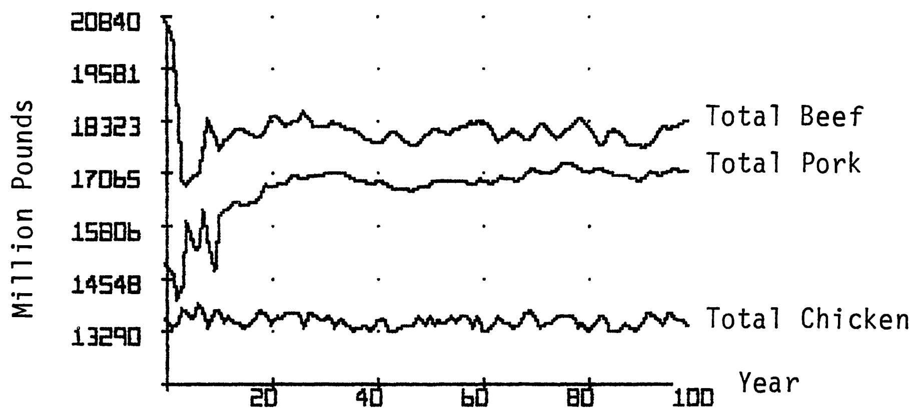


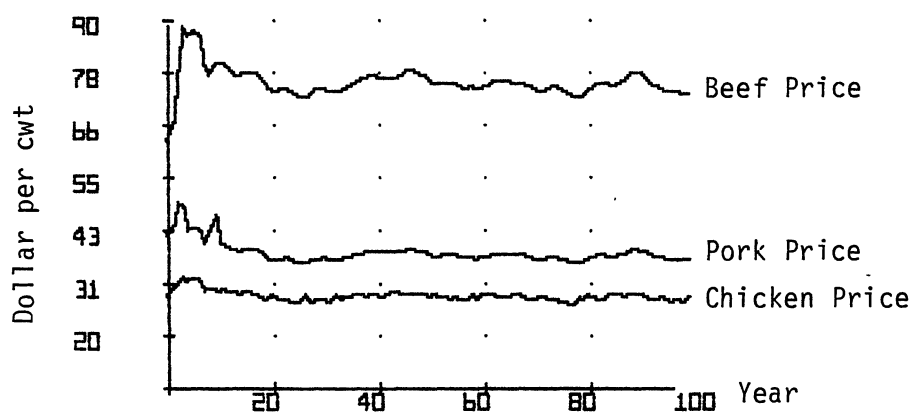
(b)

Figure 22(a). Beef, Pork and Chicken Production for Scheme #3, Option 1, Over 25 Years

(b). Beef, Pork and Chicken Prices for Scheme #3, Option 1, Over 25 Years



(a)



(b)

Figure 23(a). Beef, Pork and Chicken Production for Scheme #3, Option 1, Over 100 Years

(b). Beef, Pork and Chicken Prices for Scheme #3, Option 1, Over 100 Years

TABLE XIV

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #3 FOR HOG SECTOR, OPTION 1

Variables	10-Year Average	90-Year Average
Level of Direct Profit		
$/cwt per year	-3.613	-4.823
standard deviation	6.107	3.894
Level of Profit with Payment		
$/cwt per year	0.388	0.056
standard deviation	0.790	0.365
Level of Gross Income		
$/cwt per year	42.362	41.957
standard deviation	3.804	3.802
Level of Net Income		
$/cwt per year	0.388	0.057
standard deviation	0.790	0.365
Level of Stabilization Payment		
$/cwt per year	4.001	4.879
standard deviation	5.495	3.646
Level of Production		
million pounds per year	16,370.044	16,926.292
standard deviation	1,211.503	256.335
Level of Price Received		
$/cwt per year	38.360	37.077
standard deviation	5.014	0.852
Cost to Government		
million dollars per year	896.746	1,130.846
standard deviation	1,228.263	844.214

sector. The level of direct profit under scheme #3 (1.2 profit/0.98 profit) for the hog sector was \$-3.61 and \$-4.82/cwt per year on average for over the 10- and 90-year averages respectively. Thus, a reduction in profit was reported as the time period was extended to 90 years, the calculated standard deviation also fell to \$3.89/cwt per year for 90 years compared with \$6.10/cwt per year for 10 years.

Although negative direct profits were generated for both periods with stabilization payments of \$4.00 and \$4.88/cwt per year, the net incomes with payment were positive at \$0.39 and \$0.06/cwt per year for the 10- and 90-year averages respectively.

The level of production was slightly lower for the 10-year average (by 556.2 million pounds per year) as compared with the 90-year average. On the other hand, production variability, as indicated by the standard deviation, was 955.2 million pounds per year or approximately 4.8 times higher for over the 10-year average versus the 90-year average. Thus, as the period is extended to 90 years, the stabilizing effect with respect to production variability of the scheme is increased.

The absolute variability for prices moves in the same direction as the absolute variability for production. Standard deviations of \$5.01 and \$0.85/cwt per year were reported over the 10- and 90-year periods. But the level of price moves in the opposite pattern from the level of production, i.e. production is higher over the 90-year average while prices are lower. As in the case with beef, a greater stabilizing effect for prices could be achieved over the 90-year period versus the 10-year period. Figures 22 and 23 present the simulated production and prices for scheme #3 (1.2 profit/0.98 profit) over 25- and 100-year periods.

Summary on Cost to the Government for Both Beef and Hog Sectors for Scheme #3 (1.2 Profit/0.98 Profit)

The effect of the stabilization payments made under scheme #3 (1.2 profit/0.98 profit) on stability of production, prices and income for the beef sector are significant but costly. It would have cost the government on average about $723.7 million per year over 10 years and a higher average $905.9 million per year over 90 years to operate scheme #3 (1.2 profit/0.98 profit). On the other hand, the cost for the hog sector would have been $896.7 and $1130.8 million per year on average for the 10- and 90-year periods.

Total cost to government on the average would have been $1620.4 (723.6 + 896.7) million per year over the 10-year period and $2035.9 (905.1 + 1130.8) million per year over the 90-year period for both the beef and hog sectors under scheme #3 (1.2 profit/0.98 profit).

Scheme #3 (1.2 profit/0.98 profit) proves to be the most effective scheme tested for stabilizing income variation. However, it is also the most expensive. Government payments over the first 10 years with this scheme are approximately 5.7 percent of the gross value of beef produced and 14.3 percent of the gross value of hog produced. For this cost, net income variability, as compared with the base run in scheme #3 (1.2 profit/0.98 profit) with no program, is reduced for beef by approximately 11.5 percent and for pork by 84 percent. Hence this program appears to work for pork but not for beef. Perhaps a more significant effect was that net income was raised by the program 372 percent for beef and 162 percent for hogs. Similar, but greater effects, are seen for a 90-year period. Net income variability for beef is reduced relative to scheme #1 (base) by approximately 65 percent, while pork net income variability is reduced by 92 percent. The net income levels for scheme #3 (1.2 profit/0.98 profit) versus scheme #1 (base) over 90-year periods are revealing. In the base scheme, scheme #1 (base), where no payments are made, the 90-year average net income for beef and pork are slightly negative, but basically equal to zero indicating that a breakeven competitive production equilibrium over the long run is being maintained. In scheme #3 (1.2 profit/0.98 profit) pork net income, with payments included, over a 90-year period is positive at $0.06/cwt. This basically is very close to zero or breakeven net income. Hence for pork, the previously hypothesized response of production being stimulated due to subsidy has occurred. In fact it has occurred to the degree that nearly all of any income subsidy present in the program has been driven out. All that remains is the stabilization affect of the program. Over a 90-year period scheme #3 (1.2 profit/0.98 profit) reduced pork prices by approximately 12.5 percent relative to the base scheme. This was due mainly to pork production being stimulated by approximately 8.3 percent through the payments made. Similar, but less complete effects are seen for beef over a 90-year period. Beef's net income levels remain significantly above zero or breakeven under scheme #3 (1.2 profit/0.98 profit), i.e. the average $4.50/cow per year over 90 years. However they have dropped significantly from the 10-year average of $9.28/cow per year. Relative to the base scheme over 90 years, scheme #3 (1.2 profit/0.98 profit) stimulates beef production on the average approximately 1.7 percent per year and depresses beef's market price by approximately 6.3 percent per year. Part of the depression of beef's price is likely due to increased pork production as well and the increase in beef production.

Scheme #3 (1.2 profit/0.98 profit) clearly demonstrates that many stabilization schemes, if not well planned, become income subsidization schemes. In so doing they stimulate production and drive prices down, escalating the cost of the stabilization program. This effect is clearly indicated in scheme #3 (1.2 profit/0.98 profit) as average annual costs for the 10- versus the 90-year periods increased by 25 and 26 percent respectively for beef and pork. Again, since the parameters used in this model were estimated from non-subsidy situations, the speed and magnitude of this production stimulation generated the resulting increases in program costs are likely to be underestimated. One saving factor preventing rapid production stimulation in the livestock sector through price/income subsidization is the biological time delay and constraint to increasing production. In reality this, and the uncertainty as to whether the government stabilization program will remain in effect, would be inhibitors to production growth.

Philosophically another point evolves from the simulation of scheme #3 (1.2 profit/0.98 profit). When nearly all of the variability is removed from net income, as in the case for pork over a 90-year period, no profit remains. Under the theory that profit is the reward for risk taking, the results here verify that no risk leads to no profit. For beef, variability of net income remains as some profit remains. It appears, however, that if the program were continued long enough beef would also eventually reach the status of pork, that is, it would achieve near stability in net income with zero profits.

Scheme #4 (Margin/Price)

In scheme #4 (0.9 margin/0.5 price) support payments for cow-calf producers were based on a "guaranteed margin." Payments for the hog sector were based on the difference between the indexed moving average of prices and the current prices received for hog.

Stabilization Payment Scheme for Beef Sector. The guaranteed margin approach is used to calculate the support price for calves. The support price for any period was equal to the cost of production plus 90 percent of the average margin of the preceding 10 years. The margin for any period was equal to the national average market price for any given period minus the national cost of production for any given period. The stabilization payment in any period was based on the market price and support price. Thus in any period, if the market price falls below the support price, the stabilization payment will be equal to the support price for any given period minus the average market price. The above stabilization payment can be represented as follows:

$$BR(0) = FB - BC + SPB \tag{130}$$

$$SUPB = BC + 90\% * BMBR(0) \tag{131}$$

$$SPB = SUBP - FB \tag{132}$$

$$IF\ SPB \leq 0\ THEN\ SPB = 0 \tag{133}$$

i.e. FB > SUBP, NO PAYMENT

$$IF\ SPB > 0\ THEN\ SPB = SPB \tag{134}$$

where

BR(0) = margin or profit with payment of any given year ($/cwt)

FB = farm beef price ($/cwt)

BC = cost of production of 400 pound calf ($/cwt)

SUPB = support price for any given year

SPB = stabilization payment ($/cwt)

BMBR(0) = 10-year moving average of profit

In scheme #4 (0.9 margin/0.5 price) if the moving average for the profit is negative it is converted into a positive value and 90 percent of it is added to the cost of production variable BC. But if the moving average is positive it will assume the value of zero. The conversion procedure can be presented as follows:

6900 IF BMBR(0) < 0 GO TO 6904 (135)

6902 IF BMBR(0) ≥ 0 GO TO 6906 (136)

6904 BMBR(0) = BMBR(0) * -1 (137)

6905 GO TO 6907 (138)

6906 BMBR(0) = 0 (139)

6907 CONTINUE (140)

where

BMBR(0) = 10-year profit moving average ($/cwt)

Thus from equation (131), if BMBR(0) is zero then SUBP will take the value of BC.

Again the two different options were run simultaneously in the beef and hog payment schemes.

Stabilization Payment Scheme for Hog Sector. The hog stabilization payment scheme used an indexed moving average of prices for hogs which is defined as the national average market price for hogs in the same quarter for the preceding eight years. Payment will be based on per cwt of hog produced. In any quarter the market price for hogs falls below the indexed moving average price, the payment for cwt of hog will be equal to 50 percent of the indexed moving average price minus the market price. Thus, if the market price is above the indexed moving average, no payment will be made. Mathematically the above payment scheme can be presented as follows:

$$SPHq = 50\% * (HMFPq - FPq) \quad (141)$$

$$\text{IF } SPHq \leq 0 \text{ THEN } SPHq = 0 \quad (142)$$

i.e. FPq > SPHq, NO PAYMENT

$$\text{IF } SPHq > 0 \text{ THEN } SPHq = SPHq \quad (143)$$

where

SPHq = stabilization for the quarter ($/cwt)

FPq = farm hog price for the quarter ($/cwt)

HMFPq = eight year moving average of hog prices ($/cwt)

The quarterly payment is then converted into an annual figure by summing each of the payments in the quarter of the same period.

Simulation Results for Scheme #4 (0.9 Margin/0.5 Price)

Beef Sector for 10- and 90-Year Averages. Results for the beef sector can be seen in Table XV for 10- and 90-year averages respectively. The level of direct profit generated under scheme #4 (0.9 margin/0.5 price) was negative for both of the 10- and 90-year average. However the levels of profit with payment [BR(0)] were positive for both cases. On average the level of profit with payment was $7.45/cwt per year over the 10-year average. The profit with payment dropped to $6.21/cwt per year, a reduction of almost 124 percent over a 90-year average. However the absolute variability as shown by the standard deviation was greatly reduced over the 90-year

TABLE XV

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #4 FOR BEEF SECTOR, OPTION 1

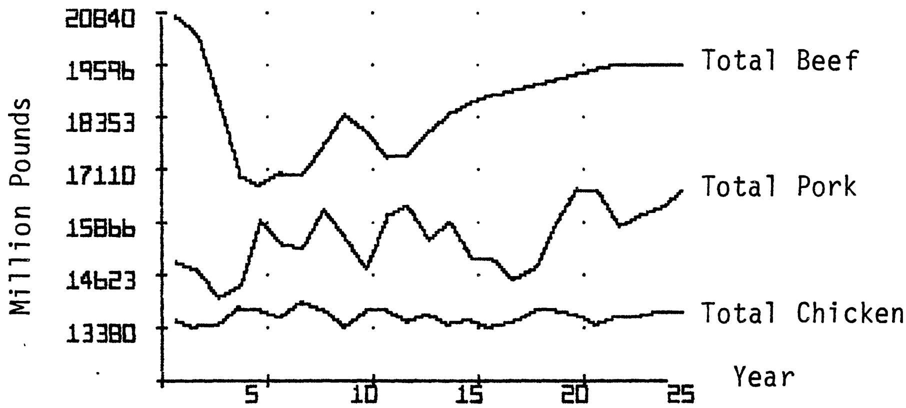
Variables	10-Year Average	90-Year Average
Level of Direct Profit		
$/cwt per year	-4.769	-10.690
standard deviation	7.872	3.780
Level of Profit with Payment		
$/cwt per year	7.451	6.212
standard deviation	2.208	0.769
Level of Gross Income		
$/cow per year	365.788	359.969
standard deviation	18.074	12.942
Level of Net Income		
$/cow per year	32.653	26.646
standard deviation	10.037	3.352
Level of Stabilization Payment		
$/cwt per year	12.407	16.923
standard deviation	5.941	3.231
Level of Production		
million pounds per year	18,555.510	19,541.307
standard deviation	766.290	425.847
Level of Price Received		
$/cwt per year	73.157	67.280
standard deviation	8.056	3.106
Cost to Government		
million dollars per year	1,985.792	2,807.387
standard deviation	1,056.530	554.490

average, an indication of the stabilizing effect of the stabilization program over an extended period of time.

The net income per cow on average was higher for the 10-year average than the 90-year average. However income variability was three times higher than the 90-year average. Thus, compared with scheme #1 (base), implementation of stabilization payment scheme #4 (0.9 margin/0.5 price) caused net income to increase tremendously for beef producers accompanied with a reduction in variability as indicated by the reduced standard deviation. To generate such a high level of net income, scheme #4 (0.9 margin/0.5 price) required approximately $12.40 and $16.92/cwt per year as a stabilization payment on average for the 10-year and 90-year periods respectively.

The level of production was lower for the 10-year average, but generated a higher price when compared with the 90-year average. The 90-year average was almost 986 million pounds per year greater, but the level of price received dropped to $67.28/cwt per year, a reduction of $5.88/cwt per year from the 10-year average. This is consistent with prior expectations, i.e. as production (supply) increases, the price received will fall given that demand remains the same. Figures 24 and 25 graphically present the production and prices over 25- and 100-year periods.

A stabilizing effect of the stabilization payment scheme on production and prices with respect to absolute variability could be seen by the decrease in standard deviation of beef production. It fell from 1294.615 million pounds per year (for 10-year average) to 425.847 million pounds per year (for 90-year average). Similarly, increased stability of prices was achieved over the 90-year period versus the



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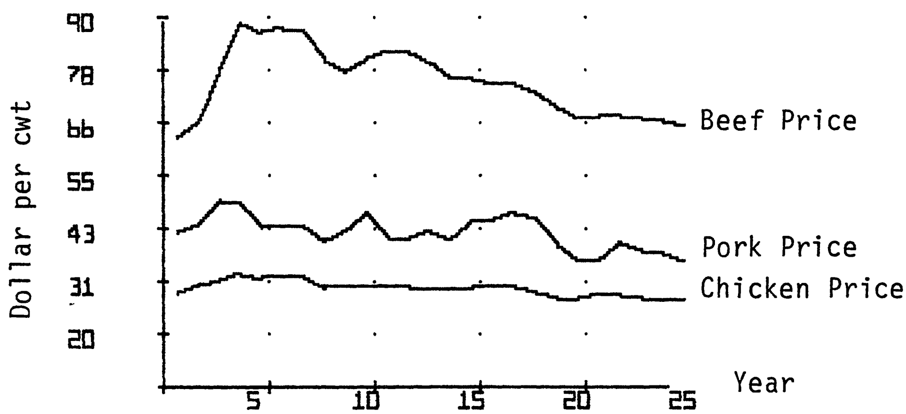
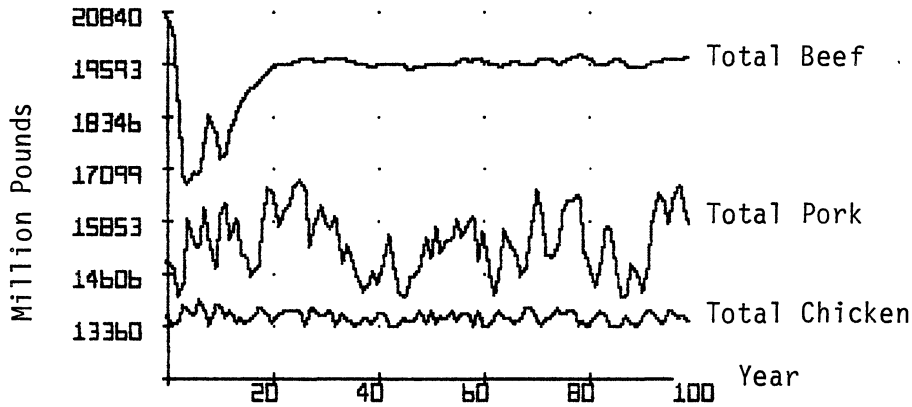


(b)

Figure 24(a). Beef, Pork and Chicken Production for Scheme #4, Option 1, Over 25 Years

(b). Beef, Pork and Chicken Prices for Scheme #4, Option 1, Over 25 Years



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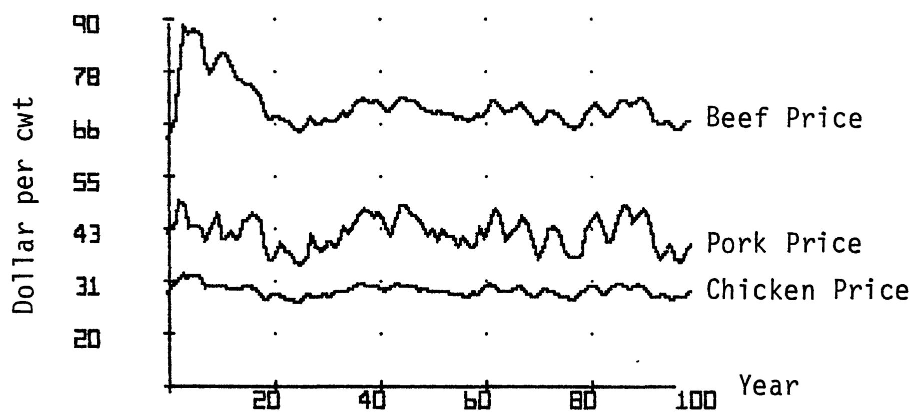


(b)

Figure 25(a). Beef, Pork and Chicken Production for Scheme #4, Option 1, Over 100 Years

(b). Beef, Pork and Chicken Prices for Scheme #4, Option 1, Over 100 Years

10-year period, with a reduction in standard deviation of $4.95/cwt per year, i.e. from $8.05 to $3.10/cwt per year. Comparatively, production and prices generated by scheme #4 (0.9 margin/0.5 price) in Figure 25 were more stable than production and prices generated by scheme #1 (base) without any stabilization payment.

Hog Sector for 10- and 90-Year Averages. Table XVI presents the simulated results of scheme #4 (0.9 margin/0.5 price) for the hog sector. Under scheme #4 (0.9 margin/0.5 price) the average direct profit was $-0.50 and $-0.77/cwt per year for the 10-year and 90-year averages respectively. However, the absolute variability as shown by their standard deviation was relatively large at $4.74 and $4.44/cwt per year for 10- and 90-year averages respectively.

With stabilization payments (SPH) of $0.80/cwt per year, the net income received by producers was $0.30/cwt per year over the 10-year average. However, this is not the case with the 90-year average. Although scheme #4 (0.9 margin/0.5 price) requires $0.68/cwt per year stabilization payment, it does not generate positive net income on average over the 90-year period. The stabilizing effect of scheme #4 (0.9 margin/0.5 price) with respect to absolute variability as shown by standard deviation for direct profit and net income was approximately the same for both 10- and 90-year averages.

The level of production was slightly higher for the 10-year average compared with the 90-year average. Similarly the price received for the 10-year average was also higher by $0.34/cwt per year as compared with the 90-year average. Thus the price moved in the same direction as production. Overall, the 90-year program did not result in any more stabilization than the 10-year program for production and

TABLE XVI

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #4 FOR HOG SECTOR, OPTION 1

Variables	10-Year Average	90-Year Average
Level of Direct Profit		
$/cwt per year	-0.506	-0.771
standard deviation	4.740	4.447
Level of Profit with Payment		
$/cwt per year	0.300	-0.085
standard deviation	4.502	4.187
Level of Gross Income		
$/cwt per year	42.273	41.815
standard deviation	2.240	2.880
Level of Net Income		
$/cwt per year	0.300	-0.085
standard deviation	4.502	4.187
Level of Stabilization Payment		
$/cwt per year	0.806	0.686
standard deviation	1.002	0.887
Level of Production		
million pounds per year	15,569.451	15,403.594
standard deviation	688.089	762.133
Level of Price Received		
$/cwt per year	41.468	41.129
standard deviation	3.126	3.427
Cost to Government		
million dollars per year	181.022	151.733
standard deviation	228.816	198.965

price. This can be seen from the increase in standard deviation from 688.1 to 762.1 million pounds per year in production and from $3.13 to $3.43/cwt per year in prices for the 10-year average versus the 90-year average. Stabilization payment scheme #4 (0.9 margin/0.5 price) did not have a stabilizing effect on the hog industry. Figures 24 and 25 present the production and prices for the hog sector for 25 and 100 years respectively. Comparatively the pattern of pork production and price received for hogs was approximately the same for scheme #4 (0.9 marging/0.5 price) and the no stabilization payment scheme #1 (base) as shown in Figures 18 and 19.

Summary on Cost to the Government for Both Beef and Hog Sectors for Scheme #4 (0.9 Margin/0.5 Price)

The implementation of stabilization payment scheme #4 (0.9 margin/ 0.5 price) is not without a cost. The average annual cost to the beef sector was approximately 11 and 18 times larger than for the hog sector for 10-year and 90-year periods respectively. On average the cost to the beef sector was $1985.8 and $2807.4 million per year for 10 years and 90 years respectively. Cost of the program increased $821.6 million per year on average over the 90-year period versus the 10-year period. On the other hand, the cost for the hog sector was relatively small. The cost fell from on average of $181.0 million per year for 10 years to $151.7 million per year for the 90-year average. Although the cost was slightly lower for the 90-year average, the net income generated was negative. It would require approximately an additional $1.3 million per year of income on average to break even (zero net income) over the 90-year period. Total cost to the government would have been $2166.8 (1985.8 + 181.0) million per year and $2959.1 (2807.4 + 151.7) million per year on average for the combined beef and hog payments over the 10- and 90-year periods respectively.

Scheme #5 (MA Profit/Profit)

Scheme #5 (0.9 MA profit/1.0 profit) was developed in order to find a scheme that could stabilize both beef and hog sectors' income, production and prices simultaneously. The program combination used was a profit moving average scheme for the beef sector and a direct profit scheme for the hog sector.

Stabilization Payment Scheme for Beef Sector. The stabilization payment scheme used for the beef sector for scheme #5 (0.9 MA profit/ 1.0 profit) was the same as the scheme developed in scheme #4 (0.9 margin/0.5 price). It requires the calculation of a support price, margin and stabilization payment. For a detailed discussion, refer to the stabilization payment scheme discussion for the beef sector in scheme #4 (0.9 margin/0.5 price).

Stabilization Payment Scheme for Hog Sector. Stabilization payments for hogs were based directly on the profit generated by the hog sector. It is similar to scheme #3 (1.2 profit/0.98 profit), however the payment will be based on 100 percent of the negative profit instead of 98 percent as was the case in scheme #3 (1.2 profit/0.98 profit). The hog stabilization payment scheme can be represented as follows:

$$PIEH = FP - ACC \qquad (144)$$

IF PIEH < 0 THEN SPH = PIEH * -1 (145)

IF PIEH $\geq$ 0 THEN SPH = 0 (146)

where

PIEH = profit for hog sector ($/cwt)

FP = farm pork price ($/cwt)

ACC = average cash cost ($/cwt)

SPH = payment for hog sector ($/cwt)

Simulation Results for Scheme #5
(0.9 MA Profit/1.0 Profit)

Beef Sector for 10- and 90-Year Averages. Table XVII presents the estimated results for the beef sector of scheme #5 (0.9 MA profit/ 1.0 profit). The direct profit for scheme #5 (0.9 MA profit/1.0 profit) was also negative as in scheme #1 (base) through #4 (0.9 margin/0.5 price). Unlike scheme #2 (0.5 price/0.9 margin) and #3 (1.2 profit/0.98 profit) the profit with payment was positive and similar to scheme #4 (0.9 margin/0.5 price) at $7.45/cwt per year over the 10-year average. Similarly, the direct profit was negative over the 90-year average but shifted to positive when profit with payments was considered. Thus, with stabilization payments of $13.87 and $19.28/cwt per year, the net income of $32.63 and $26.66/cwt per year was generated for 10- and 90-year averages respectively. Income variability as shown by standard deviation for net income with payment was reduced to $3.36/cwt per year when the time period was extended to 90 years as compared with $43.22/cwt per year for the 10-year period. Thus a 92 percent reduction in variability of net income was achieved as the program period was extended from 10 to 90 years.

TABLE XVII

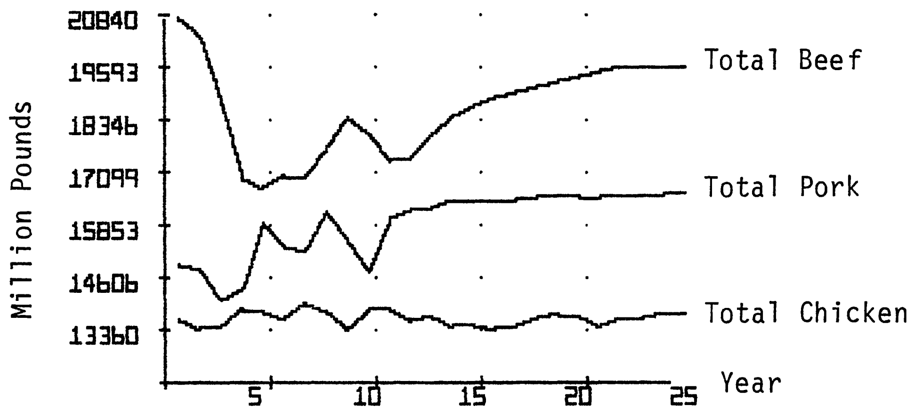
SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #5 FOR BEEF SECTOR, OPTION 1

Variables	10-Year Average	90-Year Average
Level of Direct Profit		
$/cwt per year	-6.231	-13.061
standard deviation	6.017	3.826
Level of Profit with Payment		
$/cwt per year	7.451	6.212
standard deviation	2.208	0.769
Level of Gross Income		
$/cow per year	365.788	359.969
standard deviation	43.351	12.942
Level of Net Income		
$/cow per year	32.638	26.656
standard deviation	43.226	3.350
Level of Stabilization Payment		
$/cwt per year	13.866	19.297
standard deviation	14.004	3.254
Level of Production		
million pounds per year	18,555.520	19,541.307
standard deviation	766.290	425.847
Level of Price Received		
$/cwt per year	71.698	64.906
standard deviation	6.475	2.966
Cost to Government		
million dollars per year	2,221.551	3,201.072
standard deviation	2,243.835	560.048

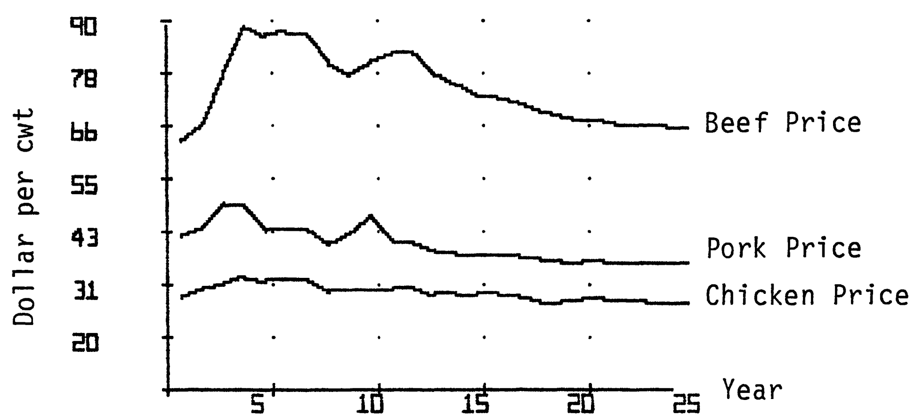
The level of production was 18555.5 million pounds per year over the 10-year average but increased to 19541.3 million pounds per year as the time period was extended to 90 years. Although the production was slightly higher on average for the 90-year average, the standard deviation was approximately 45 percent lower at 425.8 million pounds per year as compared with 766.2 million pounds per year for the 10-year average. Thus on average the production was more stable over the entire 90-year period.

As in scheme #2 (0.5 price/0.9 margin) and #3 (1.2 profit/0.98 profit) the level of prices moves in the opposite direction to production. Average prices were $71.70 and $64.91/cwt per year for the 10- and 90-year averages respectively. This represents a 10 percent drop from the 10-year average to the 90-year average. However, the variability for prices follows the same pattern as the variability for production. The standard deviation for prices fell from $6.48/cwt per year over the 10-year average to $2.97/cwt per year for the period of 90 years or by approximately 55 percent. Thus over the 90-year period the price received by producers is more stable than over a 10-year period. Figures 26 and 27 present the simulated price and production pattern over 25 and 100 years for scheme #5 (0.9 MA profit/1.0 profit).

<u>Hog Sector for 10- and 90-Year Averages</u>. Table XVIII presents the estimated results for the hog sector of scheme #5 (0.9 MA profit/ 1.0 profit). The direct profit for the hog sector under scheme #5 (0.9 MA profit/1.0 profit) was negative for both the 10- and 90-year averages. However with stabilization payment of $4.43 and $5.98/cwt per year the net income for the hog sector increased to $0.25 and $0.03/cwt per year over the 10- and 90-year averages respectively. The



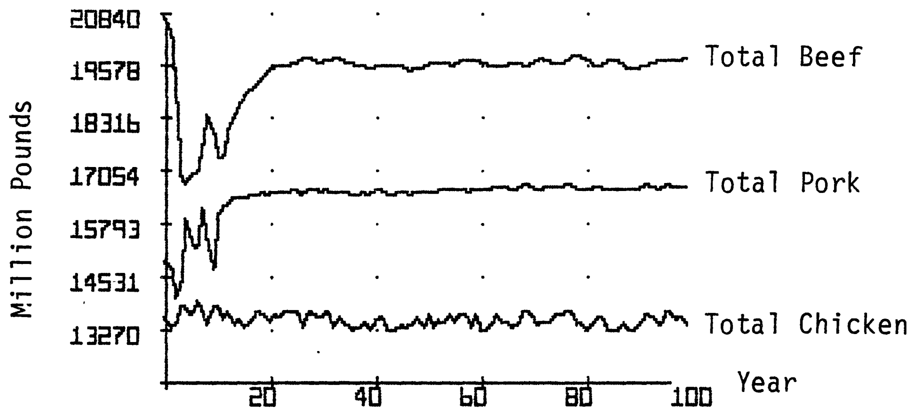
(a)



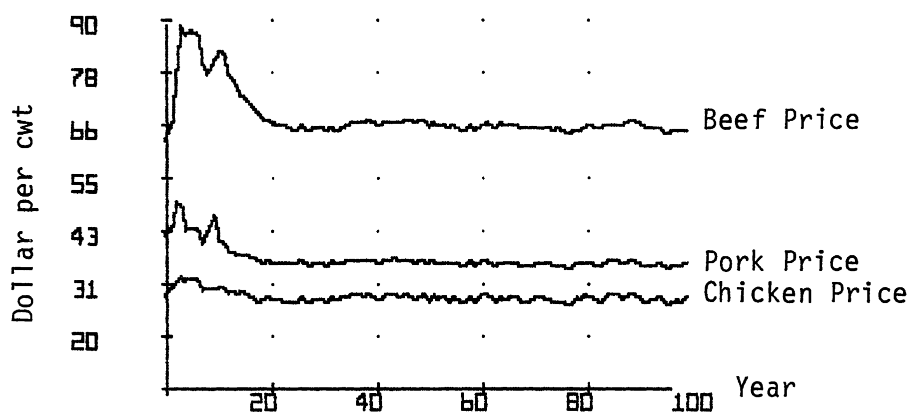
(b)

Figure 26(a). Beef, Pork and Chicken Production for Scheme #5, Option 1, Over 25 Years

(b). Beef, Pork and Chicken Prices for Scheme #5, Option 1, Over 25 Years



(a)



(b)

Figure 27(a). Beef, Pork and Chicken Production for Scheme #5, Option 1, Over 100 Years

(b). Beef, Pork and Chicken Prices for Scheme #5, Option 1, Over 100 Years

TABLE XVIII

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #5 FOR HOG SECTOR, OPTION 1

Variables	10-Year Average	90-Year Average
Level of Direct Profit		
$/cwt per year	-4.207	-5.958
standard deviation	6.431	3.778
Level of Profit with Payment		
$/cwt per year	0.225	0.030
standard deviation	0.631	0.139
Level of Gross Income		
$/cwt per year	42.199	41.930
standard deviation	4.240	4.017
Level of Net Income		
$/cwt per year	0.225	0.030
standard deviation	0.631	0.139
Level of Stabilization Payment		
$/cwt per year	4.432	5.988
standard deviation	5.907	3.748
Level of Production		
million pounds per year	16,384.545	16,608.063
standard deviation	1,247.496	114.930
Level of Price Received		
$/cwt per year	37.767	35.942
standard deviation	5.722	0.907
Cost to Government		
million dollars per year	996.422	1,362.370
standard deviation	1,326.701	850.896

absolute variability of net income over 90 years fell to $0.14/cwt per year as compared with $0.61/cwt per year for the 10-year average. Thus the net income generated under scheme #5 (0.9 MA profit/1.0 profit) was slightly more stable over the 90-year average.

The level of production was 16384.5 and 16608.1 million pounds per year on average for over the 10- and 90-year periods respectively, representing a 223.5 million pound increase, or approximately a 1.4 percent increase, on average over 90-year versus 10-year averages. As in the other schemes, the variability for the 90-year average was lower compared with the 10-year average. In this case the 90-year standard deviation was only 9.2 percent as much as the 10-year average. Figures 26 and 27 present the simulated production and prices over 25- and 100-year periods.

The price levels in scheme #5 (0.9 MA profit/1.0 profit) move in opposite direction of production, i.e. lower production for over 10 years versus 90 years generates higher prices. Similarly the absolute variability is approximately six times lower at $0.91/cwt per year for the 90-year average as compared with $5.91/cwt per year for the 10-year average. Therefore both production and prices stabilize as the time period is extended to 90 years.

Summary on Cost to the Government for Both Beef and Hog Sectors for Scheme #5 (0.9 MA Profit/1.0 Profit)

The average annual cost to implement scheme #5 (0.9 MA profit/1.0 profit) for the beef sector would have been $2221.5 million per year over the 10-year period simulated, but increased to an average of

$3201.1 million per year as the time period was extended to 90 years. The cost to the government for the hog sector program is relatively small as compared with the beef sector. The cost of the hog sector would have been $996.4 and $1362.3 million per year on average for the 10- and 90-year periods respectively.

Total cost to government due to stabilization payment scheme would have been $3217.9 (2221.5 + 996.4) million per year for both beef and hog sectors over the 10-year period. Total average annual cost to the government increases to $4563.4 (3201.0 + 1362.4) million per year over the 90-year period.

Comparative Stabilizing Effect with Respect to Absolute Variability for Production and Prices About the Mean and the Trend Line

The discussion of the variability (standard deviation) of the simulation results for scheme #1 (base) through #5 (0.9 MA profit/1.0 profit) was based on the variability about the mean of the simulated results. However the results generated not only fluctuated over the time period tested but also trended either upward or downward. Thus there is a question as to whether variability about a trend line would be significantly different than variation about the mean.

The purpose of this section is to compare and to contrast regarding the stabilizing effect for production and prices with respect to absolute variability as measured by the standard deviation about the mean and standard deviation from a trend line as measured by errors around an OLS trend line for the simulated values. Such a comparison is very important in the sense that the absolute variability around the mean may be misleading in measuring the variability if the trend line is ignored. Figure 28 illustrates the variability about the trend line, while Figure 29 presents the variability about the mean. Intuitively, one can predict that the variability about the mean is much larger than about the trend line.

Scheme #1 (Base)

Beef Sector for 10- and 90-Year Averages. Comparative stabilizing effects for scheme #1 (base) are based on the base run using the random number generator. Table XIX presents the estimated regression coefficients and the standard deviation about the trend line for beef. Table XX presents the summary of standard deviation about the trend and mean over 10- and 90-year periods. On the average, the absolute variability as shown by standard deviation about the negative trend line was reduced to 250.454 million pounds per year as compared with 540.2 million pounds per year (see Table XX) for standard deviation about the mean over the 10-year period. On the other hand, the average absolute variability shown by standard deviation about the mean and the trend line were approximately the same over the 90-year average. The trend line shifted significantly from a negative slope of -33.11 to 0.71 for the 10-year and 90-year periods respectively. Since the slope of the trend line over the 90-year period was almost flat, one would expect that the absolute variability as indicated by the two types of standard deviations would be approximately the same for both cases.

The same basic relation existed between the two measures of variability for beef quantity and beef price under scheme #1 (base).

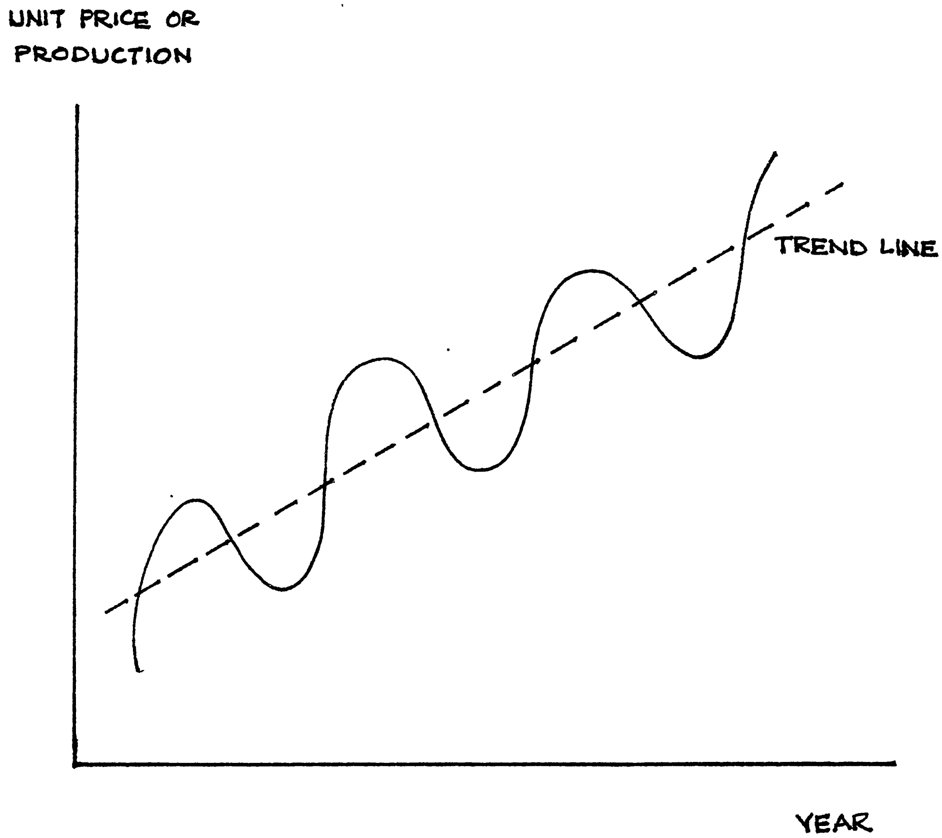


Figure 28. Illustration of the Variability About the Trend Line

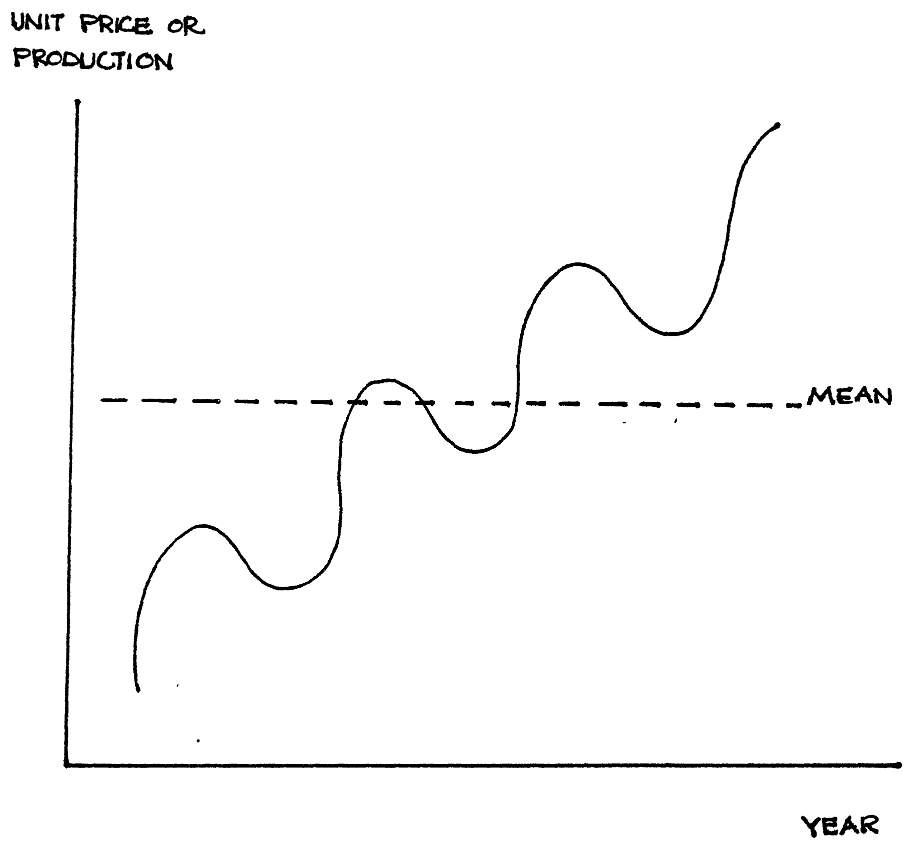


Figure 29. Illustration of the Variability About the Mean

TABLE XIX

ESTIMATED REGRESSION COEFFICIENTS AND SUMMARY STATISTICS OF THE TREND LINE EQUATIONS FOR PRODUCTION AND PRICES FOR BEEF SECTOR UNDER OPTION 1[a]

Equations	Regression Coefficients for Over 10 Years: Constant	Regression Coefficients for Over 10 Years: Time	Regression Coefficients for Over 90 Years: Constant	Regression Coefficients for Over 90 Years: Time
Scheme #1				
Total Beef Production	18,279.497	-33.107	17,769.863	0.705
	(2.668)*	(1.200)	(2.850)*	(0.425)
	SE = 250.454[b]		SE = 409.269	
Farm Level Beef Price	78.056	0.025	77.866	0.000911
	(1.003)	(0.008)	(1.482)	(0.065)
	SE = 2.844		SE = 3.447	
Scheme #2				
Total Beef Production	18,757.945	-67.464	17,731.888	1.015
	(2.578)*	(2.305)*	(2.739)*	(0.589)
	SE = 265.901		SE = 424.859	
Farm Level Beef Price	73.013	-16.367	77.024	-0.000866
	(0.974)	(1.000)	(1.395)	(0.059)
	SE = 2.739		SE = 3.623	
Scheme #3				
Total Beef Production	17,485.544	34.346	18,168.257	-1.124
	(4.879)*	(2.382)*	(6.021)*	(1.399)
	SE = 130.993		SE = 198.035	

TABLE XIX (Continued)

Equations	Regression Coefficients for Over 10 Years: Constant	Time	Regression Coefficients for Over 90 Years: Constant	Time
Farm Level Beef Price	82.194	-0.441	73.990	-0.018
	(3.971)*	(5.295)*	(3.106)*	(2.786)*
	SE = 0.756		SE = 1.564	
Scheme #4				
Total Beef Production	14,982.210	230.535	19,091.418	8.106
	(2.891)*	(11.055)*	(3.391)*	(5.407)*
	SE = 189.407		SE = 369.459	
Farm Level Beef Price	95.576	-1.446	69.869	-0.047
	(2.891)*	(12.976)*	(1.605)	(4.024)*
	SE = 1.013		SE = 2.857	
Scheme #5				
Total Beef Production	14,982.210	230.535	19,091.418	8.106
	(2.891)*	(11.055)*	(3.391)*	(5.407)*
	SE = 189.407		SE = 369.459	
Farm Level Beef Price	96.674	-1.611	68.134	-0.057
	(3.429)	(14.204)*	(1.766)*	(5.675)*
	SE = 1.030		SE = 2.548	

a/ t-statistics in parentheses

b/ standard error

* significantly different from zero at 0.05 level of significance

TABLE XX

SUMMARY OF STANDARD DEVIATION OF PRODUCTION AND PRICES OVER 10- AND 90-YEAR AVERAGES ABOUT THE MEAN AND ABOUT THE TREND LINE FOR BEEF SECTOR, OPTION 1

	Standard Deviation About the Mean		Standard Deviation About the Trend Line	
	10-Year Average	90-Year Average	10-Year Average	90-Year Average
Scheme #1				
Total Beef Production	540.219	409.684	205.454	409.269
Farm Level Beef Price	3.747	3.448	2.844	3.447
Scheme #2				
Total Beef Production	602.067	425.685	265.901	424.859
Farm Level Beef Price	3.257	3.624	2.739	3.623
Scheme #3				
Total Beef Production	255.933	200.201	130.993	198.035
Farm Level Beef Price	1.737	1.630	0.756	1.564
Scheme #4				
Total Beef Production	766.290	425.847	189.407	369.459
Farm Level Beef Price	8.056	3.106	1.013	2.857
Scheme #5				
Total Beef Production	766.290	425.847	189.407	369.459
Farm Level Beef Price	6.475	2.966	1.030	2.548

The average absolute variability for beef price as shown by the standard deviation was slightly lower about the positive trend line (by approximately $0.90/cwt per year) over the 10-year period. However the positive slope of the trend line is almost horizontal. On the other hand, the absolute variability measured by the standard deviation over the 90-year average was approximately the same, both about the trend line and the mean. The slope of the trend line is almost zero.

In summary, variability about the trend line is less than about the mean over the 10-year period but not over the 90-year period. This appears to be the case because no significant trend exists over the 90-year period but one does exist over the 10-year period.

Hog Sector for 10- and 90-Year Averages. Table XXI presents the regression coefficients and standard deviation of trend line equation for the hog sector. Table XXII presents the summary of standard deviation over 10- and 90-year averages. The absolute variability for production, as shown by the standard deviation about the trend line and the mean, were approximately the same for both the 10- and 90-year periods. Although a positive slope trend line was estimated over the 10-year period and a negative trend line was estimated for the 90-year period, the variability around the trend line was approximately the same as the variability around the mean.

Similarly, the absolute variability for prices, as shown by standard deviation about the trend line and the mean, was also approximately the same for both the 10- and 90-year averages. Thus the trend line does not result in any significantly different measures of variability for pork prices or production over either the 10- or 90-year periods considered.

TABLE XXI

ESTIMATED REGRESSION COEFFICIENTS AND SUMMARY STATISTICS OF THE TREND LINE EQUATIONS FOR PRODUCTION AND PRICES FOR HOG SECTOR UNDER OPTION 1[a/]

Equations	Regression Coefficients for Over 10 Years		Regression Coefficients for Over 90 Years	
	Constant	Time	Constant	Time
Scheme #1				
Total Hog Production	15,056.003	30.867	15,711.258	-1.611
	(0.817)	(0.416)	(1.406)	(0.541)
	SE = 673.592[b/]		SE = 733.415	
Farm Level Hog Price	43.326	-0.078	41.636	0.0034
	(0.510)	(0.228)	(0.852)	(0.263)
	SE = 3.103		SE = 3.208	
Scheme #2				
Total Hog Production	16,353.627	-16.367	16,222.200	-1.550
	(1.280)	(0.318)	(1.665)*	(0.597)
	SE = 466.948		SE = 639.493	
Farm Level Hog Price	37.038	0.175	39.661	0.0025
	(0.772)	(0.908)	(1.020)	(0.242)
	SE = 1.753		SE = 2.551	
Scheme #3				
Total Hog Production	15,327.0176	67.292	16,551.944	6.745
	(5.188)*	(5.660)*	(5.835)*	(8.930)*
	SE = 107.983		SE = 186.165	

TABLE XXI (Continued)

Equations	Regression Coefficients for Over 10 Years		Regression Coefficients for Over 90 Years	
	Constant	Time	Constant	Time
Farm Level Hog Price	42.257	-0.251	37.615	-0.00968
	(3.907)*	(5.776)*	(3.033)*	(2.932)*
	SE = 0.395		SE = 0.813	
Scheme #4				
Total Hog Production	16,012.259	-28.568	15,517.322	-2.049
	(0.845)	(0.375)	(1.340)	(0.664)
	SE = 692.45		SE = 760.251	
Farm Level Hog Price	43.502	-0.131	41.105	0.000425
	(0.523)	(0.396)	(0.787)	(0.031)
	SE = 3.008		SE = 3.427	
Scheme #5				
Total Hog Production	15,560.680	53.153	16,428.835	3.229
	(7.678)*	(6.518)*	(13.815)*	(10.198)*
	SE = 74.067		SE = 78.047	
Farm Level Hog Price	45.151	-0.476	37.084	-0.021
	(2.969)	(7.785)*	(3.335)*	(6.950)*
	SE = 0.556		SE = 0.730	

a/ t-statistics in parentheses
b/ standard error
* significantly different from zero at 0.05 level of significance

TABLE XXII

SUMMARY OF STANDARD DEVIATION OF PRODUCTION AND PRICES OVER 10- AND 90-YEAR AVERAGES ABOUT THE MEAN AND ABOUT THE TREND LINE FOR HOG SECTOR, OPTION 1

	Standard Deviation About the Mean		Standard Deviation About the Trend Line	
	10-Year Average	90-Year Average	10-Year Average	90-Year Average
Scheme #1				
Total Pork Production	719.045	734.629	673.592	733.415
Farm Level Hog Price	3.154	3.209	3.103	3.208
Scheme #2				
Total Pork Production	1,003.309	640.773	466.948	639.493
Farm Level Hog Price	3.906	2.552	1.753	2.551
Scheme #3				
Total Pork Production	1,211.503	256.335	107.983	186.165
Farm Level Hog Price	5.014	0.852	0.395	0.813
Scheme #4				
Total Pork Production	757.563	762.133	692.450	760.251
Farm Level Hog Price	3.260	3.427	3.008	3.427
Scheme #5				
Total Pork Production	1,247.496	114.930	74.067	78.047
Farm Level Hog Price	5.722	0.907	0.556	0.730

Scheme #2 (0.5 Price/0.9 Margin)

Beef Sector for 10- and 90-Year Averages. A similar explanation could be given to scheme #2 (0.5 price/0.9 margin) as in scheme #1 (base) with regard to the stability measure effect about the trend line for production and prices over the 10-year average. Absolute variability for production about the negative trend line as shown by the standard deviation was reduced to 265.9 million pounds per year as compared with 602.1 million pounds per year for about the mean over the 10-year average. However the absolute variability over the 90-year average was approximately the same both about the trend line and the mean. Although a positive slope was estimated about the trend line over the 90-year period, it was not significant enough to affect the variability of production (see Tables XIX and XX).

Absolute variability as shown by the standard deviation for prices shows a similar pattern as in production. The effect of the positive trend line estimates over the 10-year period can be seen by a reduction in standard deviation to $2.73/cwt per year as compared with $3.26/cwt per year for the mean over the 10-year period. However, in the long run for the 90-year period, the standard deviations are approximately the same for both the trend line and the mean.

Hog Sector for 10- and 90-Year Averages. Hog production and prices follow the same pattern as in the beef production and prices. Estimated variation about the trend line can be seen in Table XXI which contains the regression coefficient and standard deviation for the hog sector while Table XXII presents the mean and standard deviation about the mean. The absolute variability for hog production about the negative trend line was reduced to more than half of the absolute variability about the mean over the 10-year period, i.e. reduction in standard deviation to 466.9 million pounds as compared with 1003.3 million pounds. However, over the 90-year average, the absolute variability for both the trend line and the mean were approximately the same. Although a negative slope was estimated, it did not have any significant effect on the variability of production over the 90-year period.

The absolute variability as shown by the standard deviation for prices fell $1.75/cwt per year for about the trend line as compared with $3.91/cwt per year for about the mean over the 10-year period. However, the stabilizing effect with respect to absolute variability as shown by standard deviation was approximately the same for the 90-year average.

Overall use of the trend line measure of variability versus the mean resulted in a much lower measure of variability over the 10-year period but about the same measure of variability for the 90-year period. The significance of this difference is that the trend line measure indicates that scheme #2 (0.5 price/0.9 margin) does not become more effective with time while the mean measure does.

Scheme #3 (1.2 Profit/0.98 Profit)

Beef Sector for 10- and 90-Year Averages. The average absolute variability for production about the positive slope trend line, as shown by the standard deviation over the 10-year period, is 131.0 million pounds per year, a reduction of almost 135 million pounds per year (approximately 49 percent) as compared with 255.9 million pounds per year for about the mean in absolute variability. Thus, taking the trend line into consideration results in a significantly lower estimate of volatility for the period. On the other hand, over the 90-year period the absolute variability about the trend line and the mean became approximately the same. The slope about the trend line shifted from positive to negative as the length of period was extended to 90 years. However the slope of -1.124 was rather small to have any significant effect on the reduction of absolute variability (see Tables XIX and XX).

It should be noted that the absolute variability for production about the trend line was smaller over the 10-year period but increased approximately 69 million pounds per year on average for the 90-year period. Similarly, the absolute variability about the mean was larger over the 10-year average but fell approximately 55 million pounds per year on average for the 90-year period.

The price absolute variability about the negative trend line and about the mean also follows the same pattern as in production. The absolute variability fell almost 50 percent, i.e. from \$1.74/cwt per year for about the mean to \$0.76/cwt per year for about the trend line over the 10-year average. But the absolute variability for price about the trend line increased to \$1.56/cwt per year as the length of period extended to 90 years. The absolute variability for about the mean remains approximately the same at \$1.63/cwt per year over the 90-year period.

<u>Hog Sector for 10- and 90-Year Averages</u>. Hog production variability also follows the same pattern as in beef production but in a different magnitude. The absolute variability for production about

the positive trend line was 108.0 million pounds per year as compared with 1211.5 million pounds per year for about the mean over the 10-year period, or approximately 11.0 times smaller. This is caused by the steep positive slope observed for the trend line. For comparison see Tables XXI and XXII.

However, over the 90-year period the absolute variability for production about the mean falls to 256.3 million pounds per year (a reduction of 995.2 million pounds per year on average). The absolute variability for production increased about the trend line over 90 years and the slope of the trend line also became relatively flat.

The absolute variability as shown by standard deviation for prices moves in the same direction as the production. Over the 10-year average, the absolute variability about the mean was $5.01/cwt per year, but fell to $0.85/cwt per year as the time period extended to 90 years. On the other hand, the absolute variability as shown by standard deviation about the trend line was $0.40/cwt per year over the 10-year average but increased to $0.81/cwt per year over the 90-year period. Although a negative slope trend was generated, it was rather flat over the 90-year period compared with a steeper slope over the 10-year period.

Scheme #4 (0.9 Margin/0.5 Price)

Beef Sector for 10- and 90-Year Averages. The absolute variability about the mean for production had the same pattern as in beef production in scheme #3 (1.2 profit/0.98 profit) over the 10-year period. A standard deviation about the mean of 766.3 million pounds per year was recorded, but fell to 425.8 million pounds per year as the length of simulated period was extended to 90 years. On the other hand, the absolute variability about the positive slope trend line exhibited the same pattern as in scheme #1 (base), scheme #2 (0.5 price/0.9 margin), and scheme #3 (1.2 profit/0.98 profit), i.e. lower absolute variability about the trend line over the 10-year average and slightly higher for the 90-year average.

The absolute variability for prices moves in a similar pattern as in production. Higher absolute variability about the mean was generated over the 10-year average as compared with the 90-year average, i.e. a reduction of almost $5.00/cwt per year. Meanwhile the absolute variability about the negative trend line was $1.01/cwt per year over the 10-year average as compared with $2.86/cwt per year over the 90-year average. For comparison see Tables XIX and XX.

<u>Hog Sector for 10- and 90-Year Averages</u>. The hog sector shows relatively stable absolute variability for production both about the trend line and the mean at 760.2 and 762.1 million pounds per year over the 90-year average. However, over the 10-year period, the absolute variability was slightly lower about the trend line as shown by standard deviation at 692.5 million pounds per year as compared with 757.6 million pounds per year about the mean, a reduction of 65.1 million pounds per year. In both cases they are lower than the 90-year average. Based on the variability about the trend line, both 10- and 90-year averages do not show any stabilizing effect. The variabilities were as large as those under scheme #1 (base). (See Tables XXI and XXII.)

The absolute variability of prices as shown by the standard deviation was approximately the same for both about the trend line and the mean at $3.01 and $3.26/cwt per year respectively over 10 years. The absolute variability about the trend line and the mean increased in the same magnitude as the time period extends to 90 years. Thus, the trend line measure of variability for prices was not effectively different than the deviation from the mean measure for the hog sector in scheme #4 (0.9 margin/0.5 price).

Scheme #5 (0.9 MA Profit/1.0 Profit)

Beef Sector for 10- and 90-Year Averages. Again the absolute variability as indicated by the standard deviation for production follows the same pattern as the rest of the stabilization payment schemes. The absolute variability about the mean over the 10-year average was approximately 44 percent larger than over the 90-year period. On the other hand, the absolute variability about the trend line for production moves in the opposite direction, i.e. over the 10-year average the absolute variability about the positive trend line was 189.4 million pounds per year but increased to 315.8 million pounds per year as the time period was extended to the 90-year average.

The price level generated by scheme #5 (0.9 MA profit/1.0 profit) also follows the same pattern as in production. The absolute variability about the mean is $6.48 and $2.97/cwt per year over 10 and 90 years respectively. By the same token the absolute variability about the negative trend line is $1.03 and $2.55/cwt per year for 10- and 90-year averages respectively. Again the stabilizing effect, as indicated by the reduction in standard deviation, could be achieved by taking into account the trend line (see Tables XIX and XX).

Hog Sector for 10- and 90-Year Averages. Unlike the beef sector, the absolute variability about the mean for the hog sector shows a more volatile pattern under scheme #5 (0.9 MA profit/1.0 profit). The absolute variability for production was 1247.5 million pounds per year over the 10-year average but fell to 114.9 million pounds per year over the 90-year period. On the other hand, the absolute variability as shown by standard deviation about the positive trend line was slightly different for both 10- and 90-year averages at 74.1 and 78.0 million pounds per year respectively. Scheme #5 (0.9 MA profit/1.0 profit), taking trend into consideration, generates a significantly lower measure of production variability for both the 10- and 90-year periods.

The absolute variability of hog prices follows the same pattern as hog production but with different magnitude. The absolute variability for prices about the mean is $5.72/cwt per year but falls to $0.91/cwt per year on average for 10 and 90 years respectively, a reduction of 84 percent as the period extends to 90 years. This is an indication that stability could be achieved over a period of time. Stabilizing effect with respect to absolute variability about the trend line could be seen by the reduction in standard deviation for 10- and 90-year averages as compared with the standard deviation shown about the mean. However, the absolute variability about the trend line over the 10-year average was smaller than for the 90-year period. This could be due to the prominent trend line over the 10-year period which dampened the measure of variability (see Tables XXI and XXII).

Summary: Comparison of Measure of Variability Using Deviation About the Mean and About the Trend Line

As expected the variability about the trend line was less in all cases than about the mean. However the reduction in variation for trend versus the mean measure of variability seemed to be greater for the 10-year period. In general there were relatively large reductions in variation about the trend line versus the mean when the slope coefficient of the trend line was significant. In the 10-year period it is felt that a significant trend was, in general, being picked up because the model was still somewhat in disequilibrium and moving constantly toward an equilibrium. The stabilization scheme was not designed nor intended to deal with transition from one equilibrium to another, but rather to stabilize production and prices about one equilibrium.

In most cases the measures of variation were quite similar for the 90-year period. This is basically the case because no large positive or negative trends existed over the 90-year period for any of the schemes. Those schemes that did have relatively larger and significant trends, including #4 (0.9 margin/0.5 price) and #5 (0.9 MA profit/1.0 profit) for beef, and #3 (1.2 profit/0.98 profit) and #5 (0.9 MA profit/1.0 profit) for pork, did tend to have smaller deviation measures about the trend than about the mean. The 90-year periods which had relatively strong trends are the same ones that, in general, (especially for pork) had low overall variability. Thus the logic deduced is that the 90-year periods with relatively strong trends are for schemes which stabilized income, production and prices, but in so doing stimulated production. In all the cases cited [beef #4 (0.9 margin/0.5 price) and #5 (0.9 MA profit/1.0 profit), and pork #3 (1.2 profit/0.98 profit) and #5 (0.9 MA profit/1.0 profit)], the trends are positive for production and negative for prices.

Description of Stabilization or Deficiency Payment Schemes with Taxes (Option 2) for 10- and 90-Year Simulations

The stabilization payment schemes described in the first option (i.e. stabilization or deficiency payment schemes without taxes) were assumed to be financed totally by the government. However, in option 2 as outlined in the earlier part of this chapter, some kind of funding contribution is specified to be collected from producers in order to decrease the burden of funding to the government. In the case tested here, the funding for the basic level of stabilization payment was specified to be shared on an equal basis by the government and producers. An equal basis was chosen because the scheme to be tested also required 100 percent stabilization payment to the producers, thus it seems appropriate to ask the producer to contribute 50 percent of the funds used to finance the program.

The calculation and formulation of the stabilization payment is similar to those that have been described earlier in the first option. Taxes and government-matching contributions will be made only in years when producers are making a profit. Payments will be made from funds accumulated during profitable years. If the accumulated funds are not adequate to meet the program's required payments the government will subsidize the program to cover the shortfall.

The common feature of the funding for beef and hog sectors can be described as follows:

$$CTFD = COP + COG, \ (COP = COG) \quad (147)$$

$$FDR = CTFD - STBPY \quad (148)$$

$$IF\ FDR < 0\ THEN\ EFDG = FDR \quad (149)$$

$$IF\ FDR \geq 0\ THEN\ EFDG = 0 \quad (150)$$

$$CGFD = COG + EFDG \quad (151)$$

$$IF\ FDR > 0\ THEN\ NC = CGFD - FDR \quad (152)$$

$$IF\ FDR < 0\ THEN\ NC = CGFD \quad (153)$$

where

COP = contribution from producers ($/cwt)

COG = contribution from government ($/cwt)

STBPY = stabilization payment ($/cwt)

CTFD = total common fund from the contribution of the government and producers ($/cwt)

FDR = fund remaining after payment to producer ($/cwt)

EFDG = extra funding required from the government if total common fund is negative ($/cwt)

CGFD = total contribution due to stabilization payment (million $)

NC = net cost profit to government ($/cwt)

The total common funding is the sum of funds collected from both producers and the government. This fund will be used to pay the producer stabilization payment. However, in the case where the fund is not able to cover the stabilization payment required, the government will then contribute the extra amount to fulfill the stabilization payment. These rules are shown in equations (149) and (150). The total contribution by the government can be presented in equation

(151). Figure 30 illustrates an example of the workings of the common fund and stabilization payment.

Another common feature of the funding is that in any period if a stabilization payment is required to be paid to the producer (which indicates that the producer did not make any money) no contribution is collected from either the producer or the government. On the other hand, if no stabilization payment is being paid (i.e. the producers made some profit), a contribution is required from the producers. Similarly, the government will also contribute the same amount to the common fund.

The total net cost for beef and hog sectors to the government for each scheme can be calculated as follows:

$$TNCB = CGFDB * 4.275 * BH \qquad (154)$$

$$TNCH = CGFDH * 2.2 * 14.4 * SH \qquad (155)$$

where

TNCB = net cost due to stabilization payment scheme for beef sector (million dollars)

CGFDB = total government contribution to stabilization payment (million $)

BH = beef breeding herd (million herd)

TNCH = net cost due to stabilization payment scheme for hog sector (million dollars)

CGFDH = total government contribution to stabilization payment

SH = swine breeding herd (million head)

4.275 = average weight for calf as defined earlier

2.2 = average weight for hog (cwt)

14.4 = average number of pigs produced per year per brood sow

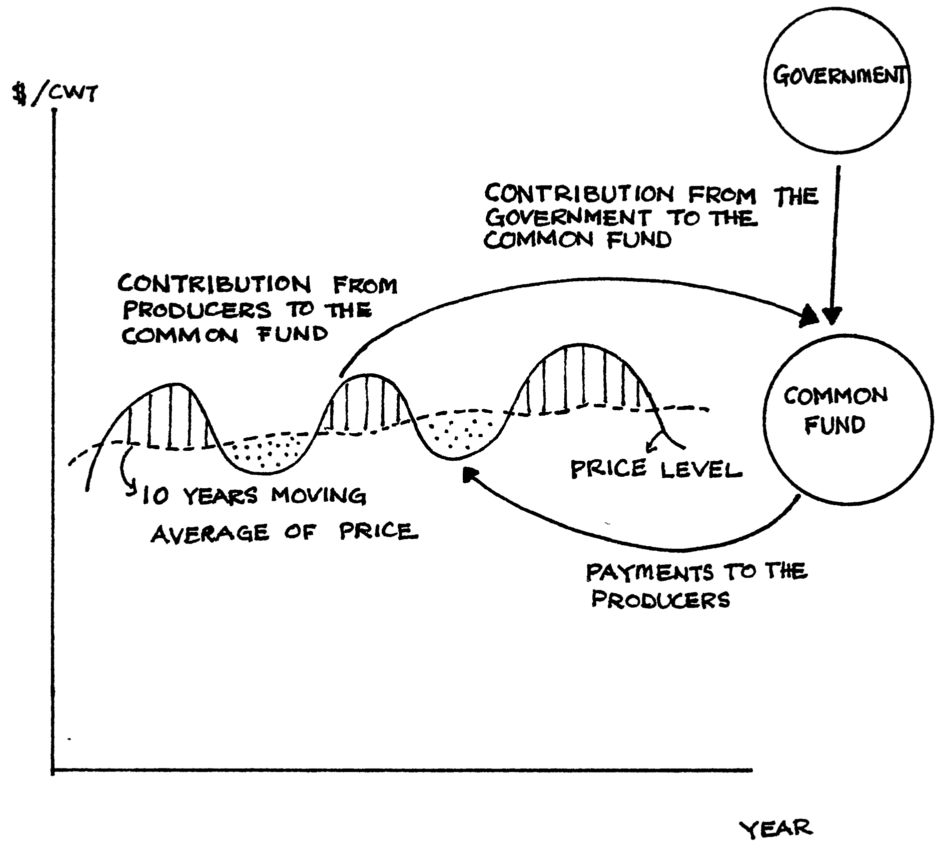


Figure 30. An Example of the Working of the Common Fund

As indicated earlier, the producers' contribution will be viewed as a tax imposed on them and will be subtracted from the profit with payment function [BR(0)] as in equation (103) in the case of beef sector and subtracted as a tax on hog price in the hog replacement and culling in equations (106) and (107).

As in the first option, the discussion of the results of each simulation run will be based on several critical variables of interest. However some modifications need to be made in the definition of the variables due to the inclusion of taxes in the stabilization payment scheme. These variables are listed below.

Beef Sector

(i) direct profit without stabilization payment ($/cwt)

PIEB = FB - BC + 6.05

(ii) profit with stabilization payment and taxes ($/cwt)

BR(0) = FB - BC + SPB - TXB + 6.05

(iii) gross income with program payment but before taxes ($/cow)

GIB = FB * 4.275 + PYCOW

(iv) net income with program payments and taxes ($/cow)

NIB = (PIEB - TXB) * 4.275 + PYCOW

(v) stabilization payment ($/cwt)

SPB = based on stabilization payment scheme

(vi) total beef production (million pounds)

TB = total beef production

(vii) price received at the farm level ($/cwt)

FB = price of beef at farm level

(viii) contribution from or taxes paid by producer ($/cwt)

COPB = contribution from producers

COPB is based on the stabilization payment formula and the calculation of the taxes.

(ix) total fund collected, i.e. an equal contribution from producer (COPB) and government (COGB) ($/cwt)

CTFDB = COPB + COGB

(x) average fund remaining after payment to producer ($/cwt)

FDRB = CTFDB - SPB

(xi) extra cost to government for negative fund balance ($/cwt)

IF FDRB < 0 THEN EFDGB = FDRB * (-1)

EFDGB is the additional contribution from government for negative fund periods that require the government to pay the producer from other funds due to stabilization funds being previously depleted.

(xii) total government contribution to the common fund ($/cwt)

CGFDB = summation of COGB and EFDGB

(xiii) net cost to government after taxes or producer contribution (million dollars)

If funds remaining are positive then the net cost ($/cwt) is equal to:

NCB = COGB + EFDGB - FDRB

Total net cost, assuming 100 percent participation from producers:

TNCB = (CGFDB - FDRB) * 4.275 * BH

In any event, if the FDRB > CGFDB then there will be a net profit instead of a net cost, i.e. the fund remaining is greater than the total government contribution, thus the government is able to recover the cost and at the same time make a profit.

If funds remaining are negative then the net cost ($/cwt) is equal to:

NCB = COGB + EFDGB

Total net cost, assuming 100 percent participation from producers:

TNCB = NCB * 4.275 * BH

(xiv) total payment made due to stabilization payment program (million dollars)

TPSB = SPB * 4.275 * BH

where

BC = cost of production of 400 pound calf ($/cwt)

TXB = taxes or contribution from beef producer ($/cwt)

PYCOW = payment per cow ($/cow)

4.275 = average weaning weight of heifer and steer calf with 10 percent mortality rate

6.05 = breakeven profit adjustment factor ($/cwt) as defined and calculated earlier in option 1

BH = beef breeding herd (million head)

Hog Sector

Similarly the discussion of the results for the hog sector will follow the same format as in the beef sector discussed above. These variables can be defined as follows:

(i) profit without stabilization payment added ($/cwt)

PIEH = FP - ACC

(ii) profit with stabilization payment and taxes ($/cwt)

PIEHP = FP - ACC + SPH - TXH

(iii) gross income with program but before taxes ($/cwt)

GIH = SPH + FP

(iv) net income with program payments and taxes ($/cwt)

NIH = GIH - ACC - TXH

(v) stabilization payment ($/cwt)

SPH = based on stabilization payment scheme

(vi) total hog production (million pounds)

TP = total hog production

(vii) price received at the farm level ($/cwt)

FP = price of pork at farm level

(viii) contribution from or taxes paid by producer ($/cwt)

COPH = contribution from producers

COPH is based on the stabilization payment formula and the calculation of the taxes.

(ix) total funds collected, i.e. an equal contribution from producer (COPH) and government (COGH) ($/cwt)

CTFDH = COPH + COGH

(x) average fund remaining after payment to producer ($/cwt)

FDRH = CTFDH - SPH

(xi) extra cost to government for negative fund balances ($/cwt)

IF FDRH < 0 THEN EFDGH = FDRH * (-1)

EFDGH = additional contribution from government for negative fund periods that required the government to pay the producer from other funds due to stabilization funds being previously depleted

(xii) total government contribution to the common fund ($/cwt)

CGFDH = summation of COGH and EFDGH

(xiii) net cost to government after taxes or producer contribution (million dollars)

If funds remaining are positive then the net cost ($/cwt) is equal to:

NCH = COGH + EFDGH - FDRH

Total net cost, assuming 100 percent participation from from producers:

TNCH = (CGFDH - FDRH) * 14.4 * 2.2 * SH

In any event, if the FDRH > CGFDH then there will be a net profit instead of net cost, i.e. the fund remaining is greater than the total government contribution, thus the government is able to recover back the cost and at the same time make a profit.

If funds remaining are negative then the net cost is equal to:

NCH = COGH + EFDGH

Total net cost, assuming 100 percent participation from producers:

TNCH = NCH * 2.2 * 14.4 * SH

(xiv) total payment made due to stabilization payment program (million dollars)

TPSH = SPH * 2.2 * 14.4 * SH

where

FP = farm level hog price ($/cwt)

ACC = average cash feeding cost for hog ($/cwt)

TXB = taxes or contribution from hog sector ($/cwt)

SH = swine breeding herd (million head)

2.2 = average hog weight (cwt)

14.4 = average number of pigs produced per year per brood sow

Scheme #1 (Base)

The description for scheme #1 (base) is the same as in the first option. There is no stabilization payment program in scheme #1 (base). Thus, the result is the same as in the first option.

Scheme #2 (0.5 Price/0.9 Margin)

Stabilization Payment and Funding for Beef Sector. Stabilization payment and the computation of funding (equal contribution from producers and government) can be presented by the following equations:

SPB = 0.5 * (BMA - FB) (156)

IF SPB $\leq$ 0 THEN SPB = 0 (157)

i.e. FB > BMA; NO PAYMENT

COPB = 0.5 * (FB - BMA) (158)

COGB = COPB, GO TO EQUATION (163) (159)

IF SPB > 0 THEN SPB = SPB (160)

i.e. FB < BMA; PAYMENT REQUIRED

COPB = 0 (161)

COGB = 0 (162)

CTFDB = COPB + COGB (163)

where

SPB = stabilization or deficiency payment ($/cwt)

FB = farm beef price ($/cwt)

COPB = contribution from producer ($/cwt)

COGB = contribution from government ($/cwt)

CTFDB = total common fund from government and producer ($/cwt)

BMA = 10-year beef farm price moving average ($/cwt)

Equation (156) is the stabilization payment scheme equation as presented in the first option. Thus, if there is no payment which indicates that the producer is making some profit, a contribution is required from the producer to the common fund. This is shown by equation (158). The government will then contribute the same amount to the common fund.

Equations (161) and (162) present the situation whereby stabilization payments are to be paid by the government to producers. In such an event, no contribution is required from either producers or the government. Equation (163) presents the collected common fund. The common feature of the calculation and utilization of the common fund was described earlier by equations (147) through (151).

Stabilization Payment and Funding for Hog Sector. The stabilization payment scheme and funding scheme (equal contribution from producers and government) for the hog sector can be presented as follows:

SPHq = SUPHq - FPq (164)

IF SPHq $\leq$ 0 THEN SPHq = 0 (165)

i.e. FPq > SUPHq; NO PAYMENT

COPH = 0.5 * (FPq - SUPHq) (166)

COG = COPH, GO TO EQUATION (171) (167)

IF SPHq > 0 THEN SPHq = SPHq (168)

i.e. FPq > SUPHq

$$COPH = 0 \quad (169)$$

$$COGH = 0 \quad (170)$$

$$CGFDH = COPH + COGH \quad (171)$$

where

COPH = contribution from producers ($/cwt)

COGH = contribution from government ($/cwt)

CGFDH = total common fund from government and producer ($/cwt)

SPHq = stabilization payment for the quarter ($/cwt)

FPq = farm pork price for the quarter ($/cwt)

SUPHq = support price for the quarter ($/cwt)

A similar explanation given for beef can be given to the hog sector with regard to the computation of the producers' and government's contribution to the common fund. Equations (164) to (171) present the stabilization payment and funding contribution for the hog sector.

Simulation Results for Scheme #2 (0.5 Price/0.9 Margin)

Beef Sector for 10- and 90-Year Averages. Table XXIII presents the summary of the estimated effect of stabilization payments with taxes for the beef sector. The level of direct profit and profit with payment under scheme #2 (0.5 price/0.9 margin) for option 2 were both positive over the 10-year period, but the level of profit with payment and taxes was negative over the 90-year period. An average stabilization payment of $0.90/cwt over the 90-year period was not able to generate positive net income for producers. Although the net income was approximately 1.5 times higher for the 10-year period, the absolute

TABLE XXIII

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #2 FOR BEEF SECTOR, OPTION 2

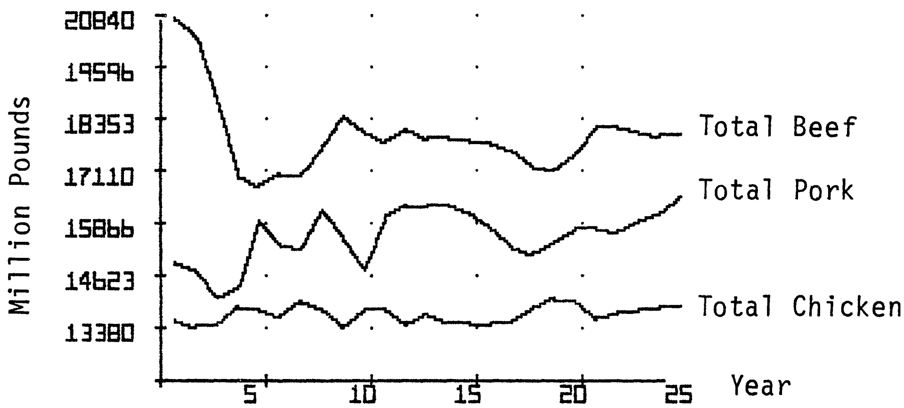
Variables	10-Year Average	90-Year Average
Level of Direct Profit		
$/cwt per year	0.475	0.269
standard deviation	5.509	4.498
Level of Profit with Taxes & Paymt.		
$/cwt	0.298	-0.100
standard deviation	4.429	3.572
Level of Gross Income with Payment But Before Taxes		
$/cow	337.933	336.075
standard deviation	13.453	13.072
Level of Net Income with Payment and Taxes		
$/cow	1.274	-0.428
standard deviation	19.073	15.403
Level of Stabilization Payment		
$/cwt per year	0.539	0.902
standard deviation	0.908	1.102
Level of Contribution or Taxes from Producer		
$/cwt	0.709	0.737
Level of Production		
million pounds per year	17,700.912	17,807.949
standard deviation	564.045	421.733
Level of Price Received		
$/cwt per year	78.510	77.712
standard deviation	3.092	3.787
Total Fund Collected (50/50 Basis)		
$/cwt	1.418	1.474
Extra Cost to Government for Negative Fund		
$/cwt	0	0
Total Government Contribution		
$/cwt	0.709	0.737
Fund Remaining After Payment		
$/cwt	0.879	0.572
Net Cost to the Govt. After Taxes		
million dollars	-24.895	24.283
Total Program Payment Made		
million dollars	78.931	132.745

variability was $19.07/cow per year as compared with $15.40/cow per year over the 90-year period, indicating a 19 percent increase in net income stability for 90 years versus 10 years.

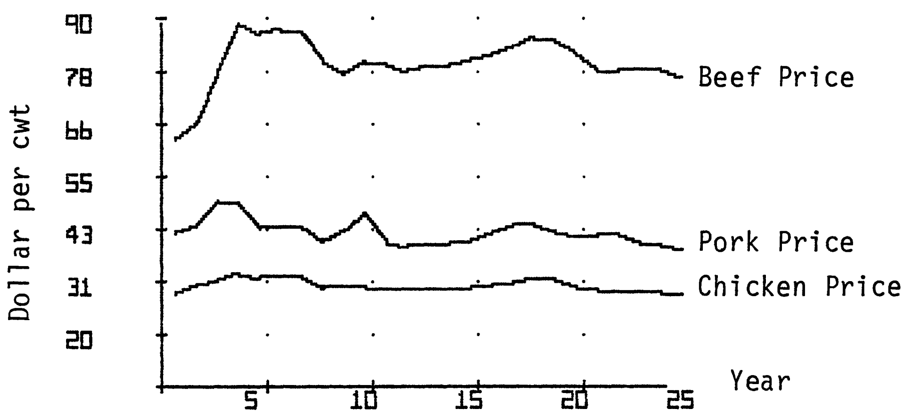
The total average beef production was 17,700.9 million pounds per year over the 10-year period as compared with an average of 17,807.9 million pounds per year for the 90-year period. However, the absolute variability was reduced approximately 142.3 million pounds per year as the time period was extended to 90 years. On the other hand, the price received was slightly higher over the 10-year period at $78.51/cwt per year as compared with $77.71/cwt per year. Absolute variability was approximately the same for both periods. Figures 31 and 32 present the production and prices over 25- and 100-year periods. Production and prices still fluctuate over these years. This indicates that scheme #2 (0.5 price/0.9 margin) does not have a complete stabilizing effect on production and prices.

<u>Hog Sector for 10- and 90-Year Averages</u>. Table XXIV presents summary of the estimated effect of stabilization payments for the hog sector. Under scheme #2 (0.5 price/0.9 margin), the direct profit was negative for both the 10- and 90-year averages. However, with stabilization payment of $2.38 and $1.96/cwt per year the net income was raised to the positive levels of $-0.22 and $0.02/cwt for the 10- and 90-year periods respectively. Net profit variability as shown by the standard deviation was $1.97 and $1.56/cwt per year on average for the 10- and 90-year periods which is a reduction of $0.41/cwt per year as the time period was extended to 90 years.

Total pork production and price received moved in the opposite direction. On average slightly higher production was generated over



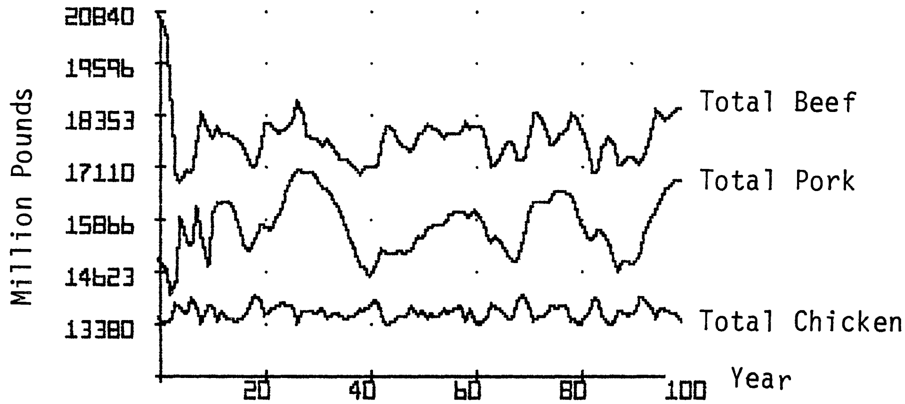
(a)



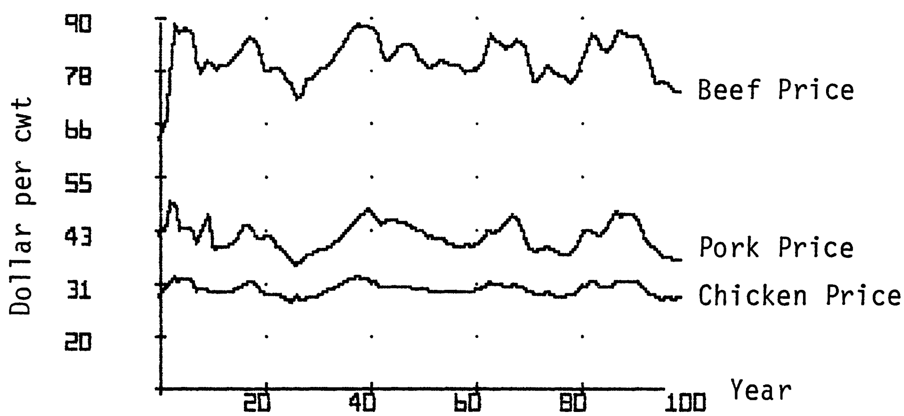
(b)

Figure 31(a). Beef, Pork and Chicken Production for Scheme #2, Option 2, Over 25 Years

(b). Beef, Pork and Chicken Prices for Scheme #2, Option 2, Over 25 Years



(a)



(b)

Figure 32(a). Beef, Pork and Chicken Production for Scheme #2, Option 2, Over 100 Years

(b). Beef, Pork and Chicken Prices for Scheme #2, Option 2, Over 100 Years

TABLE XXIV

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #2 FOR HOG SECTOR, OPTION 2

Variables	10-Year Average	90-Year Average
Level of Direct Profit		
$/cwt per year	-1.505	-1.099
standard deviation	5.845	4.235
Level of Net Profit with Taxes and Payment		
$/cwt	-0.223	0.028
standard deviation	1.971	1.561
Level of Gross Income with Payment But Before Taxes		
$/cwt	42.851	42.759
standard deviation	2.365	2.881
Level of Net Income with Payment and Taxes		
$/cwt	-0.223	0.028
standard deviation	1.971	1.561
Level of Stabilization Payment		
$/cwt per year	2.383	1.958
standard deviation	3.972	2.478
Level of Contribution or Taxes from Producer		
$/cwt	1.10	0.832
Level of Production		
million pounds per year	15,849.127	15,817.326
standard deviation	855.986	651.285
Level of Price Received		
$/cwt per year	40.468	40.801
standard deviation	3.539	2.851
Total Fund Collected (50/50 Basis)		
$/cwt	2.20	1.664
Extra Cost to Government for Negative Fund		
$/cwt	0.183	0.294
Total Government Contribution		
$/cwt	1.283	1.126
Fund Remaining After Payment		
$/cwt	-0.183	-0.294
Net Cost to the Govt. After Taxes		
million dollars	283.824	248.659
Total Program Payment Made		
million dollars	527.170	432.403

the 10-year average, while slightly higher prices were received on average over the 90-year period. However, in both cases the stabilizing effect as shown by the standard deviation was greater over the 90-year period. Although the absolute variability was slightly lower over the 90-year period for both prices and production, as shown by Figure 31, prices and production still fluctuate over the entire period.

Summary on Cost to the Government for Both Beef and Hog Sectors for Scheme #2 (0.5 Price/ 0.9 Margin), Option 2

The implementation of stabilization payment for scheme #2 (0.5 price/0.9 margin) would have cost the government total program payments of (i.e. without producer tax contributions) $78.5 and $77.7 million per year on average for the 10- and 90-year periods respectively for the beef sector. Over the 10-year period, the average tax collected from the producers and matched by the government was $0.71/cwt which generated approximately $1.42/cwt of average total common fund. Payments did not exhaust the fund. Therefore, on average, there was a balance (or fund remaining) of $0.88/cwt, and no additional contribution for shortfall years was required from the government. Since the remaining fund was more than large enough to recover all government contributions, the net cost to government was $-24.9 million. In this case the government is making a profit of $24.9 million over the 10-year period. Thus, for the 10-year period, the scheme was self-financing and no costs were incurred to the government. However, if the remaining fund after covering the government cost of

$0.17/cwt was to be returned to producers, net income to producers would increase to $2.00/cow (0.17 * 4.275 + 1.274).

For the 90-year period, the total program payments would have been $132.7 million per year. However, with average tax contributions of $0.74/cwt from both producers and governments to the common fund, the net cost compared with the government was $24.3 million per year as compared with $132.7 million per year of the total program payments. The common fund was not fully utilized in all years and had an average remaining balance of $0.57/cwt. There were no years in which the government had to subsidize the fund because all collected funds had been exhausted.

Cost to the government for the hog sector would have been $527.2 and $432.4 million per year without any contribution over the 10- and 90-year periods respectively. But with contributions of $1.10 and $0.83/cwt to the common fund by producers, the net cost to the government was reduced to $283.8 and $248.7 million per year for the 10- and 90-year averages respectively. The total common fund collected was $2.20/cwt with no remaining fund over the 10-year period. In fact, on average the fund was in deficit by $0.18/cwt. Similarly, the total common fund collected over the 90-year period was $1.66/cwt with an average deficit of $0.29/cwt. Note that the negative remaining fund was equal to an extra or additional contribution from the government. Government will contribute an additional subsidy if the fund was not sufficient to cover the required payment. Total cost to the government was reduced as the time period was extended to 90 years.

The total cost to government for both beef and hog producers would have been $283.8 per year (from the hog sector only, since zero cost to the beef sector) and \$272.9 per year (24.3 + 248.6) over the 10- and 90-year periods respectively.

Scheme #3 (1.2 Profit/0.98 Profit)

Stabilization Payment and Funding for Beef Sector. As described previously, the stabilization payment system for scheme #3 (1.2 profit/ 0.98 profit) is based on the absolute value of negative profit. Such payment and computation of tax contributions and funding can be presented as follows:

$$SPB = -BR(0) * 1.2 \quad (172)$$

$$\text{IF } BR(0) \geq 0 \text{ THEN } SPB = 0 \quad (173)$$

$$COPB = 0.5 * BR(0) \quad (174)$$

$$COGB = COPD\text{, GO TO EQUATION (179)} \quad (175)$$

$$\text{IF } BR(0) < 0 \text{ THEN } SPB = |-BR(0)| * 1.2 \quad (176)$$

$$COPB = 0 \quad (177)$$

$$COGB = 0 \quad (178)$$

$$TCFDB = COPB + COGB \quad (179)$$

where

COPB = contribution required from producer (\$/cwt)

COGB = contribution required from government (\$/cwt)

TCFDB = total common fund from government and producers (\$/cwt)

SPB = stabilization or deficiency payment (\$/cwt)

BR(0) = profit with payment and taxes (\$/cwt)

Equation (172) shows the calculation of stabilization payment for the beef sector under scheme #3 (1.2 profit/0.98 profit) as presented in option 1. Thus, if profit with payment is positive, no payment will be made [equation (173)] and the producer is required to contribute 0.5 of the positive profit with a matching contribution from the government [equations (174) and (175) respectively]. On the other hand, if BR(0) is negative, stabilization payment SPB will be paid to producers, and no contribution is necessary from the producer and the government. The payment will be subtracted from the total common fund.

Stabilization Payment and Funding for Hog Sector. The stabilization payment and contribution for the hog sector can also be represented in the similar manner as in the beef sector and can be presented as follows:

$$SPH = -PIEH * 0.98 \quad (180)$$

$$IF\ PIEH \geq 0\ THEN\ SPH = 0 \quad (181)$$

$$COPH = 0.5 * PIEH \quad (182)$$

$$COGH = COPH,\ GO\ TO\ EQUATION\ (187) \quad (183)$$

$$IF\ PIEH < 0\ THEN\ SPH = |-PIEH| * 0.98 \quad (184)$$

$$COPH = 0 \quad (185)$$

$$COGH = 0 \quad (186)$$

$$TCFDH = COPH + COGH \quad (187)$$

where

COPH = contribution required from producers ($/cwt)

COGH = contribution required from government ($/cwt)

TCFDH = total common fund from government and producer ($/cwt)

SPH = stabilization or deficiency payment ($/cwt)

PIEH = direct profit ($/cwt)

Equation (180) presents the computation of stabilization payment for the hog sector in general. As in the beef sector, a similar explanation could be applied to the hog sector regarding the computation of contribution requirement and funding calculation.

Simulation Results for Scheme #3 (1.2 Profit/0.98 Profit)

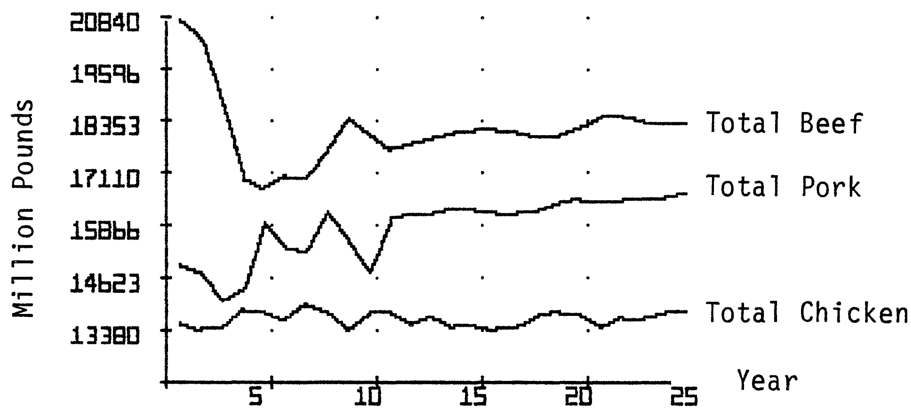
Beef Sector for 10- and 90-Year Averages. Table XXV presents the summary of the estimated effect of stabilization payment for scheme #3 (1.2 profit/0.98 profit), while Figures 33 and 34 represent production and prices over 25- and 100-year periods. Stabilization payment scheme #3 (1.2 profit/0.98 profit) generated negative profit for direct profit over the 10- and 90-year periods. However, stabilization payment of $4.62 and $5.62/cwt, profit with payment and after taxes [BR(0)] increased to a positive $2.26 and $1.38/cwt over the 10- and 90-year periods respectively. The variability of profits as shown by the standard deviation was reduced to almost half for the profit with payment and tax variable [BR(0)] as compared with direct profit for both the 10- and 90-year periods. The high payment levels of $4.62 and $5.62/cwt on average for the 10- and 90-year periods generated positive levels of net income per cow of $9.70 and $5.95/cwt per year with absolute variability of $19.74 and $5.30/cwt per year on average for the 10- and 90-year periods respectively. Thus the net income becomes more stable as the time period was extended to 90 years.

The level of production was 18,021.4 and 18,193.4 million pounds per year for the 10- and 90-year periods. Absolute variability as shown by the standard deviation fell by approximately 47.5 million pounds per year as the time period was extended to 90 years. The price received, however, was slightly higher over the 10-year period at $75.75/cwt as compared with $73.76/cwt over the 90-year period. Similarly, price variability as indicated by the standard deviation was lower over the 90-year period at $1.55/cwt as compared with $2.54/cwt

TABLE XXV

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #3 FOR BEEF SECTOR, OPTION 2

Variables	10-Year Average	90-Year Average
Level of Direct Profit		
$/cwt per year	-2.247	-4.221
standard deviation	3.773	2.049
Level of Profit		
$/cwt	2.258	1.381
standard deviation	1.548	1.235
Level of Gross Income with Payment But Before Taxes		
$/cow	343.556	339.316
standard deviation	8.984	7.573
Level of Net Income with Payment and Taxes		
$/cow	9.697	5.945
standard deviation	19.736	5.301
Level of Stabilization Payment		
$/cwt per year	4.616	5.618
standard deviation	1.795	1.474
Level of Contribution or Taxes from Producer		
$/cwt	0.028	0.006
Level of Production		
million pounds per year	18,021.377	18,193.379
standard deviation	253.600	206.090
Level of Price Received		
$/cwt per year	75.748	73.755
standard deviation	2.541	1.546
Total Fund Collected (50/50 Basis)		
$/cwt	0.056	0.012
Extra Cost to Government for Negative Fund		
$/cwt	4.56	5.603
Total Government Contribution		
$/cwt	4.588	5.609
Fund Remaining After Payment		
$/cwt	-4.56	-5.603
Net Cost to the Govt. After Taxes		
million dollars	694.423	848.958
Total Program Payment Made		
million dollars	698.661	850.320



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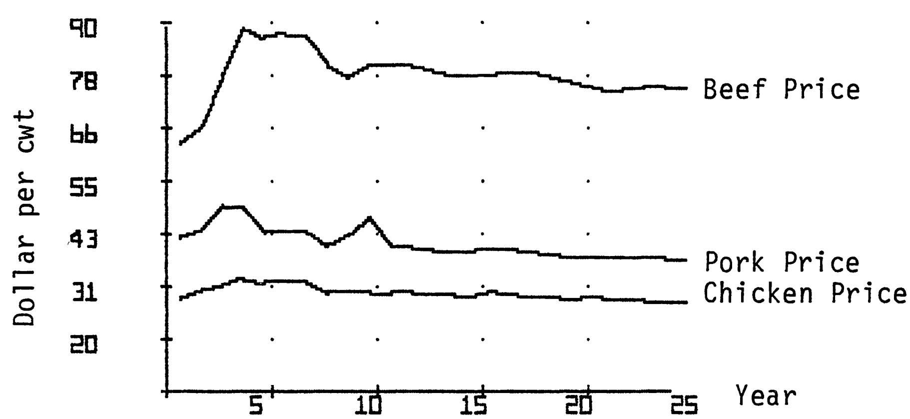
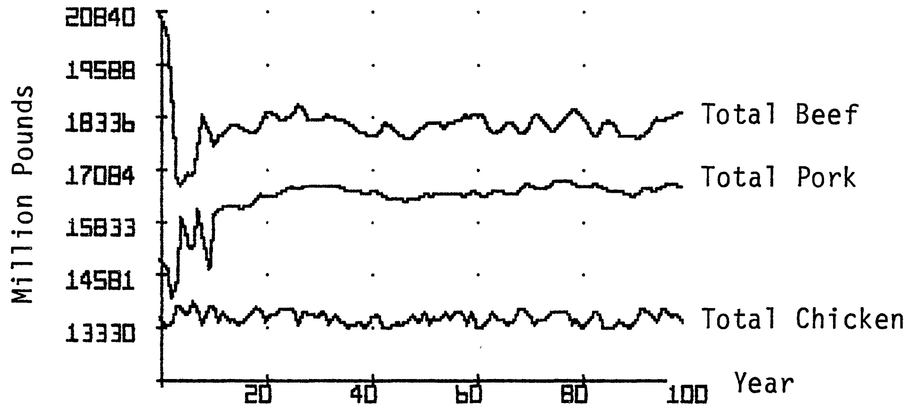


(b)

Figure 33(a). Beef, Pork and Chicken Production for Scheme #3, Option 2, Over 25 Years

(b). Beef, Pork and Chicken Prices for Scheme #3, Option 2, Over 25 Years



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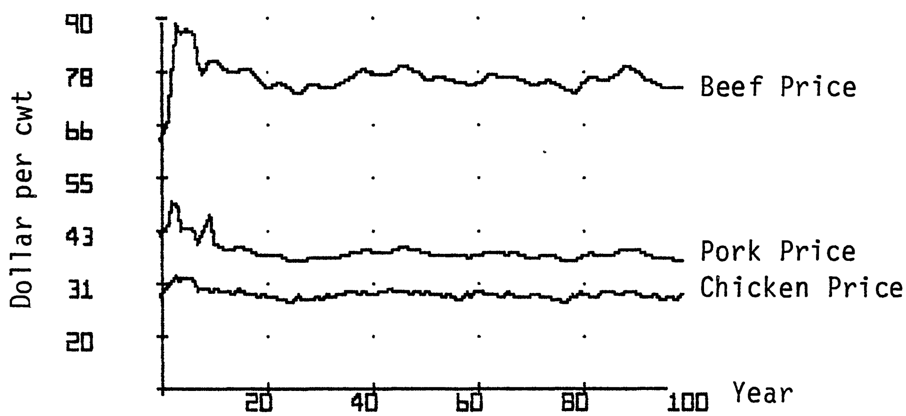


(b)

Figure 34(a). Beef, Pork and Chicken Production for Scheme #3, Option 2, Over 100 Years

(b). Beef, Pork and Chicken Prices for Scheme #3, Option 2, Over 100 Years

over the 10-year period. The reduction in variability for both production and prices was an indication that scheme #3 (1.2 profit/0.98 profit) has the ability to stabilize the beef sector in general as compared with scheme #1 (base) which fluctuated with a large variation for production, prices and income over the 90-year period (see Figures 31 and 34 for comparison).

Hog Sector for 10- and 90-Year Averages. Table XXVI presents the summary of the estimated effects of stabilization payment scheme #3 (1.2 profit/0.98 profit) for the hog sector. The level of direct profit was $-4.68/cwt over the 10-year period and $-4.70/cwt per year over the 90-year period. The stabilization payments of $4.82 and $4.78/cwt per year increased the net income after taxes to $0.20 and $0.03/cwt per year for the 10- and 90-year periods respectively.

Under scheme #3 (1.2 profit/0.98 profit) the level of production was slightly higher and the price received was slightly lower for the 90-year period as compared with the 10-year period. The variability of production and prices was reduced drastically as the time period was extended to 90 years. A standard deviation of 172.6 million pounds per year was recorded for production over the 90-year period as compared with 404.372 million pounds per year over the 10-year period. Similarly the standard deviation for prices was $0.80/cwt per year over the 90-year period as compared with $1.51/cwt per year over the 10-year period, a reduction of almost 72 percent. Figures 33 and 34 present the simulated production and prices for the hog sector over 25- and 100-year periods.

TABLE XXVI

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #3 FOR HOG SECTOR, OPTION 2

Variables	10-Year Average	90-Year Average
Level of Direct Profit		
$/cwt per year	-4.681	-4.703
standard deviation	4.807	3.897
Level of Net Profit with Taxes and Payment		
$/cwt	0.195	0.032
standard deviation	0.693	0.270
Level of Gross Income with Payment But Before Taxes		
$/cwt	42.109	41.980
standard deviation	4.148	3.764
Level of Net Income with Payment and Taxes		
$/cwt	0.195	0.032
standard deviation	0.693	0.270
Level of Stabilization Payment		
$/cwt per year	4.816	4.784
standard deviation	3.922	3.622
Level of Contribution or Taxes from Producer		
$/cwt	0.271	0.124
Level of Production		
million pounds per year	16,234.180	16,582.981
standard deviation	404.372	172.636
Level of Price Received		
$/cwt per year	76.663	76.232
standard deviation	1.513	0.795
Total Fund Collected (50/50 Basis)		
$/cwt	0.542	0.248
Extra Cost to Government for Negative Fund		
$/cwt	4.274	4.536
Total Government Contribution		
$/cwt	4.547	4.660
Fund Remaining After Payment		
$/cwt	-4.274	-4.536
Net Cost to the Govt. After Taxes		
million dollars	1,042.344	1,069.272
Total Program Payment Made		
million dollars	1,104.005	1,097.726

<u>Summary on Cost to the Government for Both Beef and Hog Sectors for Scheme #3 (1.2 Profit/ 0.98 Profit), Option 2</u>

Table XXV presents the summary of the estimated effects of stabilization payments with government contribution to the beef sector. Average annual total program payments made were $698.7 and $850.3 million per year for the beef sector over the 10- and 90-year periods respectively.

The contribution required from the producers was $0.03/cwt per year for the 10-year period for the beef sector. Thus, with government matching contributions, the total common fund collected was $0.06/cwt. The total fund of $0.06/cwt was not sufficient to cover the payments, thus it required the government to contribute an additional subsidy of $4.56/cwt to the fund making the total government contribution of $4.59/cwt per year for the beef sector over the 10-year period. Hence, with producers' contribution of $0.03/cwt per year, the cost to the government with contribution was reduced to $694.4 million per year as compared with $698.7 million per year without any contribution over the 10-year period.

Similarly, a contribution of $0.01/cwt was required from the producer of the beef sector over the 90-year period. As in the 10-year period the total funds collected were not sufficient to pay the stabilization payment of $5.62/cwt per year. Thus the government has to contribute another $5.60/cwt per year, making the total government contribution to the common fund about $5.61/cwt per year. The total cost to the government with producers' contribution was $848.9 million per year, a reduction of $1.4 million per year as compared with $850.3 million per year without contribution.

The hog sector, on the other hand, had annual average total payments of $1104.0 and $1097.7 million per year over the 10- and 90-year periods. It required $0.27/cwt per year contribution from the producers over the 10-year period. With a matching contribution from the government, the total common funds collected were $0.54/cwt per year. As in the beef sector, the fund collected is not sufficient to cover the stabilization payment of $4.82/cwt per year over the 10-year period. Therefore it required another $4.27/cwt per year of an additional contribution from the government in order to meet the payment. The total net cost to the government with producers' contribution was $1042.3 million per year as compared with $1104.0 million per year without any contribution over the 10 years, a reduction of $61.7 million per year on average.

Contributions from producers were only $0.12/cwt per year over the 90-year period which is a reduction of $0.15/cwt per year compared with the 10-year period. Again the amount of funds collected was not sufficient and required a total contribution of $4.54/cwt per year from the government over the 90-year period. Cost to the government with taxes would have been $1069.3 million per year as compared with $1097.8 million per year from cost to the government without any tax contribution.

The overall net cost to the government for both the beef and hog sector over the 10-year period was estimated to be $1736.7 (694.4 + 1042.3) million per year versus $1918.2 (848.9 + 1069.3) million per year over the 90-year period.

Scheme #4 (0.9 Margin/0.5 Price)

Stabilization Payment and Funding for Beef Sector. The stabilization payment and computation of funding for scheme #4 (0.9 margin/0.5 price) can be presented as follows:

SPB = SUPB - FB (188)

IF SPB $\leq$ 0 THEN SPB = 0 (189)

i.e. FB > SUPB, NO PAYMENT

COPB = 0.5 * (FB - SUPB) (190)

COGB = COPB, GO TO EQUATION (195) (191)

IF SPB > 0, THEN SPB = SPB (192)

COPB = 0 (193)

COGB = 0 (194)

TCFDB = COPB + COGB (195)

where

COPB = contribution required from the producers ($/cwt)

FB = farm beef price ($/cwt)

COGB = contribution required from the government ($/cwt)

TCFDB = total contribution collected from producers and government ($/cwt)

SPB = stabilization payment ($/cwt)

SUPB = support price for any given year ($/cwt)

A detailed discussion of computation of stabilization payment in equation (188) was presented earlier in option 1. Equations (189) to (195) present the computation of tax contributions required from producers and the total fund collected. Therefore, if the price received is greater than the support price, producers are required to contribute as in equation (190) or otherwise no contribution is necessary.

Stabilization Payment and Funding for Hog Sector. The stabilization payment for the hog sector and computation of funding can be presented as follows:

SPHq = 50% * (HMFPq - FPq) (196)

IF SPHq $\leq$ 0 THEN SPHq = 0 (197)

i.e. FPq > SPHq, NO PAYMENT

COPH = 0.5 * (FP - HMFPq) (198)

COGH = COPH, GO TO EQUATION (203) (199)

IF SPHq > 0 THEN SPHq = SPHq (200)

COPH = 0 (201)

COGH = 0 (202)

TCFDH = COPH + COGH (203)

where

COPH = contribution required from the producers ($/cwt)

COGH = contribution required from the government ($/cwt)

TCFDH = total common fund collected from government and producers ($/cwt)

FPq = farm hog price for the quarter ($/cwt)

SPHq = stabilization payment for the quarter ($/cwt)

HMFPq = eight year moving average of hog price ($/cwt)

A detailed discussion of the computation for the stabilization payment calculations made in equation (196) has been already presented in option 1. Equations (197) to (203) represent the computation of contributions required from the producers and government to the common fund.

Simulation Results for Scheme #4 (0.9 Margin/0.5 Price)

Beef Sector for 10- and 90-Year Averages. As indicated in Table XXVII, the level of direct profit was negative for both the 10- and 90-year averages. However, with stabilization payment of $12.13 and $16.67/cwt per year the level of net profit (with payment and taxes) was raised to $7.45 and $6.21/cwt per year for the 10- and 90-year periods respectively. The level of profit with payment was quite high for the beef sector under scheme #4 (0.9 margin/0.5 price) as compared with scheme #1 (base), it also generated a very low level of profit as shown by the standard deviation of $2.21 and $0.77/cwt per year over the 10- and 90-year periods respectively.

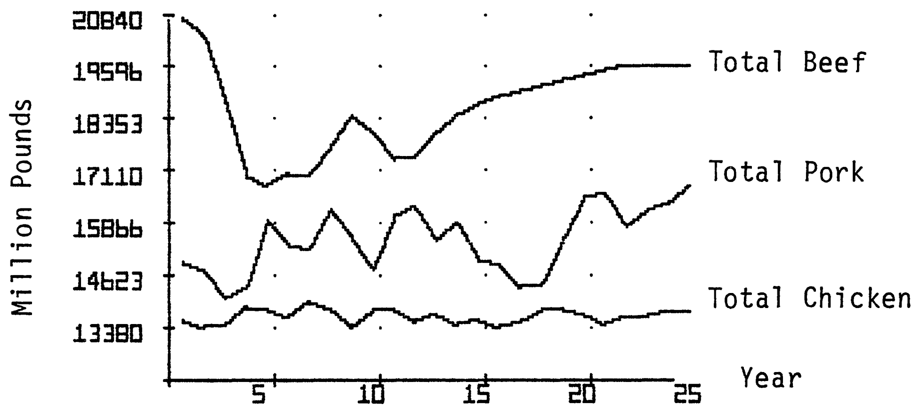
The level of net income per cow with payment and taxes generated under scheme #4 (0.9 margin/0.5 price) was $31.85 and $26.56/cow per year for the 10- and 90-year periods respectively. The absolute variability was approximately three times smaller over 90 years as compared with 10 years, thus indicating that more stability could be achieved as the time period was extended to 90 years.

The level of production was 18,555.5 and 19,541.3 million pounds per year over the 10- and 90-year periods respectively. The stabilizing effect of the program as indicated by absolute variability could be seen as the time period was extended to 90 years. The absolute variability fell to 425.8 million pounds per year as compared with 766.3 million pounds per year over the 10-year period. Figures 35 and 36 present graphically the simulated production and prices for 25- and 100-year periods respectively.

TABLE XXVII

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #4 FOR BEEF SECTOR, OPTION 2

Variables	10-Year Average	90-Year Average
Level of Direct Profit		
$/cwt per year	-4.490	-10.439
standard deviation	7.816	3.830
Level of Profit with Taxes & Paymt.		
$/cwt	7.451	6.212
standard deviation	2.208	0.769
Level of Gross Income with Payment But Before Taxes		
$/cow	365.788	359.969
standard deviation	18.074	12.942
Level of Net Income with Payment and Taxes		
$/cow	31.854	26.558
standard deviation	42.508	3.286
Level of Stabilization Payment		
$/cwt per year	12.126	16.672
standard deviation	5.927	3.302
Level of Contribution or Taxes from Producer		
$/cwt	0	0
Level of Production		
million pounds per year	18,555.510	19,541.307
standard deviation	766.290	425.847
Level of Price Received		
$/cwt per year	73.438	67.531
standard deviation	7.940	3.188
Total Fund Collected (50/50 Basis)		
$/cwt	0	0
Extra Cost to Government for Negative Fund		
$/cwt	12.126	16.672
Total Government Contribution		
$/cwt	12.126	16.672
Fund Remaining After Payment		
$/cwt	0	0
Net Cost to the Govt. After Taxes		
million dollars	1,939.956	2,765.936
Total Program Payment Made		
million dollars	1,939.956	2,765.936



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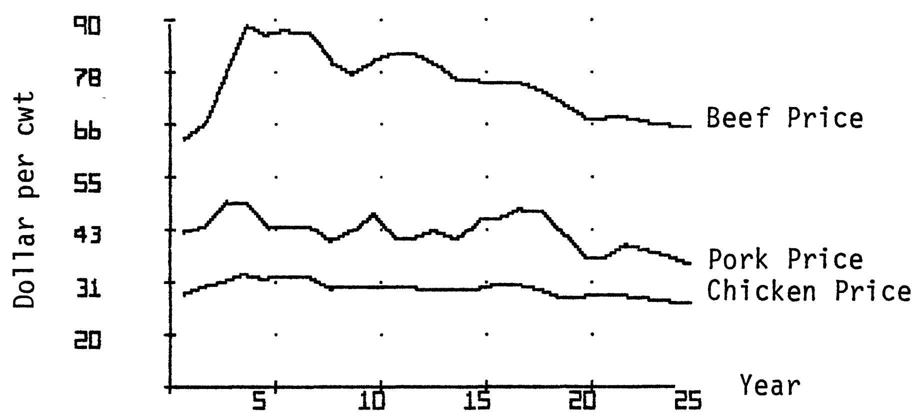
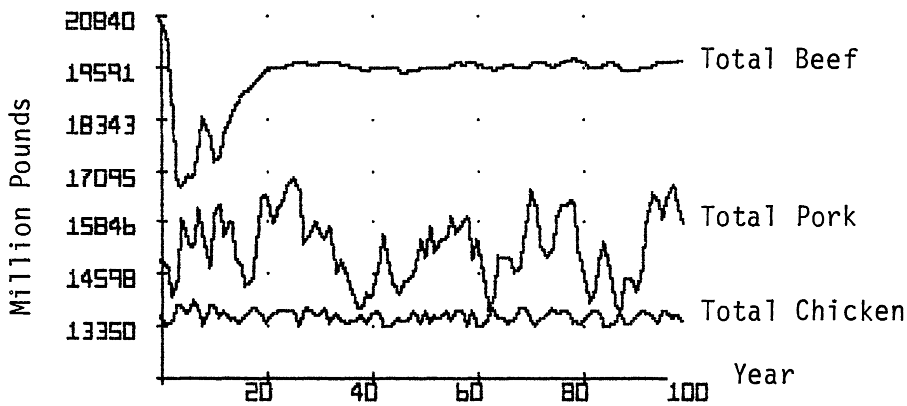


(b)

Figure 35(a). Beef, Pork and Chicken Production for Scheme #4, Option 2, Over 25 Years

(b). Beef, Pork and Chicken Prices for Scheme #4, Option 2, Over 25 Years



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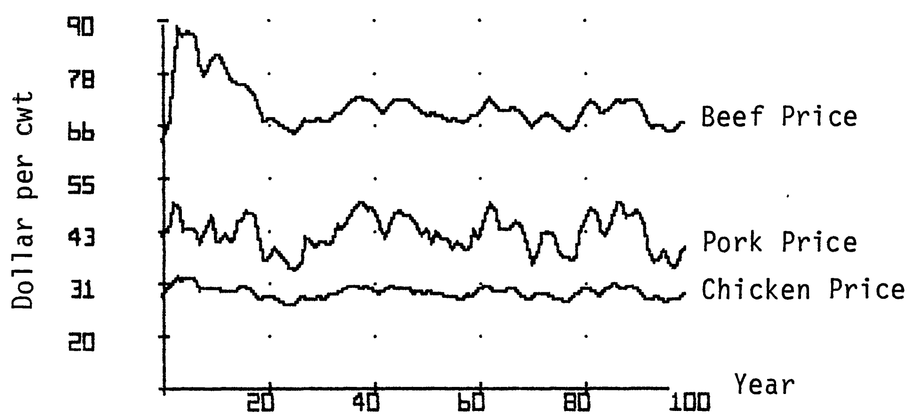


(b)

Figure 36(a). Beef, Pork and Chicken Production for Scheme #4, Option 2, Over 100 Years

(b). Beef, Pork and Chicken Prices for Scheme #4, Option 2, Over 100 Years

The price level moves in the opposite direction of the level of production. Higher prices of $73.44/cwt per year and lower prices of $67.53/cwt per year were generated over the 10- and 90-year periods respectively. The absolute variability of prices was approximately 2.5 times lower over the 90-year period at $3.19/cwt per year as compared with $7.94/cwt per year over the 10-year period.

Hog Sector for 10- and 90-Year Averages. Table XXVIII presents the summary of the estimated effect of the stabilization payment program for the hog sector under scheme #4 (0.9 margin/0.5 price). The hog sector program does not generate the same results as in the beef sector under scheme #4 (0.9 margin/0.5 price). The level of direct profit was $0.15/cwt per year over the 10-year period, but was negative ($-0.21/cwt per year) over the 90-year period. However, with stabilization payment of $0.73 and $0.76/cwt per year, net income with payment and taxes becomes $0.27 and $-0.10/cwt per year over the 10- and 90-year periods respectively. Although the net income was still negative over the 90-year period, it was reduced to $-0.10/cwt as compared with $-0.21/cwt of direct profit. The absolute variability of the net income was approximately the same for both the 10- and 90-year periods.

Total hog production was slightly higher at 15,424.7 million pounds per year over the 10-year period. It also generated higher prices. Hog production and prices were 15,280.3 million pounds per year and $41.69/cwt per year respectively over the 90-year period. The absolute variability for both production and prices were slightly lower over the 10-year period. As indicated in Figures 35 and 36 the

TABLE XXVIII

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #4 FOR HOG SECTOR, OPTION 2

Variables	10-Year Average	90-Year Average
Level of Direct Profit		
$/cwt per year	0.152	-0.213
standard deviation	5.163	4.730
Level of Net Profit with Taxes and Payment		
$/cwt	0.274	-0.096
standard deviation	4.665	4.168
Level of Gross Income with Payment But Before Taxes		
$/cwt	42.859	42.442
standard deviation	2.356	3.216
Level of Net Income with Payment and Taxes		
$/cwt	0.274	-0.096
standard deviation	4.665	4.168
Level of Stabilization Payment		
$/cwt per year	0.733	0.755
standard deviation	0.984	1.008
Level of Contribution or Taxes from Producer		
$/cwt	0.611	0.639
Level of Production		
million pounds per year	15,424.700	15,280.311
standard deviation	744.461	853.651
Level of Price Received		
$/cwt per year	42.126	41.687
standard deviation	3.291	3.839
Total Fund Collected (50/50 Basis)		
$/cwt	1.222	1.278
Extra Cost to Government for Negative Fund		
$/cwt	0	0
Total Government Contribution		
$/cwt	0.611	0.639
Fund Remaining After Payment		
$/cwt	0.489	0.523
Net Cost to the Govt. After Taxes		
million dollars	27.259	25.646
Total Program Payment Made		
million dollars	163.786	166.896

production and prices for hog still fluctuate without showing any stabilizing patterns over the years.

Summary on Cost to the Government for Both Beef and Hog Sectors for Scheme #4 (0.9 Margin/ 0.5 Price), Option 2

Total program payments made were estimated at $1,940.0 and $2,765.9 million per year over the 10- and 90-year periods respectively for the beef sector. However, under scheme #4 (0.9 margin/0.5 price) there were no contributions from the producers, so no matching government contributions were made and collected. The total program payment was bore entirely by the government. The cost to government with and without contribution are the same for both periods.

The total program payments for the hog sector were $163.8 and $166.9 million per year for the 10- and 90-year periods respectively. A tax contribution of $0.61/cwt was collected from hog producers over the 10-year period. With government matching contribution the total fund collected was $1.28/cwt per year. This fund was more than sufficient to cover the stabilization payment of $0.73/cwt per year with remaining fund of $0.49/cwt per year, therefore making the net cost to government only $27.3 million per year (after covering some of the government contribution or cost from the remaining fund). Thus the bulk of the payment was financed by the contribution or taxes from producers with an additional $27.3 million per year average from the government. Therefore, under scheme #4 (0.9 margin/0.5 price), the hog sector was more or less a self-financing scheme for the 10-year period.

Similarly, the contribution required by producers and the government was \$0.64/cwt per year over the 90-year period. No additional contributions from the government were necessary over the 90-year period. The total fund of \$1.28/cwt per year was sufficient to cover the stabilization payment required with \$0.52/cwt per year fund remaining. The net cost to government with contribution was \$25.6 million per year, a reduction of \$141.3 million per year on average from total payment that was required to be paid to the producers.

Total cost to the government for both beef and hog sectors would have been \$1967.3 (1940.0 + 27.3) and \$2791.5 (2765.9 + 25.6) million per year for the 10- and 90-year periods respectively.

Scheme #5 (0.9 MA Profit/1.0 Profit)

Stabilization Payment and Funding for Beef Sector. Stabilization payment and funding for the beef sector under scheme #5 (0.9 MA profit/1.0 profit) was similar to that of scheme #4 (0.9 margin/0.5 price). For detailed discussion refer to the stabilization payment and funding for the beef sector under scheme #4 (0.9 margin/0.5 price).

Stabilization Payment and Funding for Hog Sector. The computation of stabilization payment and funding for the hog sector under scheme #5 (0.9 MA profit/1.0 profit) was similar to that of scheme #3 (1.2 profit/0.98 profit). The only difference is in equation (182) in scheme #3 (1.2 profit/0.98 profit). Instead of paying the producer 98 percent of the absolute negative profit, the producer is paid 100 percent of any negative profit. Thus, equation (182) can be presented as follows:

$$SPH = |-PIEH| \quad (204)$$

where

SPH = stabilization payment for hog ($/cwt)

PIEH = profit for hog sector ($/cwt)

Simulation Results for Scheme #5
(0.9 MA Profit/1.0 Profit)

Beef Sector for 10- and 90-Year Averages. Table XXIX presents the summary of the estimated effect of stabilization payment for the beef sector under scheme #5 (0.9 MA profit/1.0 profit). The direct profit was negative for both the 10- and 90-year periods at $-5.93 and $-12.89/cwt per year respectively. Stabilization payment of $13.66 and $19.13/cwt per year raise the profit with payments and taxes [BR(0)] to $7.45 and $6.21/cwt per year over the 10- and 90-year periods respectively. The level of net income per cow was slightly higher for the 10-year period at $31.85/cow per year as compared with that of $26.56/cow per year over the 90-year period. Although the net income was slightly lower over the 90-year period on average, the standard deviation was 13 times smaller than the 10-year period.

Total production was 18,555.5 and 19,541.3 million pounds per year for the 10- and 90-year periods respectively. However, the absolute variability for production as shown by the standard deviation over the 90-year period was reduced to 425.8 million pounds per year as compared with that of 766.3 million pounds per year over the 10-year period. Similarly the absolute variability for prices, as shown by the standard deviation was $2.96/cwt per year over the 90-year period as compared with that of $8.94/cwt per year over the 10-year period. Thus, as the

TABLE XXIX

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #5 FOR BEEF SECTOR, OPTION 2

Variables	10-Year Average	90-Year Average
Level of Direct Profit		
$/cwt per year	-6.026	-12.89
standard deviation	8.721	3.827
Level of Profit with Taxes & Paymt.		
$/cwt	7.451	6.212
standard deviation	2.208	0.769
Level of Gross Income with Payment But Before Taxes		
$/cow	365.788	359.969
standard deviation	18.074	12.942
Level of Net Income with Payment and Taxes		
$/cow	31.854	26.558
standard deviation	42.508	3.286
Level of Stabilization Payment		
$/cwt per year	13.658	19.126
standard deviation	6.692	3.260
Level of Contribution or Taxes from Producer		
$/cwt	0	0
Level of Production		
million pounds per year	18,555.510	19,541.30
standard deviation	766.290	425.847
Level of Price Received		
$/cwt per year	71.906	65.078
standard deviation	8.943	2.963
Total Fund Collected (50/50 Basis)		
$/cwt	0	0
Extra Cost to Government for Negative Fund		
$/cwt	13.658	19.126
Total Government Contribution		
$/cwt	13.658	19.126
Fund Remaining After Payment		
$/cwt	0	0
Net Cost to the Govt. After Taxes		
million dollars	2,188.068	3,172.688
Total Program Payment Made		
million dollars	2,188.068	3,172.688

time period was extended to 90 years, more stability in production and prices were generated under scheme #5 (0.9 MA profit/1.0 profit). Figures 37 and 38 present the production and prices over 25- and 100-year periods.

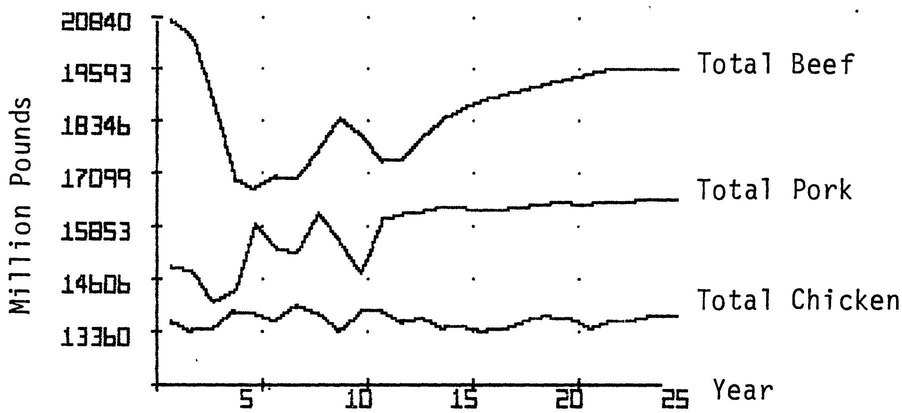
Hog Sector for 10- and 90-Year Averages. Table XXX presents the summary of the estimated effects of the stabilization payments and funding program for the hog sector under scheme #5 (0.9 MA profit/1.0 profit). The level of direct profit was negative for both the 10- and 90-year periods at $-3.75 and $-5.60/cwt per year respectively. However, with stabilization payment of $4.06 and $5.65/cwt per year, net income with payment and taxes is raised to $0.16 and $0.03/cwt per year for the 10- and 90-year periods respectively. As in the beef sector, the standard deviation for net income was approximately 7 times smaller over the 90-year period as compared with the 10-year period.

Patterns similar to the beef sector were observed for the hog sector with regard to its production and prices received . Higher production and lower prices were observed over the 90-year period and vice versa over the 10-year period. Similarly, the absolute variability for production and prices was 113.5 million pounds per year and $0.89/cwt per year as compared with that of 294.4 million pounds per year and $2.49/cwt per year for the 90- and 10-year periods respectively. Figures 37 and 38 graphically present production and prices for the hog sector.

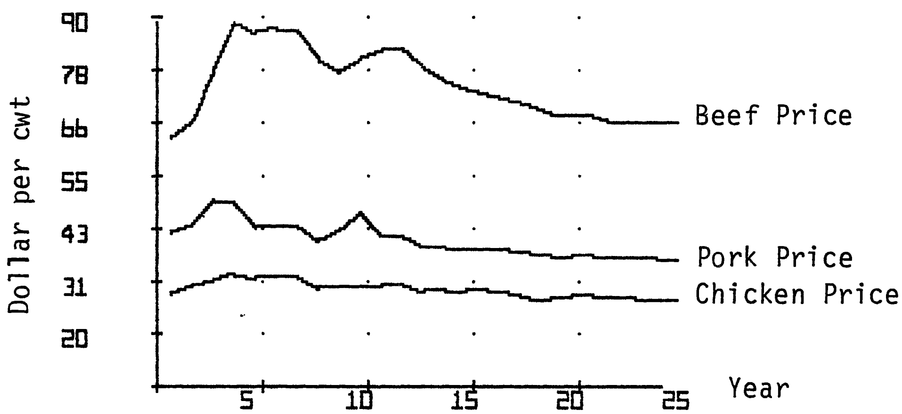
TABLE XXX

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OF SCHEME #5 FOR HOG SECTOR, OPTION 2

Variables	10-Year Average	90-Year Average
Level of Direct Profit		
$/cwt per year	-3.752	-5.597
standard deviation	4.236	3.782
Level of Net Profit		
$/cwt	0.156	0.025
standard deviation	0.531	3.998
Level of Gross Income with Payment But Before Taxes		
$/cwt	42.286	41.950
standard deviation	4.078	3.998
Level of Net Income with Payment and Taxes		
$/cwt	0.156	0.025
standard deviation	0.628	0.088
Level of Stabilization Payment		
$/cwt per year	4.064	5.647
standard deviation	3.859	3.731
Level of Contribution or Taxes from Producer		
$/cwt	0.156	0.025
Level of Production		
million pounds per year	16,276.193	16,520.427
standard deviation	294.437	113.507
Level of Price Received		
$/cwt per year	38.221	36.303
standard deviation	2.488	0.894
Total Fund Collected (50/50 Basis)		
$/cwt	0.312	0.05
Extra Cost to Government for Negative Fund		
$/cwt	3.725	5.597
Total Government Contribution		
$/cwt	3.908	5.622
Fund Remaining After Payment		
$/cwt	-3.752	-5.597
Net Cost to the Govt. After Taxes		
million dollars	871.718	1,272.024
Total Program Payment Made		
million dollars	906.509	1,277.683



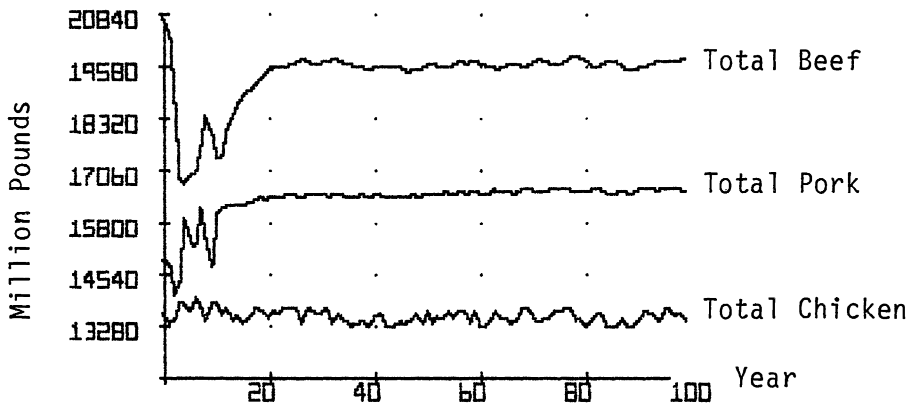
(a)



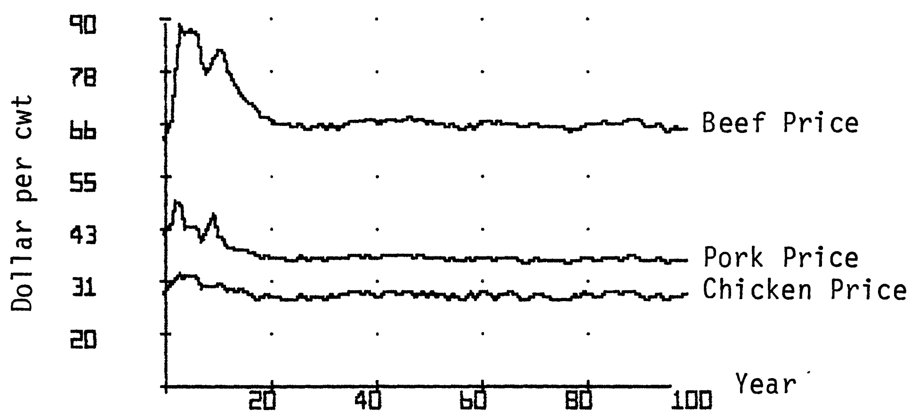
(b)

Figure 37(a). Beef, Pork and Chicken Production for Scheme #5, Option 2, Over 25 Years

(b). Beef, Pork and Chicken Prices for Scheme #5, Option 2, Over 25 Years



(a)



(b)

Figure 38(a). Beef, Pork and Chicken Production for Scheme #5, Option 2, Over 100 Years

(b). Beef, Pork and Chicken Prices for Scheme #5, Option 2, Over 100 Years

Summary on Cost to Government for Both Beef and Hog Sectors for Scheme #5 (0.9 MA Profit/ 1.0 Profit), Option 2

Total average annual beef sector program payments made were $2,188.1 and $3,172.7 million per year for the 10- and 90-year periods respectively. As in scheme #4 (0.9 margin/0.5 price), no contribution or taxes were required from beef producers. Thus, only the government had to support the entire stabilization payment for both the 10- and 90-year periods. The net cost to the government was similar to the total program payment.

Under scheme #5 (0.9 MA profit/1.0 profit), the hog sector required $906.5 and $1277.7 million per year of stabilization payments over the 10- and 90-year periods respectively. Unlike the beef sector, hog producers were required to contribute $0.16/cwt per year over the 10-year period. However, the total fund collected was not sufficient to cover the payment and required an additional contribution of $3.73/cwt per year. The total cost to the government with tax contributions was reduced to $871.7 million per year as compared with $906.5 million per year over the 10-year period without tax contribution (i.e. total program payment if there is no tax). On the other hand, average annual tax contributions of 0.025 were required from producers over the 90-year period, but the total fund collected was again not sufficient enough to cover the payment. Hence, the government was required to contribute an additional $5.60/cwt per year over the 90-year period making the total contribution of $5.62/cwt. Thus, the net cost to the government was $1277.7 million per year, a reduction of only $5.6 million per year due to tax contributions.

Comparative Stabilizing Effect with Respect to Absolute Variability for Production and Prices About the Mean and About the Trend Line Under Option 2

As in the first option, the measurement of stability used was also based on the standard deviation about the mean of the simulated result. The following section will try to compare and contrast variability as measured by standard deviation about the mean and the trend line. Such discussion was undertaken because the results generated not only fluctuated but also trended upward or downward and may have a significant role in the stabilizing effect of the different stabilizing payment with producers' contribution discussed earlier.

Scheme #1 (Base)

Beef and Hog Sectors for 10- and 90-Year Averages. The comparative stabilizing effect under scheme #1 (base) for 10 and 90 years for the beef and hog sectors was similar to that of the first option. For a detailed discussion refer to the same section in the first option.

Scheme #2 (0.5 Price/0.9 Margin)

Beef Sector for 10- and 90-Year Averages. Table XXXI presents the regression coefficient of the trend equation for beef production and prices, while Table XXXIII presents the summary of the standard deviation of production and prices about the mean and the trend line. Under scheme #2 (0.5 price/0.9 margin), the absolute variability of beef production over the 10-year average was 564.0 and 184.6 million

TABLE XXXI

ESTIMATED REGRESSION COEFFICIENTS AND SUMMARY STATISTICS OF THE TREND LINE EQUATIONS FOR PRODUCTION AND PRICES FOR BEEF SECTOR UNDER OPTION 2[a/]

Equations	Regression Coefficients for Over 10 Years: Constant	Regression Coefficients for Over 10 Years: Time	Regression Coefficients for Over 90 Years: Constant	Regression Coefficients for Over 90 Years: Time
Scheme #1				
Total Beef Production	18,279.497	-33.107	17,769.863	0.705
	(2.668)*	(1.200)	(2.850)*	(0.425)
	SE = 250.454[b/]		SE = 409.269	
Farm Level Beef Price	78.056	0.025	77.866	0.000911
	(1.003)	(0.080)	(1.482)	(0.065)
	SE = 1.321		SE = 3.467	
Scheme #2				
Total Beef Production	18,944.681	-80.243	17,737.366	1.271
	(3.751)*	(3.948)*	(2.769)*	(0.746)
	SE = 184.603		SE = 420.423	
Farm Level Beef Price	68.181	0.666	77.796	-0.0015
	(1.775)	(4.310)*	(1.348)	(0.098)
	SE = 1.404		SE = 3.787	
Scheme #3				
Total Beef Production	17,458.570	36.310	18,189.920	0.062
	(5.007)*	(2.588)*	(5.793)*	(0.075)
	SE = 127.449		SE = 206.083	

TABLE XXXI (Continued)

Equations	Regression Coefficients for Over 10 Years		Regression Coefficients for Over 90 Years	
	Constant	Time	Constant	Time
Farm Level Beef Price	81.160	-0.349	74.414	-0.012
	(4.802)*	(5.135)*	(3.226)*	(1.933)*
	SE = 0.618		SE = 1.514	
Scheme #4				
Total Beef Production	14,982.210	230.535	19,091.418	8.106
	(2.891)*	(11.055)*	(3.391)*	(5.407)*
	SE = 189.407		SE = 369.459	
Farm Level Beef Price	94.482	-1.358	70.141	8.752
	(3.131)*	(11.179)*	(1.565)	(3.940)*
	SE = 1.103		SE = 2.941	
Scheme #5				
Total Beef Production	14,982.210	230.535	19,091.418	8.106
	(2.891)*	(11.055)*	(3.391)*	(5.407)*
	SE = 189.407		SE = 369.459	
Farm Level Beef Price	94.482	-1.358	68.322	-0.058
	(3.131)*	(11.179)*	(1.766)*	(5.675)*
	SE = 1.103		SE = 2.539	

a/ t-statistics in parentheses
b/ standard error
* significantly different from zero at 0.05 level of significance

TABLE XXXII

ESTIMATED REGRESSION COEFFICIENTS AND SUMMARY STATISTICS OF THE TREND LINE EQUATIONS FOR PRODUCTION AND PRICES FOR HOG SECTOR UNDER OPTION 2[a/]

Equations	Regression Coefficients for Over 10 Years		Regression Coefficients for Over 90 Years	
	Constant	Time	Constant	Time
Scheme #1				
Total Hog Production	15,056.001	30.867	15,711.258	-1.611
	(0.817)	(0.416)	(1.406)	(0.541)
	SE = 673.592[b/]		SE = 733.423	
Farm Level Hog Price	43.326	-0.078	41.636	0.0034
	(0.510)	(0.228)	(0.852)	(0.541)
	SE = 3.103		SE = 3.208	
Scheme #2				
Total Hog Production	17,538.665	-109.002	15,947.730	-2.350
	(2.254)*	(3.481)*	(1.614)	(0.893)
	SE = 284.439		SE = 648.386	
Farm Level Hog Price	33.772	0.432	40.467	0.006
	(0.935)	(2.971)*	(0.923)	(0.521)
	SE = 1.321		SE = 2.847	
Scheme #3				
Total Hog Production	15,644.596	38.038	16,374.225	3.761
	(7.528)*	(4.548)*	(7.571)*	(6.531)*
	SE = 75.961		SE = 141.940	

TABLE XXXII (Continued)

Equations	Regression Coefficients for Over 10 Years: Constant	Regression Coefficients for Over 10 Years: Time	Regression Coefficients for Over 90 Years: Constant	Regression Coefficients for Over 90 Years: Time
Farm Level Hog Price	41.782	-0.198	38.016	-0.0089
	(4.424)*	(5.200)*	(3.285)*	(2.913)*
	SE = 0.345		SE = 0.760	
Scheme #4				
Total Hog Production	16,573.578	-74.121	15,380.979	-1.814
	(0.843)	(0.937)	(1.184)	(0.524)
	SE = 718.446		SE = 852.335	
Farm Level Hog Price	41.013	0.072	41.720	-0.00059
	(0.473)	(0.206)	(0.713)	(0.038)
	SE = 3.169		SE = 3.839	
Scheme #5				
Total Hog Production	15,669.517	39.140	16,332.076	3.394
	(11.637)*	(7.223)*	(15.124)*	(11.812)*
	SE = 49.216		SE = 70.874	
Farm Level Hog Price	44.611	-0.412	37.488	-0.021
	(3.634)*	(8.344)*	(3.519)*	(7.525)*
	SE = 0.449		SE = 0.699	

[a] t-statistics in parentheses
[b] standard error
* significantly different from zero at 0.05 level of significance

TABLE XXXIII

SUMMARY OF STANDARD DEVIATION OF PRODUCTION AND PRICES OVER 10- AND 90-YEAR AVERAGES ABOUT THE MEAN AND ABOUT THE TREND LINE FOR BEEF SECTOR, OPTION 2

	Standard Deviation About the Mean		Standard Deviation About the Trend Line	
	10-Year Average	90-Year Average	10-Year Average	90-Year Average
Scheme #1				
Total Beef Production	540.219	409.684	250.454	409.269
Farm Level Beef Price	3.747	3.448	1.321	3.447
Scheme #2				
Total Beef Production	564.043	421.733	184.603	420.423
Farm Level Beef Price	3.092	3.787	1.404	3.787
Scheme #3				
Total Beef Production	253.640	206.090	127.449	206.083
Farm Level Beef Price	2.541	1.546	0.618	1.514
Scheme #4				
Total Beef Production	1,294.510	425.847	189.407	369.459
Farm Level Beef Price	7.940	3.188	1.103	2.941
Scheme #5				
Total Beef Production	1,294.510	425.847	189.407	369.459
Farm Level Beef Price	8.943	2.963	1.103	2.539

pounds per year about the mean and the trend line respectively. However, as the time period was extended to 90 years, variability about the mean and the trend line became approximately the same at 421.7 and 420.4 million pounds per year respectively. The slope was rather flat over 90 years and is not significant enough to reduce the variability as compared with the case for the 10-year period. The variability for prices also shows a similar pattern as in production. The absolute variability was approximately the same about the trend line and about the mean for the 90-year period. The absolute variability was only \$1.40/cwt per year over the 10-year period as compared with \$3.09/cwt per year over the 90-year period. The slopes of the trend lines are significant for both production and prices. Therefore they have a stabilizing effect and reduce the variability of price and production over the 10-year period.

Hog Sector for 10- and 90-Year Averages. The hog sector shows a similar pattern as in the beef sector. Stability of production and prices could be observed about the trend line over the 10-year period. Table XXXII and Table XXXIV present the summary of the regression coefficient for the trend line and the summary of the standard deviation of production and prices for the hog sector. The variability was approximately 3.0 times larger over the 10-year period for about the mean as compared with about the trend line. This is likely due to the significant negative trend generated by the 10-year average which reduced the variability somewhat. The variability was approximately the same for about the mean and the trend line for both production and prices over the 90-year period. The trend line slopes for production and prices were not significant over the 90-year period.

TABLE XXXIV

SUMMARY OF STANDARD DEVIATION OF PRODUCTION AND PRICES OVER 10- AND 90-YEAR AVERAGES ABOUT THE MEAN AND ABOUT THE TREND LINE FOR HOG SECTOR, OPTION 2

	Standard Deviation About the Mean		Standard Deviation About the Trend Line	
	10-Year Average	90-Year Average	10-Year Average	90-Year Average
Scheme #1				
Total Pork Production	719.045	734.629	673.592	733.423
Farm Level Hog Price	3.154	3.209	3.103	3.208
Scheme #2				
Total Pork Production	855.986	651.285	284.439	648.386
Farm Level Hog Price	3.539	2.851	1.321	2.847
Scheme #3				
Total Pork Production	404.372	172.636	75.961	141.940
Farm Level Hog Price	1.513	0.795	0.345	0.760
Scheme #4				
Total Pork Production	744.461	853.651	718.446	852.335
Farm Level Hog Price	3.291	3.839	3.169	3.839
Scheme #5				
Total Pork Production	294.437	113.507	49.216	70.874
Farm Level Hog Price	2.488	0.894	0.449	0.699

Scheme #3 (1.2 Profit/0.98 Profit)

Beef Sector for 10- and 90-Year Averages. The average absolute variability for production over the 10-year period was 127.4 and 253.6 million pounds per year for about the trend line and the mean respectively, a reduction of 126.2 million pounds per year. The significant positive slope of the trend line helps to reduce the variability of production over 10 years. On the other hand, there was no difference between the absolute variability of production for both about the mean and the trend line as the time period was extended to 90 years (see Tables XXXI and XXXIII).

As in production, the price variability was reduced approximately four times for about the trend line as compared with about the mean over the 10-year period. However, as the time period was extended to 90 years the absolute variability became approximately the same for about the mean and the trend line. The variability increased from \$0.62 to \$1.51/cwt per year for about the trend line, but decreased from \$2.54 to \$1.55/cwt per year for about the mean. The slope parameter on the 90-year period trend is significantly different from zero. Because of this, one might expect the variance around the trend to be considerably less than that about the mean. This is not the case, however. This is probably because even though the parameter is significantly different from zero, it is very small.

Hog Sector for 10- and 90-Year Averages. The absolute variability of pork production about the mean was approximately five times larger than that of about the trend line over the 90-year period. However, the variability fell to 172.6 million pounds per year from

404.4 million pounds per year as the time period was extended to 90 years. On the other hand, the absolute variability about the trend line increased from 76.0 to 141.9 million pounds per year as the time period was extended to 90 years. Thus, over the 90-year period, the variabilities for about the mean and the trend line were approximately the same for production although the variability was slightly lower for about the trend line (see Tables XXXII and XXXIV).

Over the 90-year period, the price variability about the mean and the trend line was $0.80 and $0.76/cwt per year respectively. It does not show any difference at all. However, the existence of significant negative sloped price trend over the 10-year period helps to reduce the variability about the trend line to $0.35/cwt per year as compared with that of $1.51/cwt per year for about the mean.

Overall the stabilizing effect does prevail over the 10-year period for about the trend line equation but does not have any influence as the time period was extended to 90 years.

Scheme #4 (0.9 Margin/0.5 Price)

Beef Sector for 10- and 90-Year Averages. Under scheme #4 (0.9 margin/0.5 price), the stabilizing effect of the absolute variability about the trend line can be observed for both 10- and 90-year periods as compared with the absolute variability for about the mean (see Tables XXXI and XXXIII). The variability for production about the trend line over 10 years fell to 189.4 million pounds per year as compared with 1294.5 million pounds per year for about the mean. Similarly, the absolute variability about the trend line over the 90-year period fell to 369.5 million pounds per year as compared with

425.8 million pounds per year for about the mean. The large reduction could be due to the significant positive slope generated over the 10-year period which helped reduce the variability of production. A significant positive slope was being generated over the 90-year period also, but its magnitude was not as great as for the 10-year period.

The price variability follows the same pattern as those of production. Stability in prices can be observed for both 10 and 90 years for about the trend line and the mean. Scheme #4 (0.9 margin/0.5 price) is the first scheme to show significant trend coefficients for both price and quantity. It is also the first to show substantial differences between variation about the mean and about the trend line. However, it does not produce a lower overall variability than in scheme #3 (1.2 profit/0.98 profit).

Hog Sector for 10- and 90-Year Averages. The variability of production about the trend line and the mean were approximately the same for the 10-year average and 90-year average with a slightly lower value for about the trend line. Tables XXXII and XXXIV present the regression coefficients for the trend line equation and the summary of standard deviation of production and prices about the mean and the trend line respectively. A negative trend line of production could be observed over the 10- and 90-year periods. However, it is not significantly different from zero and does not reduce the production variability substantially as compared with variability about the mean.

Similarly, the variability for hog prices did not show any significant differences between about the mean and the trend line for both periods. Thus, under scheme #4 (0.9 margin/0.5 price), the hog sector did not achieve any increased stability over time as measured by variability about the mean or trend. Lower variability could be observed over the 10-year period versus the 90-year period in both measures.

Scheme #5 (0.9 MA Profit/1.0 Profit)

Beef Sector for 10- and 90-Year Averages. The absolute variability for production was exactly the same as those under scheme #4 (0.9 margin/0.5 price). More stability can be observed as shown by a large reduction in the standard deviation for about the trend line as compared with about the mean over the 10- and 90-year periods (see Tables XXXI and XXXIII).

The price variability under scheme #5 (0.9 MA profit/1.0 profit), however, does not have the same value as in scheme #4 (0.9 margin/0.5 price) but it does follow a similar pattern. Variability about the negative trend line of $1.10/cwt per year was observed over the 10-year period as compared with that of $8.94/cwt per year on average for about the mean line. As the time period was extended to 90 years the variability about the mean was reduced to $2.96/cwt per year but increased to $2.54/cwt per year about the trend line. In general, the significant slope generated by both the 10- and 90-year periods helped to reduce the variability for both production and prices tremendously.

Hog Sector for 10- and 90-Year Averages. The production variability was greatly reduced as indicated by the reduction of the standard deviation for about the trend line as compared with that of about the mean for both periods (see Tables XXXII and XXXIV). Significant positive trend lines were observed for production for both periods. These trend lines have a significant effect in reducing the variability measure for pork production.

The variability of hog prices also follows similar patterns as those for production. The absolute variability about the mean was $2.49/cwt per year but reduced to $0.45/cwt per year for about the trend line over the 10-year period. For the 90-year period the variability about the trend line is not much different from the variability of about the mean. Variability about the trend was only $0.20/cwt per year units lower than variability about the mean for the 90-year period.

Summary: Comparison of Measures of Variability Using Deviation About the Mean and About the Trend Line

For both the beef and hog sectors, significantly less variation was seen in the variation about the trend as compared with the variation about the mean for the 10-year period. This difference is attributable to the significant slope coefficients that were generated for the trend lines for production and prices especially in schemes #2 (0.5 price/0.9 margin), #3 (1.2 profit/0.98 profit), #4 (0.9 margin/0.5 price), and #5 (0.9 MA profit/1.0 profit) for the beef sector, and schemes #2 (0.5 price/0.9 margin), #3 (1.2 profit/0.98 profit) and #5 (0.9 MA profit/1.0 profit) for the hog sector. As in the first option, it is felt that a significant trend line was, in general, being detected because the model was still in disequilibrium and moving toward equilibrium.

The variability of production and prices about the mean and trend line in most cases was quite similar for the 90-year periods. However, noticeably lower variation about the trend line as compared with the mean was present for scheme #4 (0.9 margin/0.5 price) and #5 (0.9 MA profit/1.0 profit) for the beef sector and schemes #3 (1.2 profit/0.98 profit) and #5 (0.9 MA profit/1.0 profit) for the hog sector. This difference is attributable to the large and significant slope coefficients generated by both sectors under those schemes.

In general, the schemes that stabilize production, prices and income have significant 90-year period slope coefficients for price and quantity due to production being stimulated and prices driven down. This, in turn, makes the programs more costly. The costs were very high for schemes #4 (0.9 margin/0.5 price) and #5 (0.9 MA profit/1.0 profit) for the beef sector and schemes #3 (1.2 profit/0.98 profit) and #5 (0.9 MA profit/1.0 profit) for the hog sector.

Summary

This chapter began with a discussion of the different stabilization payment schemes that have been proposed for this study. Five different stabilization payment schemes were tested with two different options.

The first option was based on stabilization payment scheme without any contribution from producers, i.e. the government financed the entire cost that incurred due to the payment scheme. On the other hand, the second option was based on the stabilization payment scheme with producers' contribution to the common fund. Both producers and the government are required to contribute an equal amount to the common fund at any given point in time as suggested by the formula considered. The stabilizing affects of these two options combined with four stabilization payment schemes were measured using two measures of variation, i.e. variation about the mean and variation about a trend line. Two measures were used due to the fact that results generated not only fluctuated but also trended either upward or downward.

The results generated from the different stabilization payment schemes were analyzed by comparing the ability of the scheme to stabilize production, prices and income received by producers, and the cost that would be incurred by the government if such stabilization payment schemes were to be adopted. Results indicated that scheme #3 (1.2 profit/0.98 profit) performed well in terms of stability of production, prices and income, although the cost was quite high as compared with scheme #2 (0.5 price/0.9 margin). However, its costs were comparatively low compared with schemes #4 (0.9 margin/0.5 price) and #5 (0.9 MA profit/1.0 profit).

Scheme #5 (0.9 MA profit/1.0 profit) generates the most stable net income in general, but it has the highest cost. On the other hand, scheme #2 (0.5 price/0.9 margin) generates the lowest cost but has the highest variability. Thus, scheme #3 (1.2 profit/0.98 profit) generates the most reasonable result as compared with schemes #2 (0.5 price/0.9 margin), #4 (0.9 margin/0.5 price) and #5 (0.9 MA profit/1.0 profit). Cost to the government was reduced slightly for all schemes under option 2 with contribution from producer to the common fund. Otherwise, the results for option 2 follow the same pattern as those in the first option.

Use of a trend line to measure variability does result in significantly different results over the 10-year period. However, as the time period is extended to 90 years, the variability for production and prices about the trend line and about the mean became approximately the same.

CHAPTER V

SUMMARY AND CONCLUSIONS

This chapter will summarize results and main conclusions that can be drawn from this study. The study was based on the model developed by Ulrich. Some adjustments and modifications of the model were made in order to fulfill the objectives of this study. The major modification was the inclusion of alternative stabilization payment schemes. The stabilization payment program formulas used were based on calculated moving averages of prices generated by the model and upon profit levels generated by the model. Stochastic disturbances generated by a normal random generator were incorporated into the model in order to capture the uncertainty aspect surrounding the livestock industry. The verification and validation of the model had previously been conducted by Ulrich. He found that the model did perform in a manner consistent with economic theory and the biological constraints of the beef and pork industry.

Stabilization Payment Schemes

The objective of this study was to formulate stabilization payment programs or schemes that would stabilize the ever-fluctuating prices, production and income in the livestock industry. Besides the ability to reduce the variability of the above variables, the cost to implement the program is also an important consideration. It was hypothesized that tradeoffs would exist between stability and cost of implementing alternative stabilization payment schemes.

Comparative analyses were performed in order to compare and contrast the results of five different stabilization payment schemes. All schemes attempted to stabilize net incomes by beef and pork producers. The five different stabilization or deficiency payment schemes proposed can be described briefly as follows: a) scheme #1 (base) is actually not a stabilization scheme but is simply the model run without any stabilization payment scheme. The run/scheme is used as a basis of comparison with the simulation runs of the following four alternative stabilization schemes: b) in scheme #2 (0.5 price/0.9 margin), the payments for the beef sector are based on an index of moving average of prices while payments for the hog sector are based on a "guaranteed margin" approach; c) in scheme #3 (1.2 profit/0.98 profit), the payments are based on "guaranteed profits" for both the beef and hog sectors; d) in scheme #4 (0.9 margin/0.5 price), the payments are based on a "guaranteed margin" approach for the beef sector while the payments for the hog sector are based on an index of moving average prices and; e) in scheme #5 (0.9 MA profit/1.0 profit), the payments are based on indexed moving average of profit for the beef sector and "guaranteed profit" for the hog sector.

Two different options were run for each of the schemes. The first option was based on stabilization payment without any taxes or contribution from producers. The second option was based on stabilization payments with taxes collected from the producers to help support the program. Stabilization payment and tax feedback variables were added to the replacement and culling decision equations for both the beef and hog sectors. The feedback of stabilization payments and taxes to the above equations was very important because it helped to measure producers' responsiveness to the stabilization payment schemes. It also helped to measure the ability of such a program to stabilize the ever-fluctuating production, prices and income in the livestock industry.

Summary of Results

Mixed results were generated from the stabilization payment schemes mentioned earlier. However, none of the schemes generated results that were lower in cost to the government and at the same time would stabilize income, production and prices for both the beef and hog sectors. Therefore, tradeoffs between cost and stability need to be made in order to satisfy the condition of stability with minimum cost. This section will first summarize the results for option 1, i.e. stabilization schemes without taxes, followed by summarization of option 2, and then by comparison of the results of option 1 and option 2.

Results of Option 1

Tables XXXV and XXXVI present the summary of the estimated effects of stabilization payment programs #1 (base) through #5 (0.9 MA profit/1.0 profit) under option 1 over the 10- and 90-year periods. Both beef and pork are considered. Tables XXXVII and XXXVIII present the summary of the average absolute variability as measured by the standard deviation about the mean for selected 10-year periods within a 90-year run under stabilization schemes #1 (base) through #5 (0.9 MA

TABLE XXXV

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OVER 10- AND 90-YEAR AVERAGES FOR SCHEME #1 TO SCHEME #5 FOR THE BEEF SECTOR, OPTION 1

Variables	Scheme #1	Scheme #2	Scheme #3	Scheme #4	Scheme #5
	10-Year Average				
Level of Net Income					
$/cow per year	1.968	2.215	9.280	32.653	32.638
standard deviation	22.335	22.296	19.986	10.037	43.226
Level of Production					
thousand pounds per year	17,766.340	17,712.256	18,017.908	18,555.510	18,555.510
standard deviation	540.219	602.067	255.933	766.290	766.290
Level of Price Received					
$/cwt per year	78.445	77.686	75.358	73.157	71.698
standard deviation	3.747	3.257	1.737	8.056	6.475
Cost to Government					
million dollars per year	0	122.348	723.687	1,985.792	2,221.551
standard deviation	0	158.607	744.347	1,056.530	2,243.835
	90-Year Average				
Level of Net Income					
$/cow per year	-0.277	-0.698	4.495	26.646	26.656
standard deviation	19.896	17.589	6.763	3.231	3.350
Level of Production					
thousand pounds per year	17,806.024	17,788.207	18,105.868	19,541.307	19,541.307
standard deviation	409.684	425.685	200.201	425.847	425.847
Level of Price Received					
$/cwt per year	77.917	76.976	73.009	67.280	64.906
standard deviation	3.448	3.624	1.630	3.106	2.966
Cost to Government					
million dollars per year	0	125.059	905.086	2,807.387	3,201.072
standard deviation	0	142.412	224.339	554.490	560.048

TABLE XXXVI

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OVER 10- AND 90-YEAR AVERAGES FOR SCHEME #1 TO SCHEME #5 FOR THE HOG SECTOR, OPTION 1

Variables	Scheme #1	Scheme #2	Scheme #3	Scheme #4	Scheme #5
	---10-Year Average---				
Level of Net Income					
$/cwt per year	0.148	0.307	0.388	-0.300	0.225
standard deviation	4.918	2.808	0.790	4.502	0.631
Level of Production					
thousand pounds per year	15,534.436	16,099.932	16,370.044	15,569.451	16,384.545
standard deviation	719.045	1,003.309	1,211.503	757.563	1,247.496
Level of Price Received					
$/cwt per year	42.122	39.756	38.360	41.468	37.767
standard deviation	3.154	3.906	5.014	3.260	5.722
Cost to Government					
million dollars per year	0	561.946	896.746	181.022	996.422
standard deviation	0	910.036	1,228.263	228.816	1,326.701
	---90-Year Average---				
Level of Net Income					
$/cwt per year	-0.075	0.019	0.057	-0.085	0.030
standard deviation	4.526	2.461	0.365	4.187	0.139
Level of Production					
thousand pounds per year	15,621.875	16,136.187	16,926.292	15,403.594	16,608.063
standard deviation	734.629	640.773	256.335	762.133	114.930
Level of Price Received					
$/cwt per year	41.826	39.799	37.077	41.129	35.942
standard deviation	3.209	2.552	0.852	3.427	0.907
Cost to Government					
million dollars per year	0	475.402	1,130.846	151.733	1,362.370
standard deviation	0	587.664	844.214	198.965	850.896

TABLE XXXVII

THE AVERAGE ABSOLUTE VARIABILITY AS MEASURED BY STANDARD DEVIATION ABOUT THE MEAN FOR EVERY OTHER 10-YEAR PERIOD FOR PRODUCTION, PRICES AND INCOME FOR BEEF SECTOR UNDER SCHEME #1 TO #5, OPTION 1[a]

Variables	10-Year Average for Selected 10-Year Periods					
	First	Second	Third	Fifth	Seventh	Ninth
Scheme #1						
Total Beef Production (million pounds)	540.219	567.259	320.623	345.081	531.311	531.492
Farm Level Beef Price ($/cwt)	3.747	4.929	4.919	3.392	5.042	5.315
Net Income ($/cwt)	22.335	25.182	14.768	18.267	24.287	18.834
Scheme #2						
Total Beef Production (million pounds)	602.067	527.129	745.131	301.358	465.311	687.799
Farm Level Beef Price ($/cwt)	3.257	4.855	6.463	3.523	5.044	6.166
Net Income ($/cow)	22.296	16.661	16.593	14.989	17.547	17.058
Scheme #3						
Total Beef Production (million pounds)	225.933	398.551	254.023	247.806	189.943	238.867
Farm Level Beef Price ($/cwt)	1.737	4.199	1.803	1.979	1.787	1.696
Net Income ($/cow)	19.986	7.928	6.599	7.308	6.354	7.917
Scheme #4						
Total Beef Production (million pounds)	766.290	1,102.021	84.831	96.831	106.595	88.514
Farm Level Beef Price ($/cwt)	8.056	8.504	2.915	2.535	2.824	3.478
Net Income ($/cow)	10.037	6.868	1.114	1.482	0.891	0.929
Scheme #5						
Total Beef Production (million pounds)	766.290	1,102.021	84.831	96.831	106.595	88.514
Farm Level Beef Price ($/cwt)	6.475	7.786	0.756	1.065	0.880	0.968
Net Income ($/cow)	43.226	6.778	1.102	1.567	0.767	0.694

[a] first 10 years after the implementation of the payment scheme

TABLE XXXVIII

THE AVERAGE ABSOLUTE VARIABILITY AS MEASURED BY STANDARD DEVIATION ABOUT THE MEAN FOR EVERY OTHER 10-YEAR PERIOD FOR PRODUCTION, PRICES AND INCOME FOR HOG SECTOR UNDER SCHEME #1 TO #5, OPTION 1[a/]

Variables	10 Year-Average for Selected 10-Year Periods					
	First	Second	Third	Fifth	Seventh	Ninth
Scheme #1						
Total Pork Production (million pounds)	719.045	1,004.911	1,073.028	749.262	1,065.226	996.352
Farm Level Hog Price ($/cwt)	3.154	3.858	4.494	3.747	4.605	4.660
Net Income ($/cwt)	4.918	5.294	3.917	5.234	4.728	4.567
Scheme #2						
Total Pork Production (million pounds)	1,003.309	691.720	794.245	875.460	947.587	818.736
Farm Level Hog Price ($/cwt)	3.906	2.676	3.363	4.187	3.568	3.943
Net Income ($/cwt)	2.808	1.545	2.214	1.978	1.872	3.067
Scheme #3						
Total Pork Production (million pounds)	1,211.503	563.601	105.156	110.238	272.301	87.302
Farm Level Hog Price ($/cwt)	5.014	2.232	0.915	1.005	0.907	0.861
Net Income ($/cwt)	0.790	0.393	0.252	0.332	0.339	0.348
Scheme #4						
Total Pork Production (million pounds)	757.563	815.781	1,277.521	897.335	1,108.110	1,372.466
Farm Level Hog Price ($/cwt)	3.260	4.591	5.780	4.196	4.968	6.250
Net Income ($/cwt)	4.502	4.645	3.726	4.497	4.345	4.507
Scheme #5						
Total Pork Production (million pounds)	1,247.496	199.693	30.479	62.583	45.614	60.906
Farm Level Hog Price ($/cwt)	5.722	2.006	0.403	0.551	0.422	0.565
Net Income ($/cwt)	0.631	0.219	0.008	0.058	0.000	0.009

[a/]first 10 years after the implementation of the payment scheme profit/1.0 profit) for the beef and hog sectors respectively. Given that the results of this study are dependent on a number of assumptions and the model used, the following conclusions can be offered to policy makers. It should be noted that in searching for a scheme with the ability to stabilize production, prices and net income, the selected scheme needs to satisfy both the beef and hog sectors simultaneously. This is because both the beef and hog sectors were considered simultaneously and are closely interrelated.

1. If the government wished to stabilize production and price received by producers regardless of the cost, then scheme #5 (0.9 MA profit/1.0 profit) would be preferable. Scheme #5 (0.9 MA profit/1.0 profit) stabilized production, prices and net income for both the beef and hog sectors simultaneously. As indicated in Table XXXV, the variability of production, prices and income for scheme #5 (0.9 MA profit/1.0 profit) were somewhat larger over the first 10 years of the program than they were in any of the other schemes. This could be due to the model initially beginning from disequilibrium and movement to the equilibrium state taking a longer period of time under scheme #5 (0.9 MA profit/1.0 profit) as compared with scheme #3 (1.2 profit/0.98 profit). However, when one looks at the figures in Tables XXXVII and XXXVIII for selected 10-year periods and Figures 39 to 42, the instability of production, prices and income is shown to decrease significantly about 30 years after the implementation of the stabilization payment program.

As one could see from Tables XXXVII and XXXVIII the variabilities for the first and second 10-year periods were relatively high for both the beef and hog sectors. But following that, scheme #5 (0.9 MA

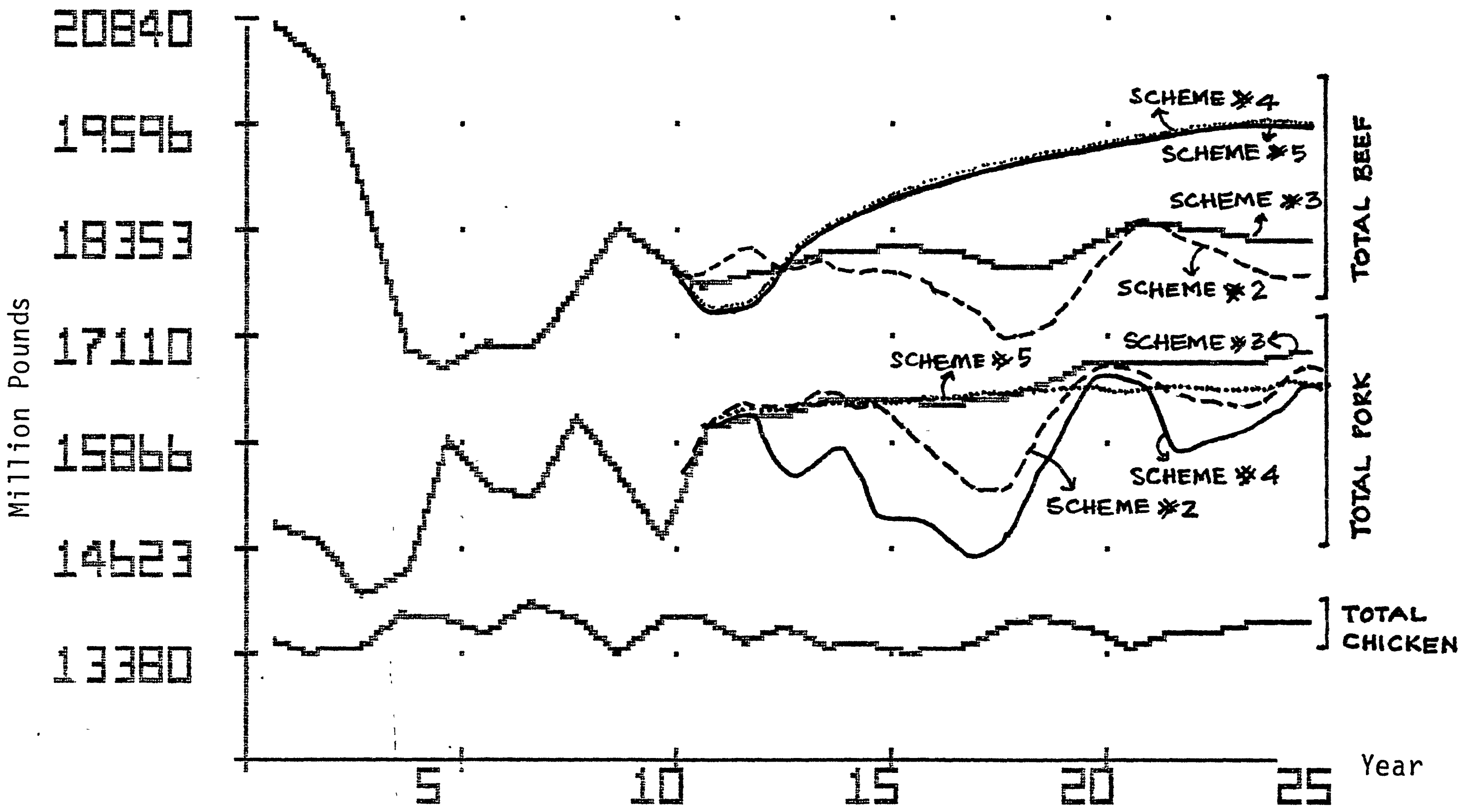


Figure 39. Beef, Pork and Chicken Production for Scheme #2 to Scheme #5, Option 1, Over 25 Years

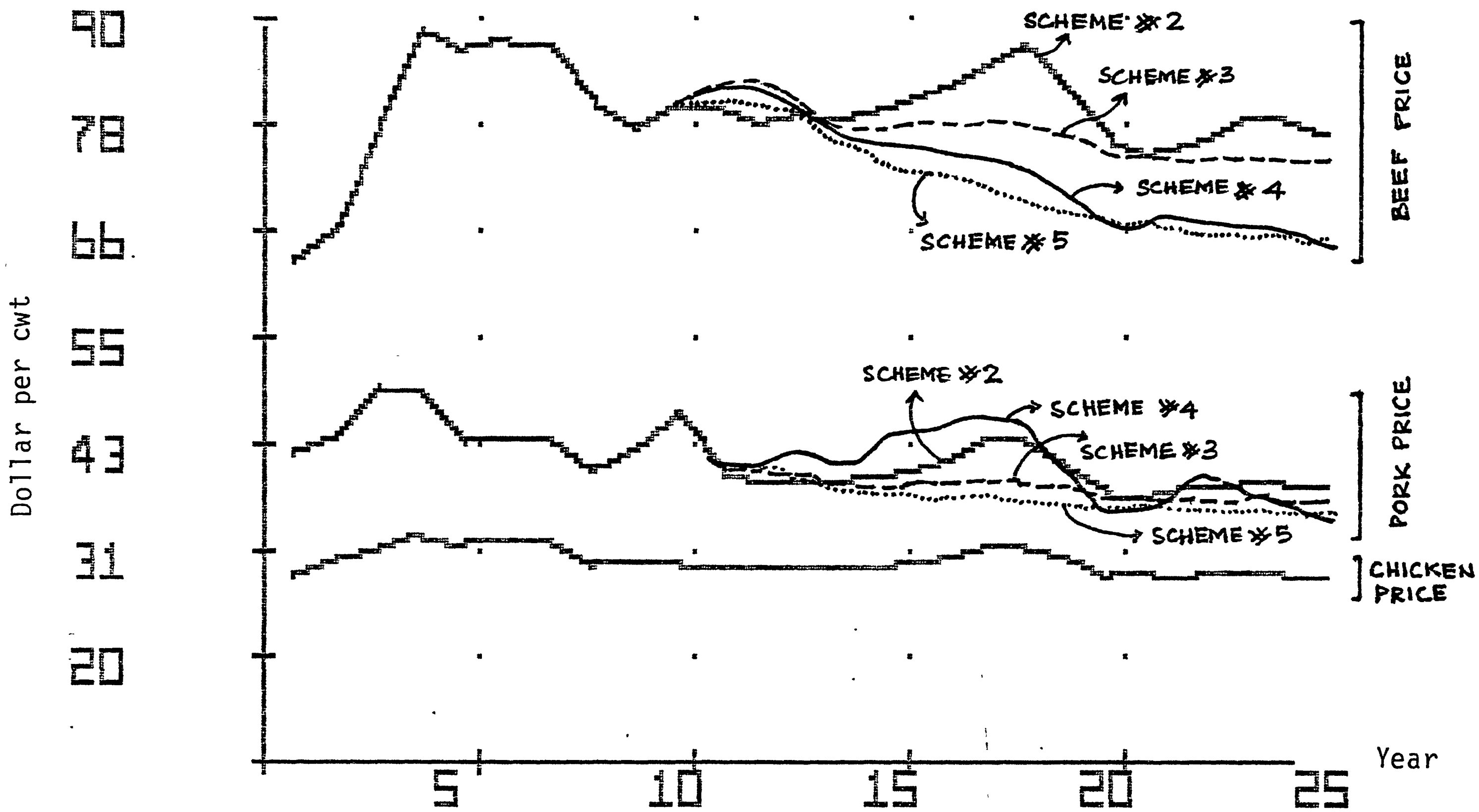


Figure 40. Beef, Pork and Chicken Prices for Scheme #2 to Scheme #5, Option 1, Over 25 Years

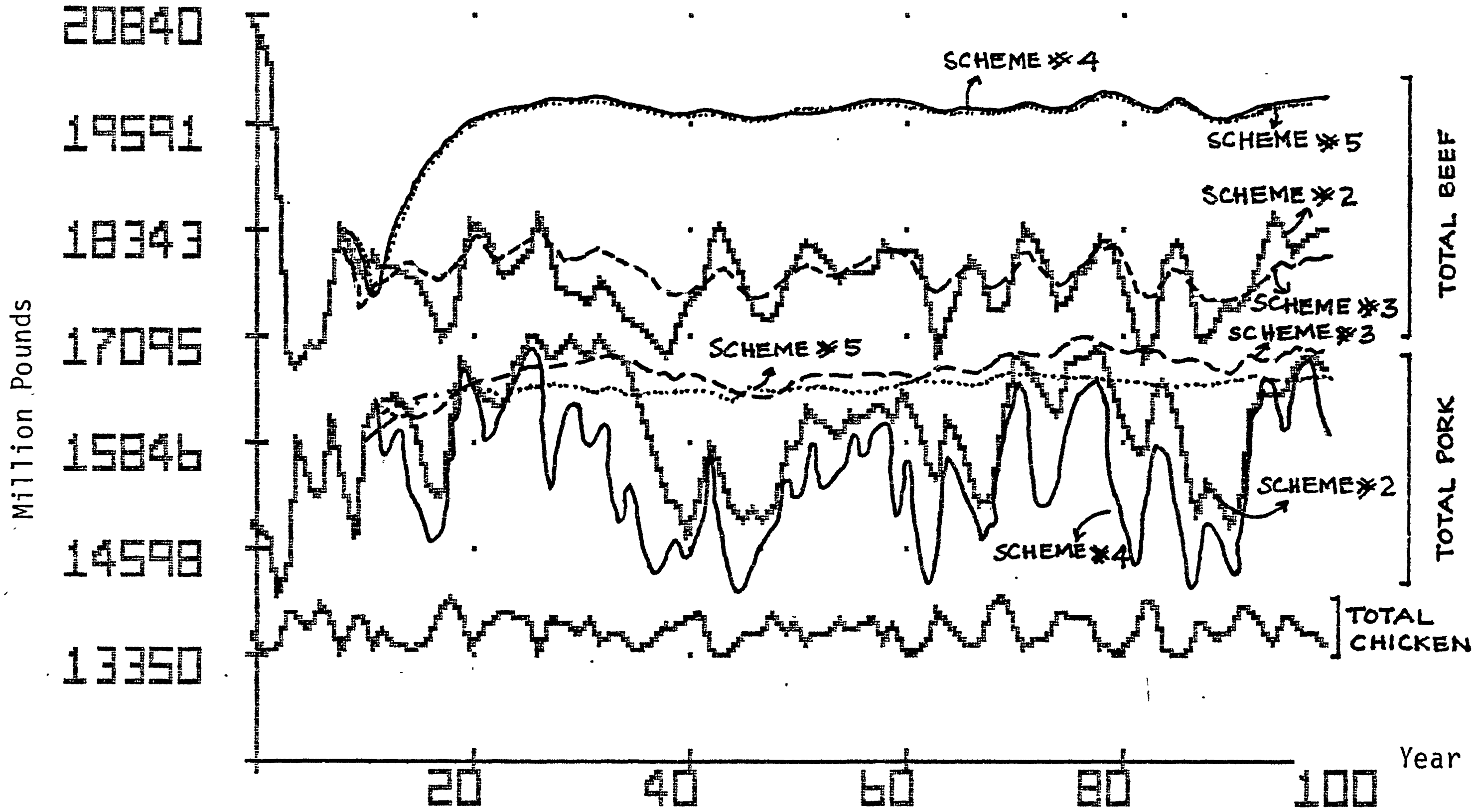


Figure 41. Beef, Pork and Chicken Production for Scheme #2 to Scheme #5, Option 1, Over 100 Years

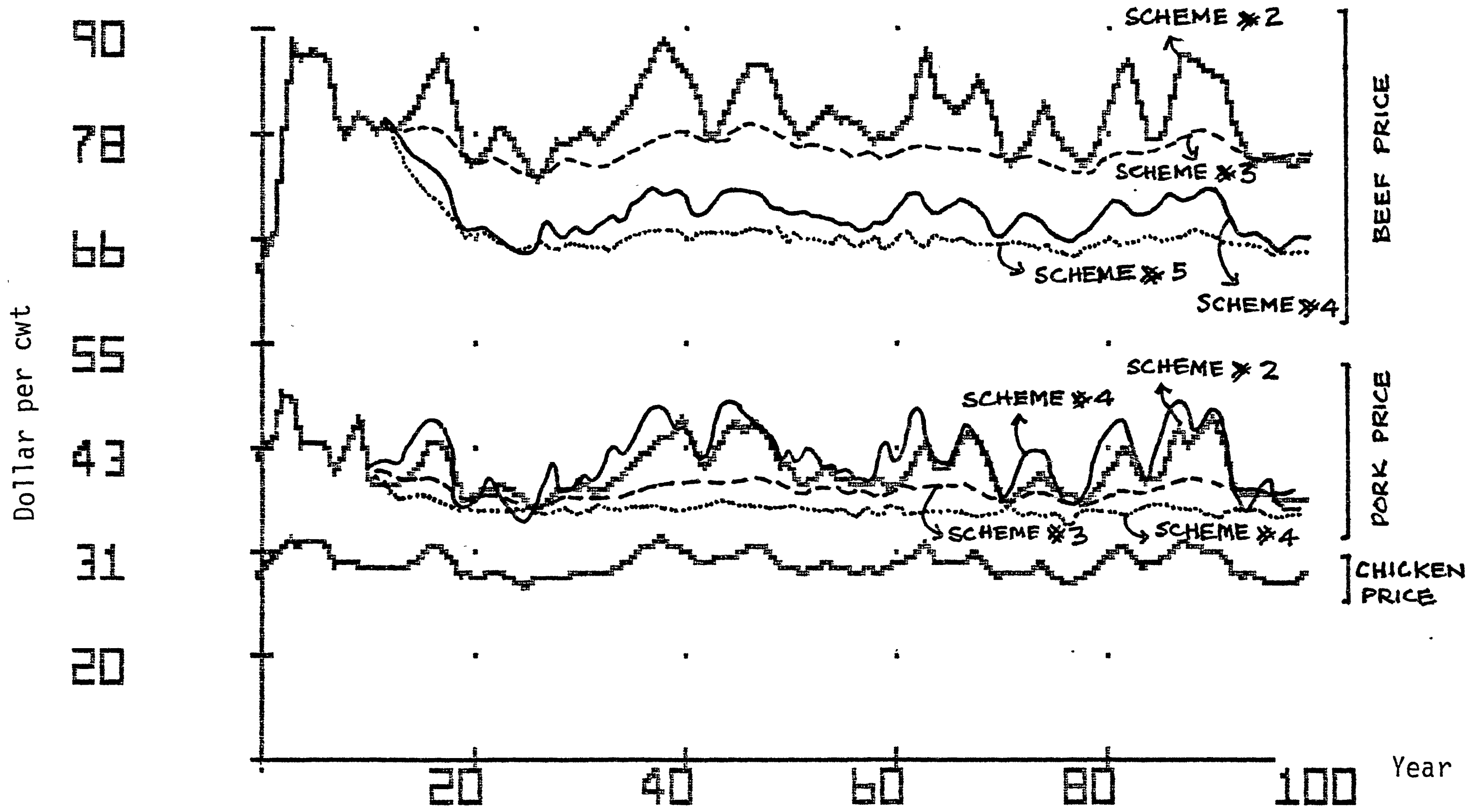


Figure 42. Beef, Pork and Chicken Prices for Scheme #2 to Scheme #5, Option 1, Over 100 Years

profit/1.0 profit) generated the lowest standard deviation of any scheme. Thus, scheme #5 (0.9 MA profit/1.0 profit) has the ability to stabilize production, prices and income for the fluctuating livestock industry over time. As expected, the cost to the government to implement such a scheme is quite large, i.e. about $5 billion per year on average over the 90-year period simulated.

2. If policy makers wished to implement a scheme that is able to generate the highest net income and at the same time have a low variability of income, scheme #5 (0.9 MA profit/1.0 profit) again prevails for both the beef and hog sectors. Although the net income for the hog sector was not as high as in scheme #3 (1.2 profit/0.98 profit), scheme #5 (0.9 MA profit/1.0 profit) did generate a reasonable positive net income and the lowest variability. On the other hand, the variability of net income for the beef sector was very high over the 10-year average for scheme #5 (0.9 MA profit/1.0 profit) but was reduced drastically over the 90-year period (stability started after 30 years, see Table XXXVII). Although scheme #4 (0.9 margin/0.5 price) generated approximately similar results as in scheme #5 (0.9 MA profit/1.0 profit) for the beef sector, it is less desirable because it generated negative net income for the hog sector. Besides generating negative net income for hogs, scheme #4 (0.9 margin/0.5 price) also permitted considerable variability of pork production and prices (see Table XXXX). As indicated earlier, cost to the government was the highest under scheme #5 (0.9 MA profit/1.0 profit).

3. If policy makers preferred to achieve stabilization programs that will generate the lowest total cost regardless of production, prices and net income stability for the beef and hog sectors, scheme #2

(0.5 price/0.9 margin) would certainly be preferable. Scheme #2 (0.5 price/0.9 margin) generates the lowest net cost to the government for the beef sector. On the other hand, scheme #4 (0.9 margin/0.5 price) generates the lowest net cost to government for the hog sector but enormous costs to the beef sector. Thus, scheme #2 (0.5 price/0.9 margin) would compromise between the two sectors and generate the lowest total net cost. Although scheme #2 (0.5 price/0.9 margin) generated the lowest cost it did not generate stability in production, prices and income (see Figures 39 to 42, and Tables XXXVII and XXXVIII). In fact, over the first 10 years of the program the stabilizing effects are almost unnoticeable. Following the first 10 years some stability is provided for the pork sector, but very little stability is ever generated for beef.

4. If the government wished to achieve stabilization in production, prices and income, and at the same time with the lowest possible cost to the government for both the beef and hog sectors simultaneously, none of the schemes were able to generate such criteria. However, tradeoffs can be made between those schemes that can perform reasonably well in terms of stability and lowest cost. As indicated earlier, scheme #5 (0.9 MA profit/1.0 profit) would provide a more stable production, price and income but it would cost the government approximately $3,217.9 (2,221.5 + 996.4) million per year on average over the 10-year period and $4,563.5 (3,201.1 + 1,362.4) million per year on average over the 90-year period. On the other hand, scheme #2 (0.5 price/0.9 margin) would provide the lowest cost on average for both the beef and hog sectors at $684.2 (122.3 + 561.9) and $660.4 (125.0 + 475.4) over the 10- and 90-year averages respectively.

However, under scheme #2 (0.5 price/0.9 margin), stability could not be achieved even if the time period was extended to 90 years. It also generated negative net income on average for the beef sector over the 90-year period.

On the other hand, scheme #3 (1.2 profit/0.98 profit) would be the better choice. Scheme #3 (1.2 profit/0.98 profit) not only generated stable production, prices and net income, but also generated a reasonably lower cost of $1,620.4 (723.7 + 896.7) and $2,035.9 (905.1 + 1,130.8) over the 10- and 90-year averages respectively. Lower cost can be achieved for the hog sector under scheme #4 (0.9 margin/0.5 price), but it costs almost three times more as compared with scheme #3 (1.2 profit/0.98 profit) for the beef sector for both the 10- and 90-year periods (see Tables XXXV and XXXVI, and Figures 39 and 40).

The variability of production, prices and income as shown by the standard deviation was lowest over the 10- and 90-year averages for the beef sector but not in the case for the hog sector. However, as shown in Table XXXVII, the variability of hog production, prices and net income was reduced after 20 years and remained approximately the same afterwards.

<u>Results of Option 2</u>

Stabilization payment schemes under option 2 were similar to option 1 but with different approaches to funding the program. Instead of the government bearing all the program costs, producers were required to contribute through the payment of taxes during relatively profitable years. Thus, it was expected that government cost would be reduced somewhat with taxes as compared with total program costs/payments without taxes.

Tables XXXIX and XXXX summarized the estimated effects of each alternative stabilization payment program under option 2, while Tables XXXXI and XXXXII present the variability about the mean for every other 10-year average. Given the results in Tables XXXIX through XXXX, the following conclusions can be offered to the policy makers under option 2.

1. If the government wished to stabilize production, prices and net income of producers regardless of the net cost (cost after subtracting taxes) that is incurred to the government, then, as in option 1, scheme #5 (0.9 MA profit/1.0 profit) would be preferable. Scheme #5 (0.9 MA profit/1.0 profit) stabilizes production, prices and income of producers for both the beef and hog sectors. The variation of production and prices for the beef sector was quite high on average for both the 10- and 90-year periods as compared with scheme #3 (1.2 profit/0.98 profit), but as indicated in Table XXXXI and Figures 43 to 46, the variation was greatly reduced from the thirtieth year onwards and is approximately 2 to 2.5 times smaller than those of scheme #3 (1.2 profit/0.98 profit). A similar pattern can also be seen for the net income. The hog sector also behaved in a similar manner. Total net cost would have been $3,059.7 (2,188.0 + 871.7) and $4,444.7 (3,172.7 + 1,272.0) million per year over the 10- and 90-year averages respectively.

2. If the government wished to achieve the scheme that is able to generate higher net income for the producers and at the same time with lower variability, scheme #5 (0.9 MA profit/1.0 profit) worked well for the beef sector with highest net income and lowest variability. However, the hog sector generated a slightly lower net income in scheme

TABLE XXXIX

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OVER 10- AND 90-YEAR AVERAGES OF SCHEME #2 TO SCHEME #5 FOR BEEF SECTOR, OPTION 2

Variables	Scheme #2	Scheme #3	Scheme #4	Scheme #5
	10-Year Average			
Level of Net Income with Payment and Taxes				
$/cow	1.274	9.697	31.851	31.851
standard deviation	19.073	19.736	42.508	42.508
Level of Production				
thousand pounds per year	17,700.912	18,021.377	18,555.510	18,555.510
standard deviation	564.045	253.600	766.290	766.290
Level of Price Received				
$/cwt per year	78.510	75.748	73.438	71.906
standard deviation	3.092	2.541	7.940	8.943
Net Cost to Government After Taxes				
million dollars	-24.893	694.423	1,939.956	2,188.068
Total Program Payment Made				
million dollars	78.931	698.661	1,939.956	2,188.068
	90-Year Average			
Level of Net Income with Payment and Taxes				
$/cow	-0.428	5.945	26.558	26.656
standard deviation	15.403	5.301	3.285	3.345
Level of Production				
thousand pounds per year	17,807.949	18,193.379	19,541.307	19,541.300
standard deviation	421.733	206.090	425.847	425.847
Level of Price Received				
$/cwt per year	77.712	73.755	67.531	65.078
standard deviation	3.787	1.546	3.188	2.963
Net Cost to Government After Taxes				
million dollars	24.283	848.958	2,765.936	3,172.688
Total Program Payment Made				
million dollars	132.745	850.328	2,765.936	3,172.688

TABLE XXXX

SUMMARY OF THE ESTIMATED EFFECT OF STABILIZATION PAYMENT PROGRAM OVER 10- AND 90-YEAR AVERAGES OF SCHEME #2 TO SCHEME #5 FOR HOG SECTOR, OPTION 2

Variables	Scheme #2	Scheme #3	Scheme #4	Scheme #5
	---10-Year Average---			
Level of Net Income with Payment and Taxes				
$/cwt	-0.223	0.195	0.274	0.156
standard deviation	1.971	0.693	4.665	0.628
Level of Production				
thousand pounds per year	15,949.127	16,234.180	15,424.700	16,276.193
standard deviation	855.986	404.372	744.461	294.437
Level of Price Received				
$/cwt per year	40.468	38.719	42.126	38.221
standard deviation	3.539	1.513	3.291	2.488
Net Cost to Government After Taxes				
million dollars	283.824	1,042.344	27.259	871.718
Total Program Payment Made				
million dollars	527.170	1,104.005	163.786	906.509
	---90-Year Average---			
Level of Net Income with Payment and Taxes				
$/cwt	0.028	0.032	0.096	0.025
standard deviation	1.561	0.270	4.168	3.998
Level of Production				
thousand pounds per year	15,817.326	16,582.981	15,280.311	16,520.427
standard deviation	651.285	172.636	853.651	113.507
Level of Price Received				
$/cwt per year	40.801	37.518	41.687	36.303
standard deviation	2.851	0.795	3.839	0.894
Net Cost to Government After Taxes				
million dollars	248.659	1,069.272	25.646	1,272.024
Total Program Payment Made				
million dollars	432.403	1,097.726	166.896	1,277.683

TABLE XXXXI

THE AVERAGE ABSOLUTE VARIABILITY AS MEASURED BY STANDARD DEVIATION ABOUT THE MEAN FOR EVERY OTHER 10-YEAR PERIOD FOR PRODUCTION, PRICES AND INCOME FOR BEEF SECTOR UNDER SCHEME #1 TO #5, OPTION 2[a]

Variables	10-Year Average for Selected 10-Year Periods					
	First	Second	Third	Fifth	Seventh	Ninth
Scheme #1						
Total Beef Production (million pounds)	540.219	567.259	320.623	345.081	531.311	531.492
Farm Level Beef Price ($/cwt)	3.747	4.929	4.919	3.392	5.042	5.315
Net Income ($/cwt)	22.335	25.182	14.768	18.267	24.287	18.834
Scheme #2						
Total Beef Production (million pounds)	564.045	581.370	784.102	381.214	548.608	738.000
Farm Level Beef Price ($/cwt)	3.092	5.691	7.289	3.924	5.514	7.041
Net Income ($/cow)	19.073	15.562	13.355	14.829	14.184	21.170
Scheme #3						
Total Beef Production (million pounds)	253.60	458.764	239.539	257.017	207.891	241.214
Farm Level Beef Price ($/cwt)	2.541	3.951	1.794	1.906	1.686	1.733
Net Income ($/cow)	19.736	5.933	5.265	4.444	5.658	7.136
Scheme #4						
Total Beef Production (million pounds)	766.290	1,102.021	84.831	96.831	106.595	88.514
Farm Level Beef Price ($/cwt)	7.940	8.865	3.539	2.651	3.220	4.145
Net Income ($/cow)	42.508	6.048	1.676	2.214	1.307	1.198
Scheme #5						
Total Beef Production (million pounds)	766.290	1,102.021	84.831	96.031	106.595	88.514
Farm Level Beef Price ($/cwt)	8.943	7.796	0.743	0.869	0.882	0.964
Net Income ($/cow)	42.508	6.048	1.676	2.214	1.307	1.198

[a] first 10 years after the implementation of the payment scheme

TABLE XXXXII

THE AVERAGE ABSOLUTE VARIABILITY AS MEASURED BY STANDARD DEVIATION ABOUT THE MEAN FOR EVERY OTHER 10-YEAR PERIOD FOR PRODUCTION, PRICES AND INCOME FOR HOG SECTOR UNDER SCHEME #1 TO #5, OPTION 2[a]

Variables	10-Year Average for Selected 10-Year Periods					
	First	Second	Third	Fifth	Seventh	Ninth
Scheme #1						
Total Pork Production (million pounds)	719.045	1,004.911	1,073.028	749.262	1,065.226	996.352
Farm Level Hog Price ($/cwt)	3.154	3.858	4.494	3.747	4.605	4.660
Net Income ($/cwt)	4.918	5.294	3.917	5.234	4.728	4.567
Scheme #2						
Total Pork Production (million pounds)	855.982	838.377	932.559	783.067	990.852	1,019.654
Farm Level Hog Price ($/cwt)	3.539	3.237	4.073	3.986	4.265	4.946
Net Income ($/cwt)	1.971	1.650	2.204	1.074	1.145	2.316
Scheme #3						
Total Pork Production (million pounds)	404.372	385.538	108.994	222.980	208.048	89.937
Farm Level Hog Price ($/cwt)	1.513	1.997	0.707	0.880	0.887	0.879
Net Income ($/cwt)	0.693	0.256	0.254	0.269	0.266	0.345
Scheme #4						
Total Pork Production (million pounds)	744.461	1,006.862	1,590.657	953.462	1,298.630	1,701.645
Farm Level Hog Price ($/cwt)	3.291	5.451	7.206	4.451	5.834	7.724
Net Income ($/cwt)	4.665	4.527	3.409	4.429	4.397	4.716
Scheme #5						
Total Pork Production (million pounds)	294.437	208.774	28.994	60.746	47.612	60.699
Farm Level Hog Price ($/cwt)	2.488	2.050	0.358	0.546	0.433	0.567
Net Income ($/cwt)	0.628	0.135	0.024	0.047	0.004	0.009

[a] first 10 years after the implementation of the payment scheme

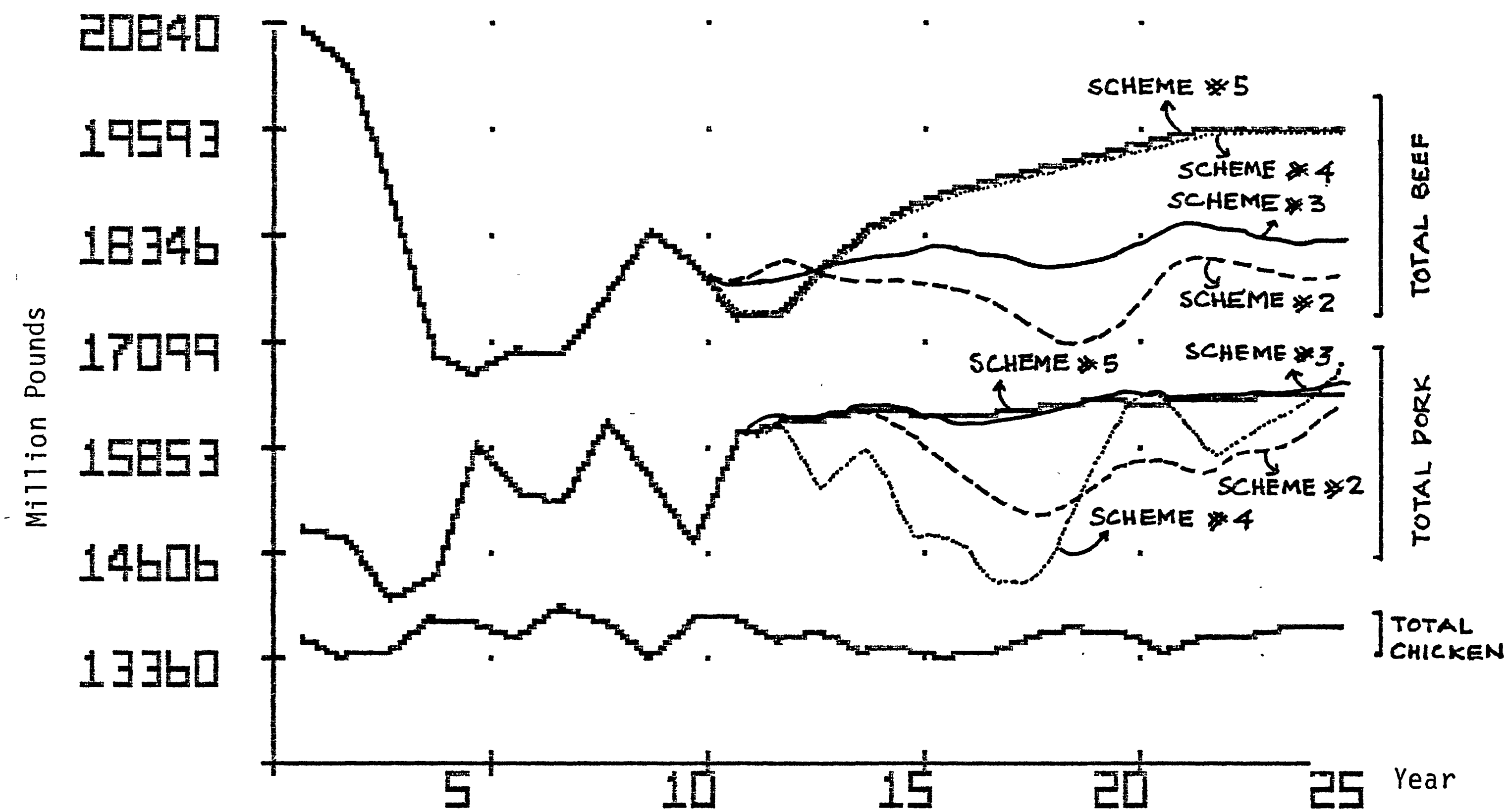


Figure 43. Beef, Pork and Chicken Production for Scheme #2 to Scheme #5, Option 2, Over 25 Years

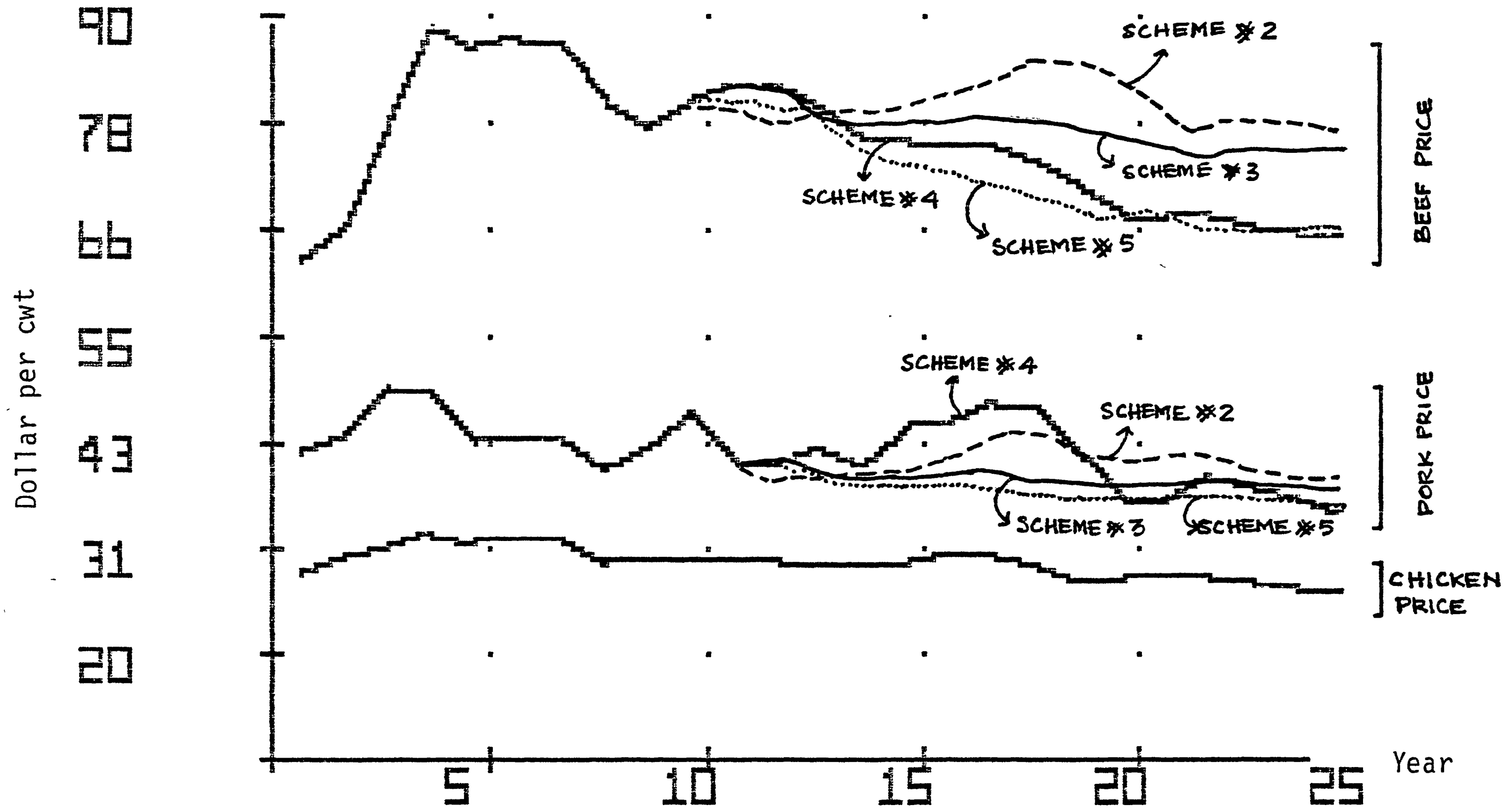


Figure 44. Beef, Pork and Chicken Prices for Scheme #2 to Scheme #5, Option 2, Over 25 Years

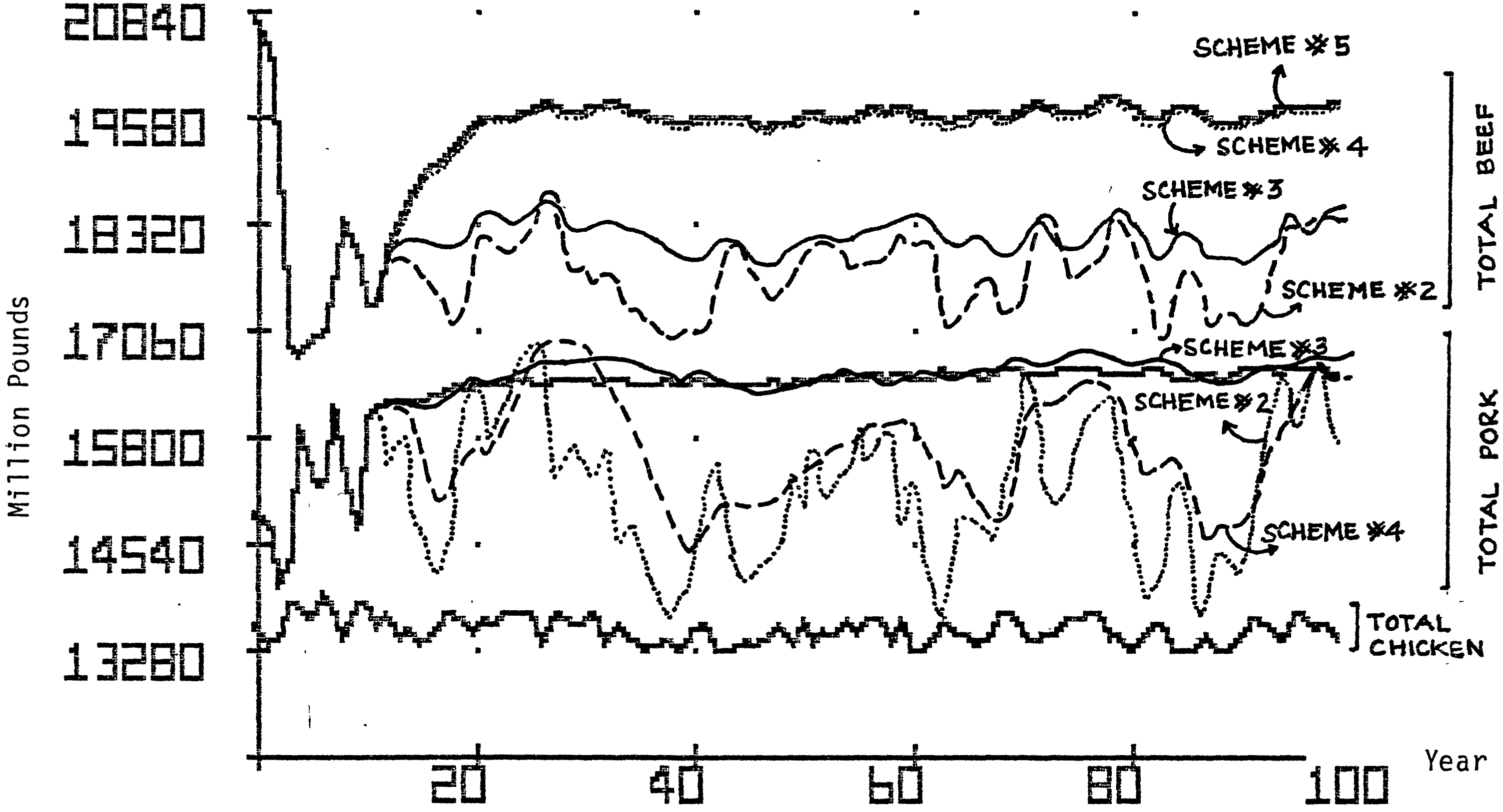


Figure 45. Beef, Pork and Chicken Production for Scheme #2 to Scheme #5, Option 2, Over 100 Years

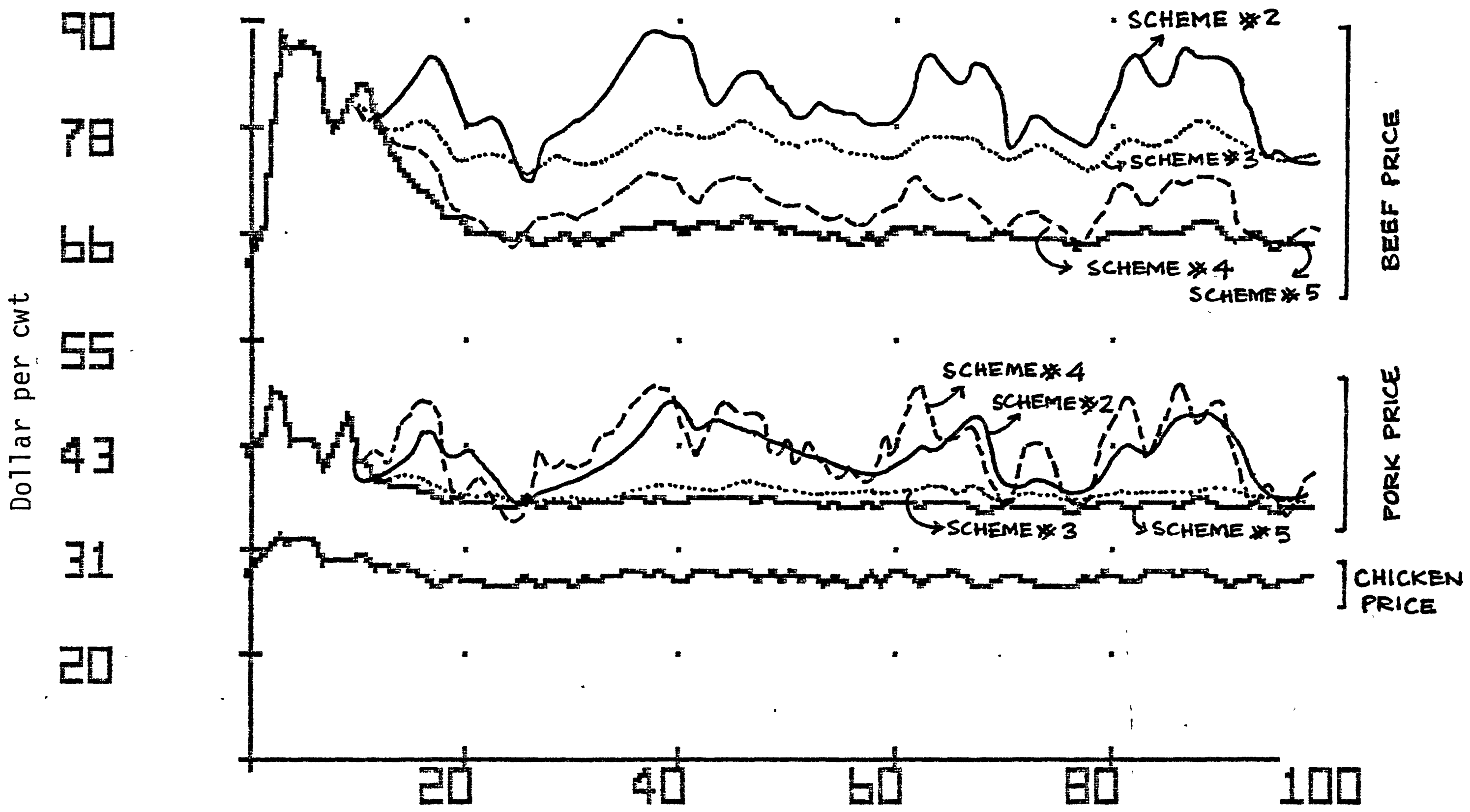


Figure 46. Beef, Pork and Chicken Prices for Scheme #2 to Scheme #5, Option 2, Over 100 Years

#5 (0.9 MA profit/1.0 profit) versus scheme #4 (0.9 margin/0.5 price) for both periods. Higher combined net income for beef and hogs can be achieved for both the beef and hog sectors under scheme #4 (0.9 margin/ 0.5 price). The variability of net income for the hog sector in scheme #4 (0.9 margin/0.5 price) was rather high (see Tables XXXXI and XXXXII). It should be noted that although the variability over the 10-year period was rather large for beef, as indicated in Table XXXXI, stability increases significantly after the thirtieth year. Thus, some tradeoff exists between stability and higher net income under scheme #4 (0.9 margin/0.5 price) and #5 (0.9 MA profit/1.0 profit).

3. If policy makers desire a stabilization program with low costs, then scheme #2 (0.5 price/0.9 margin) is clearly preferable. Under scheme #2 (0.5 price/0.9 margin), the total program payment or cost for the beef sector would have been $78.9 and $132.7 million per year on average over the 10- and 90-year averages. However, due to contribution or taxes from the producers, net cost to the government was $-24.9 million per year over the 10-year average. This is an indication that there is a net profit to the government, and in order to implement such a program it will cost nothing to the government in terms of payment that needs to be made. On the other hand, the net cost to the government would have been $24.3 million per year on the average over the 90-year period.

The net cost to the government would have been $371.5 and $325.5 million per year over the 10- and 90-year averages for the hog sector under scheme #2 (0.5 price/0.9 margin). This is a reduction of almost $56.3 and $240.5 million per year from the total program payment if no contribution or taxes were collected from producers over the 10- and

90-year averages respectively under scheme #2 (0.5 price/0.9 margin). However, this is not the lowest cost to the hog sector as compared with scheme #4 (0.9 margin/0.5 price) which generated the lowest cost. On the other hand, scheme #4 (0.9 margin/0.5 price) does not generate the lowest cost for the beef sector. On average, scheme #2 (0.5 price/0.9 margin) would generate the lowest net cost for both the beef and the hog sectors but at the expense of negative net income for beef and hog sectors over the 90- and 10-year periods respectively. As indicated in Tables XXXXI and XXXXII, scheme #2 (0.5 price/0.9 margin) does not generate as much production, prices or income stability over the years as compared with scheme #3 (1.2 profit/0.98 profit) or #5 (0.9 MA profit/ 1.0 profit). However, it does improve stability of net income significantly compared with the base run [scheme #1 (base)] with only a slight drop in the income level.

4. If the government wished to achieve stabilization in production, prices and income as well a low program costs, none of the schemes would really be accepted. However, several compromises can be considered between those schemes that performed reasonably well in terms of stability and those with low cost. As indicated earlier, scheme #5 (0.9 MA profit/1.0 profit) would be preferable because it was able to generate stability in production, prices and income simultaneously for both the beef and hog sectors. However, such a scheme would cost the government the most, i.e. approximately $3,336.8 and $4,444.7 million per year over the 10- and 90-year averages respectively for both the beef and hog sectors. On the other hand, scheme #2 (0.5 price/0.9 margin) would cost the least to the government but the main objective of stabilizing production, prices and income can

not be achieved. Scheme #4 (0.9 margin/0.5 price) would reduce the total net cost (for both the beef and hog sectors) approximately 40 percent and 37 percent for the 10- and 90-year averages respectively as compared with scheme #5 (0.9 MA profit/1.0 profit), but stability of production, prices and income only occurred for the beef sector. Production, prices and income for the hog sector still fluctuates over the years (see Tables XXXXI and XXXXII, and Figures 33 and 35). Thus, the best choice would likely be scheme #3 (1.2 profit/0.98 profit). By taxing producers $0.03 and $0.01/cwt per year for the beef sector and $0.22 and $0.12/cwt per year for the hog sector over the 10- and 90-year periods respectively, total government cost would be reduced by approximately 48 percent and 49 percent for the 10- and 90-year periods respectively as compared with scheme #5 (0.9 MA profit/1.0 profit). Likewise, competitive and, in some instances, superior degrees of stability are obtained (see Tables XXXXI and XXXXII and Figures 45 and 46).

Comparative Analysis of the Alternative Stabilization Payment Schemes Under Option 1 and Option 2

As pointed out earlier, two options were run. The first option was based on a stabilization payment scheme that was financed totally by the government while the second option was based on the stabilization payment scheme with contributions or taxes from producers. Results generated from both of these two options were quite similar, especially with respect to variability of production, prices and income (see Figures 39 to 42 and 43 to 46).

Similarity could be observed for the beef sector for both options under schemes #4 (0.9 margin/0.5 price) and #5 (0.9 MA profit/1.0 profit) for the 10- and 90-year periods. Both options generated exactly the same level of production with slightly different levels of prices. This could be due to the fact that there are no taxes being collected for schemes #4 (0.9 margin/0.5 price) and #5 (0.9 MA profit/1.0 profit) under option 1 for the beef sector. Thus, the beef sector model under option 2 is similar to that of option 1 for both schemes. On the other hand, taxes were being collected from the hog sector. Although the hog sector was not able to influence the production of beef, it did have some influence on the price level of beef, but the changes in prices were not significant enough to have any influence on beef production. Otherwise the level of production and prices for both sectors vary for both options for the different schemes.

As expected, costs to the government were lower under option 2 for both sectors for the proposed stabilization payment schemes. Net cost to the government decreased drastically, especially under scheme #2 (0.5 price/0.9 margin). Under option 2 of scheme #2 (0.5 price/0.9 margin), the beef sector program made an annual profit of $24.8 million over the 10-year period and cost only $24.3 million over the 90-year period. These estimates compare with $122.3 million and $125 million for the 10- and 90-year periods respectively under option 1. Similarly, the net cost to the hog sector was reduced by approximately 85 percent and 83 percent respectively for the 10- and 90-year periods under option 2 as compared with option 1 for scheme #2 (0.5 price/0.9 margin). In general, the total net cost to the government was lower for option 2 as compared with option 1 for both the beef and hog sectors. As in option 1, scheme #3 (1.2 profit/0.98 profit) performed reasonably well in terms of stability and cost to the government as compared with the other schemes.

Limitations

Like any other research that has been conducted, this study was also faced with several shortcomings. The obvious problem was that the study did not consider the change in value of the predetermined variables or an initial value in order to see the effect of such change to the livestock industry as a whole. Thus, more comparative analyses could be done on the effect of the initial values assumed.

Another limitation of the model is the inclusion of the stochastic disturbances generated by normal random number generating function. The purpose of the stochastic disturbances was supposedly to capture the uncertainty aspect of production in the livestock industry. Without the inclusion of random number generating function, the model would stabilize by achieving long-run equilibrium after approximately 20 years. It can be argued that randomness should have also been included in the output prices and demand model as well as in the input prices.

The third limitation could be attributed to the assumption of perfect knowledge, especially with regard to perfect information on production and prices. In scheme #3 (1.2 profit/0.98 profit) and #5 (0.9 MA profit/1.0 profit) for both options, the producers were able to cope and respond to the uncertainty surrounding the livestock industry. Hence, they were able to stabilize the cyclical behavior of the livestock industry.

Fourthly, the model was estimated with data from a period in which no stabilization program existed for livestock. Thus, the parameters may be misrepresentative of producer responses with a government program.

Finally, this study is an attempt to assess the comparative efficiency of alternative stabilization payment schemes for the livestock industry. The results are conditional and they have not exhausted all the analytical potential that could be offered by the model developed. Other formulation of stabilization payment schemes could be introduced that may perform better than the ones considered. With some minor modifications, the stabilization payment programs for the poultry sector and dairy sectors could also be made. Hence, the comparative effect of the stabilization payment for the beef, hog, poultry and dairy sectors could be analyzed simultaneously.

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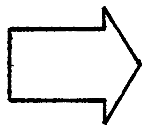
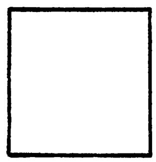
APPENDIX A

SYMBOLS

SYMBOLS



FLOW



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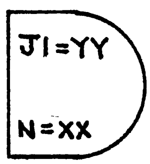
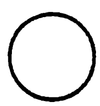


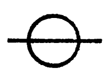
DELAY

YY = DELAY ※

XX = DELAY LENGTH



AUXILLIARY EQUATION



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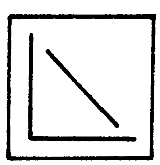

TABLE FUNCTION

MATERIAL FLOW

INFORMATION FLOW

APPENDIX B

VARIABLE NAMES USED IN SCHEMATIC DIAGRAMS

Beef Component:

BH - Beef breeding herd (million head)

CO - Culling rate per year (million head)

AC - Average culling rate per month (million head)

AD - Average change in breeding herd per month

DB - Percentage change in breeding herd per year

BI - Replacement heifers entering breeding herd (million head)

R - Replacement rate per year

AR - Average replacement rate per month

B1 - Heifer calves designated for replacement (million head)

B2 - Total heifer calves production (million head)

B3 - Heifer calves designated for production (million head)

B4 - Total steer calves production (million head)

B5 - Heifer calves available for fattening

B6 - Steer calves available for fattening

GH - Heifer calves going into grass feeding scheme

FH - Heifer calves going into grain feeding scheme

GS - Steer calves going into grass feeding scheme

FS - Steer calves going into grain feeding scheme

G1 - Grass fed heifers ready for slaughter

G2 - Grass fed steers ready for slaughter

F1 - Grain fed heifers ready for slaughter

F2 - Grass fed steers ready for slaughter

BR(0) - Net profit at time t_0 (current profit) ($/cwt)

BR(1) - Net proft lagged one year ($/cwt)

BR(2) - Net profit lagged two years ($/cwt)

BC - Cost of producing 400 pound calf ($/cwt)

CR - Calving rate in calves per brood cow

MO - Months, 12

FB - Farm level beef price

FF - Percentage of steer and heifer calves going into high energy ration

Hog Component:

GP - Gilt pool (million head)

H2 - Replacement gilt (million head)

H3 - Culling rate (million head)

H4 - Number of cull sow leaving the breeding herd (million head)

H5 - Number of pigs produced (million head)

H6 - Total hog production (million head)

H7 - Gilts entering breeding herd (million head)

SH - Swine breeding herd (million head)

MH - Marketed hog (million head)

FP - Farm level hog price ($/cwt)

CN - Corn price ($/bushel)

MO - Months, 12

Poultry Component:

CN - Corn price ($/bushel)

CL - Corn price lagged one year ($/bushel)

CP - Chicken price ($/cwt)

CC - Chicken price lagged one year

TC - Total chicken production

Market Component:

C1 - Dressed carcass weight 520 pounds per G1

C2 - Dressed carcass weight 540 pounds per G2

C3 - Dressed carcass weight 620 pounds per F1

C4 - Dressed carcass weight 650 pounds per F2

C5 - Dressed carcass weight 500 pounds per CO

C6 - Dressed carcass weight 160 pounds per MH

C7 - Dressed carcass weight 180 pounds per H4

G1 - Grass fed heifers ready for slaughter

G2 - Grass fed steers ready for slaughter

F1 - Grain fed heifers ready for slaughter

F2 - Grain fed steers ready for slaughter

CO - Culling rate per year

NF - Total non-fed (grass) beef meat (million pounds)

F - Total fed (grain) beef meat (million pounds)

CB - Total cull cow beef (million pounds)

TB - Total beef meat produce (million pounds)

MH - Marketed hog ready for slaughter (million head)

TP - Total pork meat produced (million pounds)

TC - Total chicken meat produced (million pounds)

TM - Total meat produced (million pounds)

M - Total meat consumption per capita

QC - Quantity of chicken (pounds)

QP - Quantity of pork (pounds)

PM - Composite meat price ($/pound)

RC - Projected ratio of chicken to beef price

RP - Projected ratio of pork to beef price

BP - Beef price ($/pound)

CP - Chicken price ($/pound)

FB - Farm level beef price ($/cwt)

PP - Pork price ($/pound)

FP - Farm level pork price ($/cwt)

CAP - Population

VITA

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