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COMPUTER MODELS OF PRICE AND OUTPUT DETERMINATION IN THE LIVESTOCK-MEAT ECONOMY

by

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CHAPTER I: THE PROBLEM AND ITS POLICY CONTEXT

In recent years a widening disparity has been observed in firm size and market position of businesses operating in the beef and pork sectors of the livestock-meat economy (39). These shifts in market structure, coupled with changing technology and consumer tastes, have led to expressed grievances and inequities among different economic units, including both livestock producers and meat packers. Their concern over changing market practices has focused on an alleged increase in bargaining power enjoyed by the retailing sector; they also have expressed concern over other characteristics of market conduct and performance (6).

In examining the performance of livestock and meat markets, it is helpful, first, to distinguish between economic structure and market structure. Economic structure, in the context of this study, refers to the parameters that relate the variables of production, consumption, and prices in a comprehensive system of interdependent events within the livestock-meat industry. Market structure is viewed as encompassing those attributes of the livestock-meat industry that are related in a causal sense to market behavior or conduct, for example, the number of firms in the industry, the size of firms, the geographical distribution of firms, the degree of specialization or diversification among firms or establishments, the economies of size and the barriers to entry, the transportation and storage facilities, and the quality of market information.

Estimates of the structural parameters of the industry are obtained by econometric analysis. Economic theory is used to develop hypotheses concerning the effects of postulated changes in market structure on market performance. The deductive approach in economics is used, also, to specify the relevant structural relationships that must be estimated as a basis for establishing the social significance of different forms of market organization.

Objectives

Consistent with the notions of market structure, conduct and performance used in this study, are its three principal objectives:

(a) To construct and test a simulation model of the livestock-meat economy that will depict market performance in terms of the spatial and temporal interaction of livestock inventories, meat production and prices;

(b) To develop hypotheses of market performance with reference to postulated alternative market structures and to test the hypotheses by use of the simulation model;

(c) To evaluate the market performance associated with alternative forms of market organization in light of behavioral norms that are an essential part of public policy.

The initial task in the development of this study was the identification and description of the norms to be used in evaluating market performance under alternative market structures. First, however, a summary of some of the public policy issues surrounding the problem is presented as a basis for the development of the norms in the following chapter.

Policy Issues

One of the leading policy issues throughout our nation's history has been the degree of governmental control to be exercised with reference to the production and marketing processes. During the past seventy-five years, governmental regulation has increased at the local, state, and national levels commencing with the enactment of the Sherman Anti-Trust Act.

To date, the regulation of agricultural industries has involved essentially marketing agencies, processors, and distributors. Producer programs generally have been aimed at increasing the ability of the producer to compete with buyers who possess superior bargaining power as a result of imperfect knowledge and other attributes of an imperfectly competitive market structure.

In his recent book, G. R. Allen (2, p. 2) cites the following principles to determine the extent and nature of public intervention in British agricultural markets:

> ....if agricultural marketing is made costly or wasteful because of farmers imperfect knowledge of the future, and particularly if important production cycles occur, public intervention to limit the waste is desirable and control through the marketing system must be assessed in the light of any contribution it may make to the efficiency of agricultural production. In principle there may be conflict between marketing policies designed to minimize distributive costs and those intended to secure direct or indirect benefits to agricultural production, although in practice these can often be avoided.....if marketing is independent of production, the general aim should be to promote competition. Where economies of scale are unimportant the first step is to ensure a sufficient number of firms..... But even here competition may be half-hearted when all are ignorant of market opportunities....sometimes the various barriers to economic advance can be overcome only by a development which destroys the basis of effective competition. Moreover, the promotion of competition where economies of scale are large may destroy competition and thereby make marketing control a necessity.

A second policy issue was introduced by Allen with the comment on the amount of inefficiency or waste in the system resulting from imperfect knowledge. In a "free" market economy operating under imperfect knowledge, it is difficult to envision the absence of excess production where production is of an atomistic nature or where a substantial lag occurs between the decision to produce and realized production.

No comprehensive answers can be given to the question of how much resource mis-allocation society will tolerate to minimize public regulation. For example, public programs of market news information and outlook material were initiated some years ago and have been expanded in recent years. The goal is to reduce the economic losses of individual producers that would accompany sharp and unexpected price fluctuations. If more and better outlook information were available, and if it were used effectively in individual producer decisions, then an increase in market knowledge on the part of the producer could reduce the need for other forms of market regulation to maintain satisfactory levels of competition.

The maintenance of price and output stability poses another series of policy issues. Consumers are alleged to prefer stable as opposed to cyclical prices as they expect more total satisfaction from stable consumption (46, p. 192). Public sentiment also is said to lean toward maintaining an "effective" degree of competition in the economic system (15, p. ix). This tendency can be ascribed to the popular desire that emanates from the democratic tradition, namely, the desire to maintain the sovereignty of the consumer. Conflict occurs, however, between the legislation supporting price stability, resale price maintenance, the union shop, market orders, wage rigidities, and the notions of efficiency and effective competition.

Even though agitation for more competition led to the Sherman Act and subsequent legislation, the "rule of reason" standard developed by the courts requires that only "unreasonable" actions in restraint of trade can be held in violation (21, p. 12). Galbraith's "counterveiling power" concept (2, p. 151), if generally accepted, could result in a more widespread acceptance of "bigness", particularly where potential economies of scale exist.

Finally, the notion of equitable returns for productive factors in various alternative uses has its roots deep in the Christian heritage and the prevailing sentiment of capitalist society. This notion has been manifest during the past thirty years in the farm parity concept as well as in the profit rate calculations of many market investigations in which reasonable rates of return for alternative forms of market organization have been estimated (4, 39, 59). However, the concept of equitable remuneration of productive resources has lacked precision and extensive application in dealing with the effects of administrative overhead, taxes, retained earnings, and other elements of the corporate business.

An understanding of some of the major policy issues is germaine to the establishment of norms for the evaluation of market performance. Certain legal-economic norms will be developed in the following chapter, therefore, along with the appropriate institutions and procedures for achieving the related performance goals.

Basic Concepts

Among "the basic" concepts used in this study are norms, strategies, models, structure and simulation. Norms include objective functions, goals, and decision rules. An objective function is a choice criterion which may be maximized or minimized. Goals are objectives toward which the economy or society directs its energies or concerns. Decisions are statements of choice for a specified set of conditions or events a particular decision unit may face. Where the decision has discretion, it forms what we will call decision strategies or rules.

The concept of market strategy is used in an aggregate sense; it refers to the composite of decisions undertaken by individual decision making units with reference to a particular activity such as pricing. The aggregate phenomenon is made up of a variety of individual strategies specified by the decision rules of individual firms. In using the concept of a composite strategy, we need appropriate assumptions regarding the distribution of decisions, their policies and practices, and the interaction among these units.

A model is a set of relationships among a set of variables, the relationships being specified in the form of equations. If the parameters of the equations are given numerical values, we have a particular structure. Thus a model is a class of structures. While parameters are the constants of the model, variables may take on different values. For endogenous variables, their values are determined by the model. Lagged endogenous variables are endogenous variables whose values are determined by the model in a prior time period. Exogenous variables are variables whose values are determined outside the model.

Two types of relationships may be contained in the model--identities and functional relations. Identities specify an exact relationship between variables with no deviations. When this exact relationship does not occur, but the variables do not change independently of each other (there is a connection between corresponding values) the relationship may be described as a functional relationship. A functional relation, therefore, "is not necessarily exact, but in general is more or less blurred by random disturbances" (64, p. 7).

Functional relations may be further sub-divided into behavioral and technical relations. Technical relations specify the relationship between two physical quantities and are often supplied as engineering data. Behavioral relations describe the consequences of human behavior in economic decision making.

Earlier, we defined a model to have a particular structure when the parameters of the model are given numerical values. The economic structure of the livestock-meat economy is therefore specified by a model in which the variables are livestock and meat prices, outputs and inventories. Since the numerical values assigned to the parameters of this model for the 1955 to 1963 period are deemed to be quite stable, they can be used to depict a particular structure of the livestock-meat economy.

Trend variables are included in several behavioral and technical relations to account for slowly changing productivity and consumer tastes. The trend components are not a mask for unknown phenomena that are highly correlated with time, but serve as a surrogate for the gradually changing phenomena. In making long-run projections, small adjustments must be made in the coefficients of some of the trend terms to account for expected changes in technology and demand.

Simulation, finally, is a process of conducting experiments on a model. The object of simulation is to change the values of initial conditions, exogenous variables, or parameters, and then to trace out the effects of these changes on the time paths of the endogenous variables. The concept of simulation and its comparison with a conventional mathematical technique will be discussed further in Chapter IV.

CHAPTER II: ECONOMIC NORMS

A variety of norms have been proposed in studies of market organization. Several of these norms are summarized by Sosnick (48, p. 380) as follows: (a) efficient operations, (b) promotion expenses not excessive, (c) profits at a level to reward investment and induce innovation, (d) output consistent with good resource allocation, (e) no cyclical intensification, (f) quality should conform to consumer interest, (g) success should accrue to sellers who give buyers what they want, (h) entry and exit as free as the nature of the industry permits, (i) employee welfare not neglected and (j) excessive political and economic power not in the hands of small groups.

Most of the market norms that have been proposed are quite general and for the most part almost non-operational as they stand. In addition, neither the current nor normative means for their attainment is mentioned.

Inasmuch as a well defined series of workable norms for evaluation of market performance in the livestock-meat economy is not available, an attempt has been made to develop a set of operational norms for use in this study. While these norms may not lend themselves to precise quantitative measurement, they should be explicit enough to allow comparisons to be made between particular performance dimensions in different market situations.

The basic norms of economic efficiency, economic growth, equity and legislatively unrestricted foreign trade must be tailored to fit the livestock-meat economy. Six norms have been developed. Their theoretical basis, quantification and empirical verification are the subject of the remainder of this chapter.

Stabilization of Price and Output Cycles

The amplitude of the price and output cycles concerns both producers and consumers. While reduction (or elimination) of price and output cycles has been an objective of public forecasting, its desirability has been questioned from both the producer and consumer standpoint.

From the producer standpoint, stabilization of the cattle and hog cycles offers opportunity for more efficient production. The fixed plant needed for breeding herds, feeding operations, slaughter and meat processing can operate at the most efficient point on the long-run cost curve, given output stability. In addition, more efficient, specialized plants (with less flexibility) may be constructed in the future. However, cyclical stability will not eliminate the need for flexibility arising from short-term variation in slaughter.

It has been argued on theoretical grounds that reduction of price variability will raise producer incomes through the reduction in the allowance he must make in production plans for the risk of an unfavorable price at the end of the production period. For example, Johnson (29, p. 30) contends that the price for an agricultural product should be announced soon enough to allow time for production adjustments. The price would be set at a level estimated to draw forth the desired supply; yet this supply should be of a magnitude that would clear the market without large government purchases. This price would be maintained throughout the production period and then changed to guide next year's production. Johnson does not believe that (a) the price should be a goal, (b) the price should be tied to the past, or (c) the price should be a measure of well being. He does believe, however, that a price policy should be used to reduce output fluctuations.

Oi (41) advances a contrary theory, namely, that price instability is desirable under pure competition from the standpoint of the individual firm. Under the assumption that (a) firms maximize short-run profits during each time period, and (b) the marginal cost curve of each firm is upward sloping throughout its relevant range, Oi contends that price instability increases the expected stream of profits to the firm over time. He defines total profits as total revenue associated with a particular output minus the variable costs associated with that output. This definition includes both fixed costs and profits. Thus as price increases, total profit increases. Total profit may then be plotted against price as shown in Figure 1. If profits (Y) are dependent on price (P), and the range in profit due to the range in price is denoted by the chords AB and CD with a common mean $\overline{P}$, the longer chord CD denotes a higher average profit than chord AB.

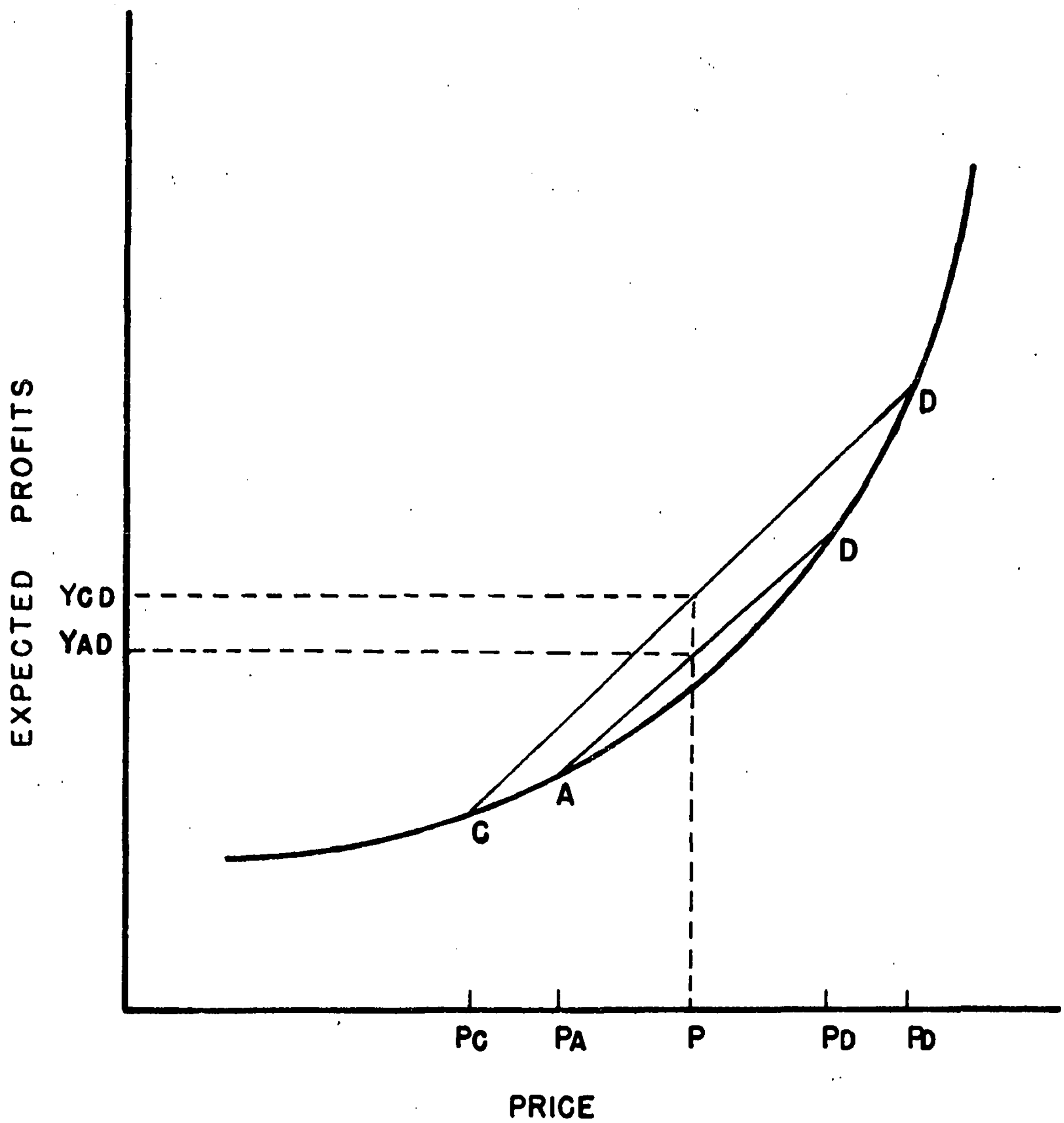


Figure 1. Average expected profit levels under different levels of price variability

With the advent of professional management, the entrepreneurs who are successful in anticipating the direction of prices can benefit from increased rather than reduced cyclical variability. However, a firm faced with several consecutive years of low prices and profits may face insolvency. New firms would be particularly vulnerable to a period of low or negative profits as would firms with little equity financing.

From the consumer standpoint, the desirability of cyclical stabilization also has been subject to criticism on theoretical grounds. Waugh (6, p. 242) argues that consumers are benefited by fluctuating prices if the alternative is a price stabilized at the mean of the fluctuations. He supports his position with the theory of consumer surplus. For periods in which the price of a particular commodity is less than its mean value, the area of consumer surplus is greater than the area of consumer surplus when prices exceed their mean value. This argument is not new; it has been in the literature since its inception by Dupuit (32, p. 74). Although Hicks (24, p. 38) pointed out the need for the corollary assumption regarding the constant utility of money, the concept still remains useful in evaluating directions of change even though absolute measurement may be questionable.

Shepherd (46, p. 192) acknowledges Waugh's position, but contends that consumers get more satisfaction from stable consumption since the extra worth of the stable supply is greater in terms of utility than the amount actually paid for the goods. Also, the inelastic demand curve for most agricultural products results in little gain in consumer surplus unless the price decline is quite large.

The economic literature lacks empirical refutation of the theoretical arguments concerning the desirability of price and output stability in consumption and production. From the position of the individual consumer, it is recognized that various groups react differently to price stability. The aged and other segments of the population with fixed or declining incomes (in real if not in current dollars) prefer stable food prices in order to maintain their level of living. While the more affluent groups of society have indicated a preference for stable prices of durable goods and other items purchased rather infrequently, they show less concern over price fluctuations in minor items of consumer expenditure. Indeed, short-term variability in retail meat prices allows a range of choice in different cuts and quality of meat for the shopper maintaining a given level of food expenditures.

Similarly, the producer who considers himself a good manager and has maintained a successful operation over the production cycle, may have found that a certain amount of cyclical variability improves his net earnings over time, providing he is able to anticipate the turning points far enough ahead to adjust production decisions. Livestock producers' reactions to price variability may lead, however, to dissatisfaction with extreme fluctuations in price and output cycles, recent examples being the current (1964) low cattle price levels and the ten dollar hogs of late 1959.

Conversely, more unfavorable consumer reaction to prices may be expected at times of cyclical price peaks. Although an irregular type of price movement, the high retail prices in September, 1962 (during the producer holding action sponsored by the National Farm Organization) provided an example of adverse consumer reaction to "excessive" price change.

In light of the theoretical arguments dealing with the behavioral consequences of price variability, the norm concerning price and output stability in the beef and pork sectors of the livestock mean economy may be summarized as follows: Some degree of price and output variability is not objectionable and may be desirable. However, extreme variation in the price and output cycle should be avoided. This will not preclude short-term fluctuations to clear the market of existing livestock supplies. Precise quantification may be difficult, however, inasmuch as the acceptable range in prices is a function of the price level.

During the past few years, producers generally accepted U.S.D.A. Choice grade steers as low as $24.00 per hundredweight and hog prices as low as $13.00 per hundredweight (Chicago basis). At the upper extreme, liveweight prices (assuming the current dressing percentage and marketing margins) in excess of $30.00 for Choice grade steers and $19.00 for hogs brought consumer resistance.

Forecasting has been viewed as one means of controlling cyclical variability (20). Forecasts, however, are subject to error. Moreover, public acceptance of the forecast may not be widespread. Thus, an empirical verification of the forecasting approach to cyclical stabilization in agriculture would be difficult to obtain. Devletoglou (20) argues on logical grounds, nevertheless, that given the ability to forecast events with precision, forecasting would stabilize the cycle when the cycle is generated by imperfect foresight alone.

On the legal side, most of the past and present price support and storage operations have contained elements of cyclical stabilization. Breimyer (9, p. 672) cites the effect of corn price stabilization leading to a regular cycle in hogs as all of the variability in the corn-hog ratio is due to a change in the numerator (hog price). Legislation establishing counter-cyclical fiscal and monetary policies also affects the livestock-meat economy from the demand side. However, the economic remedies of supply control would require enabling legislation.

Absence of price variability over an extended period of time often times has led to investigations of price collusion. A market strategy leading to price stability could invite, therefore, investigation and possible prosecution under the Packer and Stockyards Act or by Federal Trade Commission authorities.

Reduction of Marketing Margins

Reduction of marketing margins is a well recognized goal of agricultural marketing research. The farmer's share of the consumer dollar accruing to beef and pork producers has been calculated by the United States Department of Agriculture since 1919. Inasmuch as consumer demand reflects the quantity that will be taken at a retail price, given the other factors that affect consumption, a reduction in marketing margins can be shown to result in higher primary market prices. However, the marketing services (including any product transformation) may vary with the price level. Thus, reduction in marketing margins and corresponding services may alter the level and slope of the demand curve.

The marketing margin norm is subject to the qualification that marketing margins must be high enough to provide adequate returns for innovation and growth among marketing enterprises. In his "choice versus growth" dichotomy, Wiles (62, p. 244) warns of placing too much emphasis on the goal of marketing efficiency and too little attention on adequate retained earnings. This notion is consistent with the argument that part of the retail demand curve represents a demand for both current and new marketing services embodied in the final product.

The marketing margin norm is related to the norms of technology, free entry, minimum sales promotion and price discrimination. The present economic mechanism for adjusting marketing margins depends heavily on maintaining effective competition by entry of new firms and legislative curtailment of monopoly to force adoption of new technology and restricting profits. In addition, the voluntary grading programs have tended to standardize a homogenous product so that promotion expenses have been kept below those in manufacturing industries. Transportation economies have also resulted in a substantial shift toward relocation of processing plants to production centers, thus further reducing marketing costs.

In the future, reductions in marketing margins may be possible, given the present level of marketing services demanded by consumers. Better forecasting, for example, could result in a further minimization of transport costs (by reducing cross-hauling). Full participation in a revised grading program (that describes product attributes without implying quality differentials) would further reduce promotion costs as well as give more adequate signals that convey consumer preferences for particular products.

Existing legislation has tended to support increased farm bargaining power through cooperatives (51). It is alleged that an increase in the bargaining power of producers also could lead to a more rapid adoption of technology by the marketing industry as producers are able to capture a larger share of marketing the margin (2, p. 228).

At the primary market level, any collusion, discrimination or other restraints of competition or fraudulent dealings in the live animal trade are enjoined by the Packer and Stockyards Act (52). Several test cases have set norms for prompt payment, no "string" sales, accurate weight and grade, resale provisions and identical offering of stock to all buyers (43, 44, 56, 57).

At the wholesale level, the Packer and Stockyards Act prohibits any form of fraud in sales promotion. A recent administrative ruling prohibits packers and processors from giving meat or other gifts to employees of customer accounts (52). Price discrimination has been prohibited since the inception of the Packer and Stockyards Act. Any discounts and rebates are limited to those consistent with (a) savings realized from volume operations and (b) price concessions given to meat "bona fide competitive offers".

Court decisions to date have been based on establishment of fact as to whether or not the defendant acting in good faith attempted to meet but not beat a competitive lower price. This position of the courts was recently reaffirmed in two cases. One case involved a price rebate in an attempt to force a competitor out of business (28) whereas the other case involved a rebate to a customer in excess of volume cost savings (27). In the second case the motive was an attempt to secure more business as opposed to the motive in the first case of attempting to regain some business lost to a new competitor.

Legislative measures might initially involve repeal of state resale price maintenance laws which at times may lead to excessive margins. Mandatory grading and inspection of all meat would lead to product standardization; accordingly, promotion could become essentially an informative activity. Finally, legislation and court interpretation eliminating institutional inconsistencies in transport tariff rates should reduce transportation costs to shippers.

The marketing margin norm must be considered over the entire period under study. Margin strategies having variable elements produce different margins which must be adjusted for the level of consumption involved. Although the average retail margin over the period under alternative margin strategies will give us some information for comparing the margins over time, a more precise comparison is provided by adjusting the retail price for each time period to a base per capita consumption. The margin strategy giving the lower retail price for any given consumption level over time will be considered superior in light of the marketing norm.

Reasonable Rate of Return on Investment

On theoretical grounds, under the goal of profit maximization in a competitive economy, investment is rewarded the value of its marginal product. In practice, however, the amount of excess capacity in the industry, and the degree of adoption of available cost-saving technology must be considered when comparing returns on investment.

A firm refusing to adopt cost-saving technology is not likely to receive the same rate of return on its investment as the firm having a progressive management using the most up-to-date cost-saving methods. Similarly, a firm operating in an industry plagued with productive capacity in excess of present and foreseeable demand is not likely to recover a rate of return on investment equal to that of a firm operating in an industry where excess capacity is nonexistent. The firm operating under conditions of excess capacity entails higher costs of production. Thus, attainment of a satisfactory rate of adoption of technology and elimination of excess capacity (through desirable rates of entry and exit) would raise the rate of return on investment.

In recent years the meat packing sector of the livestock-meat economy has been faced with both excess plant capacity and obsolete facilities. The rapid growth in cattle feeding facilities has also resulted in a growth in feedlot capacity that may be approaching excess proportions.

Certain segments of the industry have expressed concern over low returns on their investment. While their rate of return on investment may be low due to excess capacity or obsolete facilities, they will be compared, nevertheless, with the rate of return on assets in the food and kindred products industries, as reported by the First National City Bank of New York (3).

Consumer Sovereignty

Our capitalist society is built on the tradition that production is guided by the decisions of the consumer in the market place (45, pp. 51-82). At the present time, the consumer is faced with a problem of not only separating the meaning of the quality implications of the grade names, but also comparing the quality of graded and ungraded meats. He has little capability as an individual to investigate any possible fraudulent dealings of marketing firms. In addition, the pricing policies of the retail outlet he patronizes may provide a poor signal of his choice at the meat counter back to the livestock producer.

With reference to meat consumption, consumer outlook programs, grading, and education concerning the standards implied by the grades are intended to improve consumer knowledge. An attempted synthesis of meat grades with notions of meat quality has led to grade terminology denoting a ranking of qualities (e.g., "Prime", "Choice", and "Good"). The meat grading program has been voluntary. In addition, much of the meat moving in intra-state commerce has not been required to meet sanitary and health inspection.

Price-quality differentials among grades have been reduced by short supplies which have resulted in the confounding of signals being transmitted from the retail markets to producers. Problems in promotion of the meat-type hog program bear testimony to this. During periods of short supply, the price incentive for meat type hogs fell as prices of heavy hogs were bid up. This provided producers with little incentive for obtaining new breeding stock at higher prices than that of their usual breeding stock replacement price. Thus conversion to the production of meat type hogs was impeded by the lack of continued price-quality differentials.

The inability of the consumer to protect himself as an individual from possible fraudulent dealings of marketing firms led to legislation establishing the Federal Trade Commission and passage of consumer sections of the Packer and Stockyards Act. Most of the investigations of fraudulent dealings in the livestock-meat industry are relegated to the Packer and Stockyards Division even in the case of investigations at the retail level. The activities of the Packer and Stockyards Division regarding fraud were discussed under the marketing margin norm.

The reflection of consumer choice to the producer through the pricing mechanism is associated with the margins policies of the retailing segment of the industry. Consider a fixed versus a constant percentage mark-up over wholesale price as alternative margin policies: If the cobweb model is employed, the transmission of consumer choice differ for the variable and fixed margins. In Figure 2, we see that at the intersection point of the derived demand curves DF (the derived demand curve of the fixed mark-up) and VD (the derived demand curve of the variable mark-up), the primary market price is the same. However, at greater quantities to the left of the intersection point, the primary market price is higher under the variable mark-up. Hence, the variable mark-up will call forth a greater output the following period than the fixed margin will. Conversely, at lower quantities to the right of the intersection point of the derived demand curves, the fixed margin would give a higher primary market price and greater output the following period. In the case of a high fixed margin, the derived demand curves would not have to cross at all (or at least not in a relevant range of production). Also, depending on the relative slopes of the derived demand curves and the supply curve, the margin strategy employed would affect the rate of divergence from or convergence to equilibrium over time.

Three aspects of the consumer sovereignty norm have been discussed: First, normative status can be attained for the consumer through both legal and market action. Second, uniform grading laws at the national level would enable the consumer to know the quality of meat offered for sale. Continued investigation and prosecution of price fixing, misrepresentation of the product or other fraudulent activity on the part of marketing agencies would minimize the violation of consumer

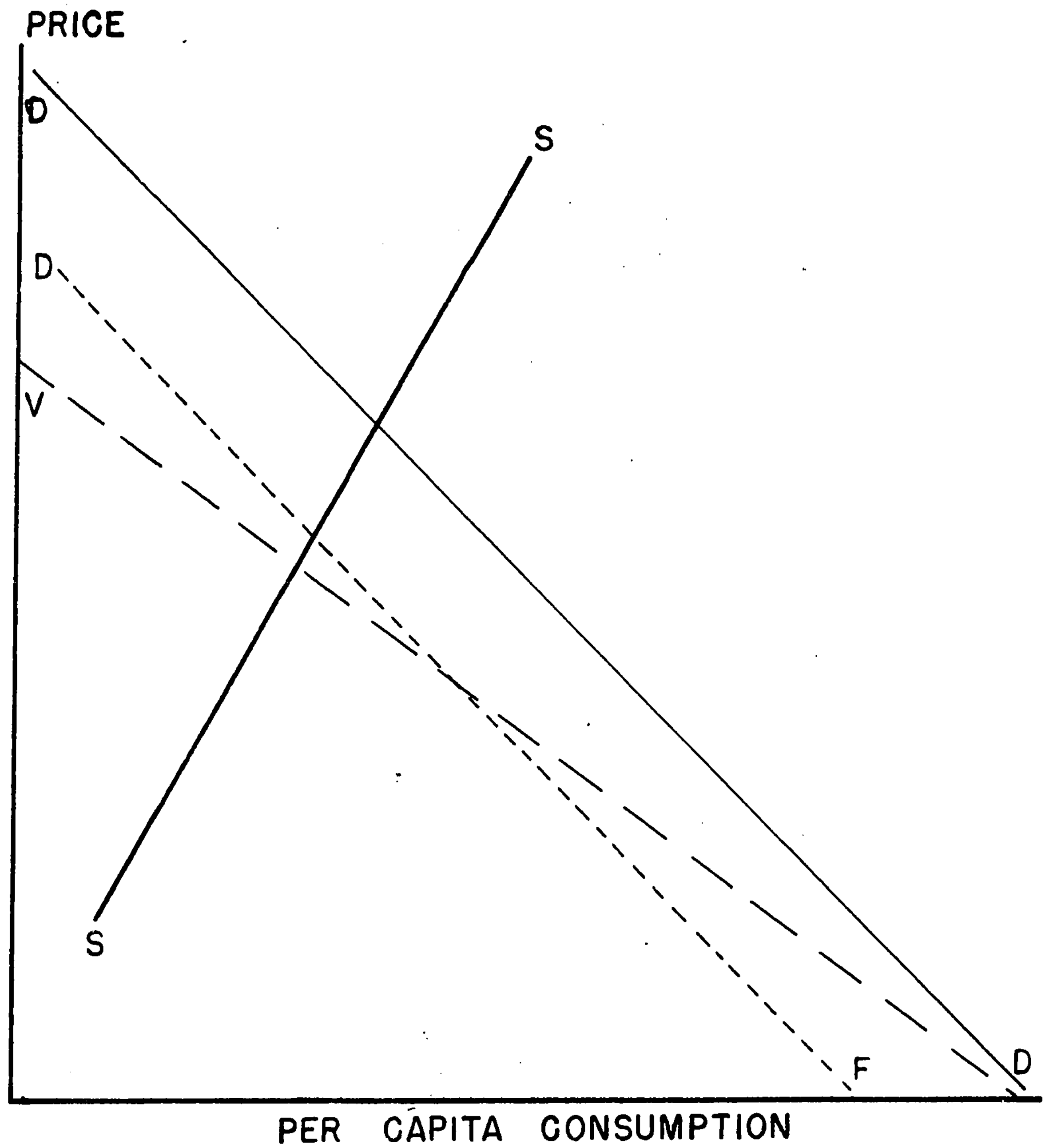


Figure 2. Derived demand curves under alternative margin strategies

sovereignty in this respect. Third, use of a marketing margin that would allow consumer choice to be conveyed to the livestock producer gives normative status to the market activities of the private sector.

Unrestricted Foreign Trade

High domestic prices of low grade beef, brought about by low levels of cow slaughter, result in a rapid build-up of low grade beef imports. These imports have tended to reduce the cost of beef in manufacturing. The magnitude of the effect of beef imports on prices of higher grade beef, however, is a subject of current controversy between beef producers and meat importers.

Cattle producers have indicated that imports of beef would not appreciably affect their net returns if maintained at a level equal to or below that of the 1958-62 period. During these five years, net foreign trade in beef averaged seven percent of domestic beef production. For this study, therefore, the foreign trade norm will be considered as a net import level less than or equal to that of the 1958-62 period.

Because of the scope of the problem, however, the discussion of beef import levels is confined simply to an evaluation of the price and output effects of a prescribed import quota. Fluctuations and secular trends in beef supplies in the major exporting countries are not included explicitly except in the trend term of the net import equations.

Maintenance of Effective Competition

In his recent book on the dynamics of competition, J. M. Clark (15, p. 112) holds that the present form of competition in the United States today is superior to pure or perfect competition since it makes for economic progress through stimulation of product innovation, utilization of economies of scale, and other socially desirable activties. He concludes that effective competition is a dynamic theory of competition. Pure competition, according to Clark, implies free and costless exit of firms which is not the case.

The norm of effective competition actually is an objective from which the resulting market performance is manifest in several other performance norms. In the past, the effective competition norm has held the door open to reasonably free entry of new firms. At the same time, economies of scale, local codes (such as building codes), unionization, and initial capital requirements have limited entry of new firms.

As a result of the trend towards monopoly in the economy, legal action was resorted to in an attempt to maintain workable competition.

Since the initial wave of anti-merger activity following passage of the Sherman and Clayton Acts, the courts modified their position with regard to the issue of "bigness" to the extent that the size of the firm must "actually prevent" new firms from entering the industry (21, p. 27). Mergers also have been approved in the past decade where evidence indicates that the new firm could achieve cost economies which would allow it to compete with existing firms. This position of the courts supports Galbraith's counterveiling power thesis. However, a recent test case taken to the Supreme Court shows a trend away from merger approvals. In a suit involving merger of a manufacturer-retailer with a chain retailer of shoes, the Supreme Court upheld the lower court decision (36) which held that the merger was in restraint of trade on grounds that the trend toward controlling a larger absolute share of the market rather than the percentage share of the market was the factor to be considered. Also, the increased percentage share of the market in relation to the existing fragmentation of the industry was deemed more important than the absolute relative share of the market. In the "Brown Shoe Case", the court also outlined the following issues for determining the relevant market to be considered: (a) the line of commerce as commonly recognized by the public, and (b) the area of the country involved (36, p. 342). Defendants in merger cases generally argue for a national market and as broad a product line as possible. According to Martin (36, p. 344) in his review of the case, this definition of the market, coupled with the definition of relevant market share, would preclude many mergers approved during the past two decades. Cases involving economies of scale, for example, might be viewed differently than those where no possible gains in efficiency exist.

The norms derived from Martin's analysis of the Brown Shoe Case are criticised by Jones (30). Jones' criticism of the new norms are three-fold. (a) There is no difference in the "broad" or "narrow" market definition; thus there should be no difference in market definition between an anti-trust case and a merger case; (b) The restraint of vertical mergers will be greater than Martin foresees, thus many economies of scale advantages will be lost; and (c) few horizontal mergers will be allowed under the market share statistics. Therefore, the "rule of reason" doctrine will be scrapped and inefficient firms will have to leave the industry via the painful road of bankruptcy and foreclosure rather than the less painful route of merger.

The 1963-64 term of the Supreme Court (18) not only followed the precedent of the Brown Shoe Case but also strengthened the court's position against mergers. In five cases contesting mergers of large corporations, the findings of lower courts were reversed. The impact of these most recent decisions is to limit the growth of large corporations to internal growth. The court defines the relevant market as "where you find it" and indicated a willingness to cross over industry lines to establish the market. For example, a merger of a can manufacturer and a glass jar manufacturer was dissolved since both competed for the container market. Joint ventures of two or more corporations into another industry was forbidden by this session of the Court when any of the individual corporations would have established the new firm independently of the other corporations.

The result of the Brown Shoe Case and subsequent litigations point to a new set of legal restraints on mergers in the future. While Martin feels the Brown Shoe Case set a precedent that the courts will pay increasing attention to the economic aspects of mergers, Jones felt that future court decisions will tend toward limitation of mergers in an attempt to maintain competition to the extent of sacrificing not only the ability of small firms to compete through reorganizations but also the realization of economies of scale.

The norm of competition complements that of the right to enter the industry; but ease of entry, as a means of maintaining competition, makes for the development of excess plant capacity where imperfect knowledge exists. While entry, exit, and the number of firms will not be traced out for alternative market structures by the price-output model to be presented, the norm of effective competition, accompanied by entry and exit consistent with the growth in demand, will be considered when dealing with the alternative market assumptions.

CHAPTER III: ECONOMIC STRUCTURE OF THE BEEF AND PORK SECTORS

The need for identifying the economic structure associated with market organization in the livestock industry was suggested in the introductory chapter. Before attempting to estimate the parameters of the economic structure of the beef and pork sectors, however, a more specific notion of the relevant variables and cause-effect relationships is needed.

Initially, the variables selected for study can be classified into those exogenous to the system at all times, current endogenous variables, and lagged (predetermined) endogenous variables. As a second-round approximation, all endogenous variables can be further classified as inventory variables, production variables, foreign trade variables, and price variables. Inventory variables are January 1 livestock on hand, and stocks of beef or pork at the end of a production period. Production variables refer to live-animal slaughter and meat production. Foreign trade in beef and pork are considered on a net basis, i.e., imports minus exports. Price variables are defined at the wholesale, live, and feeder (cattle only) market levels.

Supply and Demand Relationships

The complex interactions of the three categories of variables may be depicted through the use of a stock-flow diagram. In order to reduce space requirements to a minimum, the variable names are coded following the computer language format used in subsequent chapters. The list of variables, code names, and description appear in Table 1. The structure is identified on a semi-annual basis.

Table 1. Description of variables used in the computer model of the livestock-meat economy

Fortran variable name[a]	Unit of measure	Description
		ENDOGENOUS VARIABLES
H21	1,000 head	"Other" calves less than 1 yr. old on hand January 1.
H22	do.	"Other" heifers 1-2 yrs. old on hand January 1.
H23	do.	"Other" cows and heifers over 2 yrs. old on hand January 1.
H24	do.	Steers, bulls, and stags 1 yr. old and over on hand January 1.
H26	do.	Cattle on feed January 1 in 26 states.
FIBCN	do.	Federally inspected cow slaughter - annual basis.
H32	do.	Sows and gilts over 6 months old on hand January 1.
SF31	do.	Sows farrowing Dec.-May.
SF32	do.	Sows farrowing June-Nov.
CS2j	mil. lbs. (live wt.)	Commercial cattle slaughter.
CS2RK[b]	do.	Regional commercial cattle slaughter - annual.
CS3jK[b]	do.	Regional commercial hog slaughter.
FIC2j	do.	Federally inspected cow slaughter.
BP2j	mil. lbs. (carcass wt.)	Commercial beef production.
PP3j	do.	Commercial pork production.
FTR2j	do.	Imports minus exports of beef.

[a]j = 1, Jan.-June; j = 2, July-Dec.

[b]K = A, Iowa; B, Colorado; C, California; N, 11 other N.C. states; X, other 34 states.

Table 1 (Continued)

Fortran variable name[a]	Unit of measure	Description
FTR3j	mil. lbs. (carcass wt.)	Imports minus exports of pork.
ES2j	do.	Ending stocks of beef in cold storage.
ES3j	do.	Ending stocks of pork in cold storage.
QPH2j	lbs.	Per capita civilian consumption of beef.
QPH3j	do.	Per capita civilian consumption of pork.
PWB2j	dol. per cwt.	Wholesale price of choice 6-700 lb. steer beef at Chicago.
PWB3j	do.	Wholesale value of 100 lbs. of pork at Chicago.
P2jL	do.	Price of choice steers at Chicago.
P3jL	do.	Price of 200-220 lbs. U.S. No. 1,2,3 grade barrows and gilts at Chicago.
P2L	do.	Annual average of P2jL.
P3L	do.	Annual average of P3jL.
P2jFC	do.	Average price of Good and Choice 3-500 lb. steer calves at Kansas City.
P2FC	do.	Annual average of P2jFC.
P2LFS	do.	July 1 through June 30 average of P2jL.
AWFSj	lbs.	Average weight of steers slaughtered under Federal Inspection.
		EXOGENOUS VARIABLES
Ti	-[c]	Time
OMHj	lbs. per hour	Output per man hour in the meat packing industry.
RM2j	dol. per cwt.	Retail margin on choice steer beef at Chicago.

[c]i = 1, Annual, 1949 = 1; 2, July-Dec. 1948 = 1; 3, Jan.-June 1949 = 1; 4, Annual, 1964 = 1.

Table 1 (Continued)

Fortran variable name[a]	Unit of measure	Description
RM3j	do.	Retail margin on pork at Chicago.
P6j	do.	Average price of No. 3 corn at Chicago.
P6	dol./bu.	Annual average price of No. 3 corn at Chicago Nov. 1, Oct. 30.
HCPj	mil. people	U.S. civilian population at midpoint of the period.
HF6	1,000 bus.	Stocks of corn on farms January 1.
H13	1,000 head	Dairy cows 2 yrs. old and over on hand January 1.
AMC2j	mil. lbs. (carcass wt.)	Military consumption of beef.
AMC3j	do.	Military consumption of pork.
YPHj	dol.	Per capita disposable personal income.
CPI	---	Consumer price index.
RANGE	---	October 1 range conditions in 17 Western states.
AMRGE	---	April-May range conditions in 17 Western states.

Considerable work has been reported in the identification and estimation of partial supply and demand relations -- perhaps more than in developing a comprehensive structure of the several sectors of the livestock-meat economy (5, 7, 8). Many of the analyses of the beef and pork sectors have focused on the support or refutation of the cobweb theorem, especially in the pork sector.

Inventory phenomena

The cobweb theorem was given formal status by Ezekiel in 1938 (22). However, notions of its mechanism were used by Benner as early as 1876 (22) in his "Prophecies of Future Ups and Downs in Prices". The theory lay dormant until revived in separate articles by Schultz (22), Tinbergen (22), and Ricci (22) in the early 1930's. Ezekiel credits the naming of the cobweb theorem to Nicholas Kaldor who wrote on the subject in 1934.

Ezekiel considered all three cases of the cobweb; convergence, divergence and the stationery cycle depending on the relative slopes of the demand and supply curves. He laid out the three basic conditions necessary for operation of the cobweb: (a) price is determined by the available supply; (b) production decisions are based on the current price; and (c) a time lag of at least one period occurs between the decision to produce and the realization of production. Two years later, Buchanan (11) refuted the cobweb theorem on the grounds that the supply curve was not necessarily reversible. He also maintained that the three necessary conditions for the cobweb did not hold even under the perfect competition of agricultural production. The case of a divergent cobweb was criticized by Hooten (26) on the theory that risk always makes the supply curve less elastic than the demand curve. Nerlove refined the cobweb theorem in 1958 (40) with his theory of adaptive expectations. According to Nerlove, producers consider prices over the last few years in making productive decisions. Current prices changes are averaged with those of previous periods and thus in effect are discounted.

In 1925 Sewall Wright (65) examined correlations in corn and hog production concluding that ".....any cause which leads to unusual profits or losses tends to set up oscillations in the hog population four years from crest to crest". Bean (5) also examined farmer's response to price in light of the cobweb theorem in the late 1920's. In 1932, O. V. Wells (61) estimated the effects of farrowings, shifts in demand the preceding year, and the change in the price of the feed input. He also developed regional supply relations which were differentiated by the major feed input; barley in the West, corn in the North Central, skim milk in the Northeast, and change in corn acreage (resulting from change in cotton prices) in the South. Wells felt that the cobweb phenomenon offered an appropriate explanation of the structure of the pork sector.

Coase and Fowler (16) in an article analyzing the British swine industry rejected the cobweb theory on grounds that it specified a two-year cycle whereas the British hog cycle was usually much longer. In 1959, Breimyer (9) noted the changing role of the corn-hog ratio in that government price support programs made hog prices the only variable portion of the ratio. He illustrated that the variable numerator gave rise to a tendency to over-adjust production and resulted in a more clearly defined hog cycle. Another factor that gave rise to the emerging hog cycle was the assurance of ample corn supplies inherent in the large surplus stocks.

Harlow (23, p. 848) verified the existence of a four-year cycle in hogs during the post war period. He concluded

> .....The three measures of the hog cycle are related in the following manner. Price in one period affects the size of the pig crop the following period, which in turn determines the number of hogs slaughtered. The number slaughtered affects the price, which influences the next pig crop and so on around a circular chain of events. The cyclical nature of the relationships is obvious. The lag between price and pig crop and between pig crop and slaughter determined the length of the cycle. A four year cycle, such as the one now observed for hogs, will result if each of the above lags is assumed to be one year.....

Harlow dismissed arguments that the cobweb is inappropriate on the basis that those who argue that the cobweb can generate only a two-year cycle fail to take account of both the price-to-pig-crop and the pig-crop-to-slaughter lag.

Some aspects of the cobweb reaction may be associated with the cattle cycle (e.g. the unalterable production lag, plans based on current prices, and product price determined essentially by the available supply). However, the production cycle is much longer -- six years at a minimum. Also several alternative decisions are possible during this time span. For example, animals can be slaughtered at almost any stage of their life cycle. Heifers may be fed or kept for breeding purposes.

The longer span of time associated with the cattle cycle led to an addition of inventory theory to the cobweb phenomenon in explaining the cattle cycle. The inventory theory of business cycles was discussed in a journal article in 1917 by J. M. Clark (14). Clark charted the cycle in final demand and the demand for producer goods. He observed the operation of the inventory accelerator where an increase in sales of consumer goods was preceded by an increase in the demand for producer goods. However, the demand for producer goods fell as the demand for consumer goods slackened but still increased at a slower rate. Metzler examined the nature of the stability of the inventory cycle in 1941 (38). He concluded that there is a coefficient of expectations associated with the inventory accelerator that tends to make it more destabilizing than the ordinary accelerator. During periods of rising sales, store managers usually hold expectations of a continued increase. Inventories are built up. When these managers realize sales are falling off and likely will continue to decline, orders are cut drastically not only to be in line with the reduced demand but also to reduce inventories to "normal" levels. Metzler contributed another article on the length of inventory cycles a few years later (37). In this analysis, he presents an excellent numerical example demonstrating the dynamic interaction of stock changes, sales, and production.

Lorie (33) classified previous research dealing with the structure of the beef sector and the cattle cycle into an exogenous theory and a production process theory. He identified the exogenous influences with the business cycle, other shifts in demand, and weather. The production process was deemed a function of the biologic time lag. Although somewhat non-committal, Lorie favored the latter theory of the production process in explaining the cattle cycle.

Breimyer (10) acknowledged these two theories of the cattle cycle advanced by Lorie, and then proceeded to develop a balance sheet approach similar to that used by Metzler in his second article. The balance sheet approach helps isolate the points of decision making by the producer. Although all classes of cattle are held on farms and ranches somewhat longer during the initial build-up phases of the cycle, the disposition of calves, according to Breimyer, is the controlling factor in determining the turning point of the cycle.

Maki (34, p. 613) combined cobweb theory and elements of both of Lorie's theories and Breimyer's balance sheet approach, in explaining the cattle cycle. He also drew on a theory of inventories developed by Devletoglou (20, p. 149) in considering public prediction in relation to stable equilibrium. Devletoglou separated the lag in inventory change into a production response component and a production process component. The production response component resulted from a lag between the realized price and the decision to change production while the production process lag resulted from the length of time needed for actual production to take place. Maki likened the inventory phenomenon of the cattle industry to that of a conventional manufacturing industry. He synthesized elements of the cobweb and inventory theories as a basis for forecasting cattle prices and outputs with an econometric model as follows:

> .....The former analysis supports the use of inventory variables in forecasting models. In fact, inventory variables perform an indispensable role in connecting the cobweb structure of a model with the accelerator affects arising from inventory adjustments.
>
> The two models.....support the case that public forecasting is feasible on logical grounds. In the cobweb case, correct forecasting reinforces the equilibrating tendency and accelerates movement to equilibrium. In the inventory case, accurate public forecasting cannot eliminate the induced production aimed at maintaining established or normal inventory levels.....

The structural relations developed by Harlow and Maki are used as a guide in determining the appropriate length of lags in causal variables. Inasmuch as the nature of the causal lags in the pork sector specify a semi-annual model for that sector, the entire economic structure was developed on a semi-annual basis.

Since meat is a perishable product, all of the commodity produced is consumed at some price. Few consumers purchase meat in a large enough quantity to be able to affect price individually; therefore, they behave as price takers. Retail outlets, however, buy large quantities of meat from wholesalers, usually packers. With many retail buyers, the orders are large enough to affect the price. In the model of the beef and pork sectors of the livestock-meat economy, the relevant price making forces will be considered to operate at the wholesale level with retail prices consisting of the wholesale price plus a retail mark-up, and live-animal price consisting of the wholesale price minus the live-wholesale margin.

<u>Supply versus sales response</u>

On an individual state basis, farm production of cattle and calves, and hogs, reported on a liveweight basis, is the sum of all marketings for slaughter, out-shipments of non-slaughter animals, and the change in inventories from the beginning to the end of the year, minus the in-shipments of non-slaughter animals (feeder and breeding stock). On a national basis, the in-shipments cancel the out-shipments of non-slaughter animals, except for the relatively small foreign trade balance in live animals. Commercial slaughter, which is used on a liveweight basis in this study, is reported from the state in which the slaughter occurs regardless of the origin of the animal. Data on marketings for slaughter are not available for publication. At the national level, marketings for slaughter should equal commercial slaughter.

Farm production represents the producer supply response; it includes the build-up or depletion of inventories as well as the production for immediate slaughter. Commercial slaughter plus farm slaughter for a given year is viewed as the sales response (with producers who slaughter animals for their own consumption behaving in the same manner as consumers who purchase from retail outlets). The sales response may be greater, equal, or less than the supply response where producers are liquidating, maintaining, or building up their inventories of breeding stock and feeder animals.

A functional relationship between total slaughter, farm production and the change in January 1 inventories from beginning to end of a year shows the statistical relationship between the supply and sales response. Cattle and calves must be considered as an aggregate since farm production is not divided between these two components. In the case of cattle and calves, the functional relationship between total slaughter (SL2) and the explanatory variables of farm production (FP2) and the change in January 1 inventories of all cattle (ΔH2) is:

$$SL2_t = 1.72 + \underset{(0.0763)}{0.9415^{**}} FP2_t - \underset{(0.0924)}{0.7463^{**}} \Delta H2_t \qquad R^2 = 0.962 \qquad \text{(Eq. 3.1)}$$

for the 1949-62 period. Total slaughter and farm production are expressed in billions of pounds liveweight while the change in all cattle inventories is expressed in units of one million head. The estimated coefficient associated with the farm production variable is not significantly different from one.

Logically, the difference between total slaughter and farm production is a function of the change in inventories. A one-million-head increase in cattle and calf inventories is associated with a 746-million-pound decrease in total slaughter. Since this change in inventories may involve any combination of changes in cows, heifers, steers or calves, the value of the coefficient represents the average weight of the animals involved over the specified period.

The empirical evidence confirms the postulated relation, namely that total slaughter is equal to farm production minus the change in inventories. Because the three statistics are not available in the same units (i.e., number of head or live weight), nor as a balance relation, the statistical model was estimated simply to show the degree of discrepancy between the slaughter and production data.

In the statistical relationship between total hog slaughter and the explanatory variables of farm production and change in inventories, the inventory change is divided between the number of sows and gilts over six months of age and all other hogs on hand January 1. Since there are only two components to the hog inventory, compared with eight components of the cattle inventory, the estimated relationship between total hog slaughter and the three explanatory variables is:

$$SL3_t = 1.41 + \underset{(0.1581)}{0.9091^{**}} FP3_t - \underset{(0.2774)}{0.1800} \Delta H32_t - \underset{(0.0242)}{0.1066^{**}} \Delta H31_t$$

$$R^2 = 0.865 \qquad \text{(Eq. 3.2)}$$

for the 1949-62 period. The estimated coefficient associated with the farm production variable is less than one but is not significantly different from one. The lack of statistical significance of the relationship associated with the change in sow and gilt numbers ($\Delta H32$) suggests the maintenance of breeding herds that may vary only slightly from year to year, at least in comparison with the variation in total slaughter associated with the January 1 inventories of hogs under six months of age.

In the model used in this study, the supply response has been separated into its components of sales response, represented by commercial slaughter, and inventory change, represented by January 1 inventories and sows farrowing during the year. Estimation of commercial slaughter enables estimation of beef or pork production, the essential determinant of consumption.

The causal ordering of the system

The perishable nature of the product establishes the supply offered as the major determinant of price in the short run. The short-run prices make up the monthly, quarterly, semi-annual, or annual aggregates that enter the decision process. Therefore, the lag between price formation and decision to change production, plus the biologic time lag, generates an economic structure in which the causal variables are determined during one or more prior time periods. Although some variables are determined during the same time period (e.g., meat production, wholesale price and live price), the causal links describe a sequential series. In short, the economic structure of the livestock-meat economy is basically a series of lag relations.

The nature of the lag relationships may be illustrated by examination of a simplified model of the production system. Consider a closed model of the pork sector as shown in Figure 3. The five variables are live-hog price, the January 1 farm inventory of sows and gilts over six months of age, sows farrowing, and commercial hog slaughter.

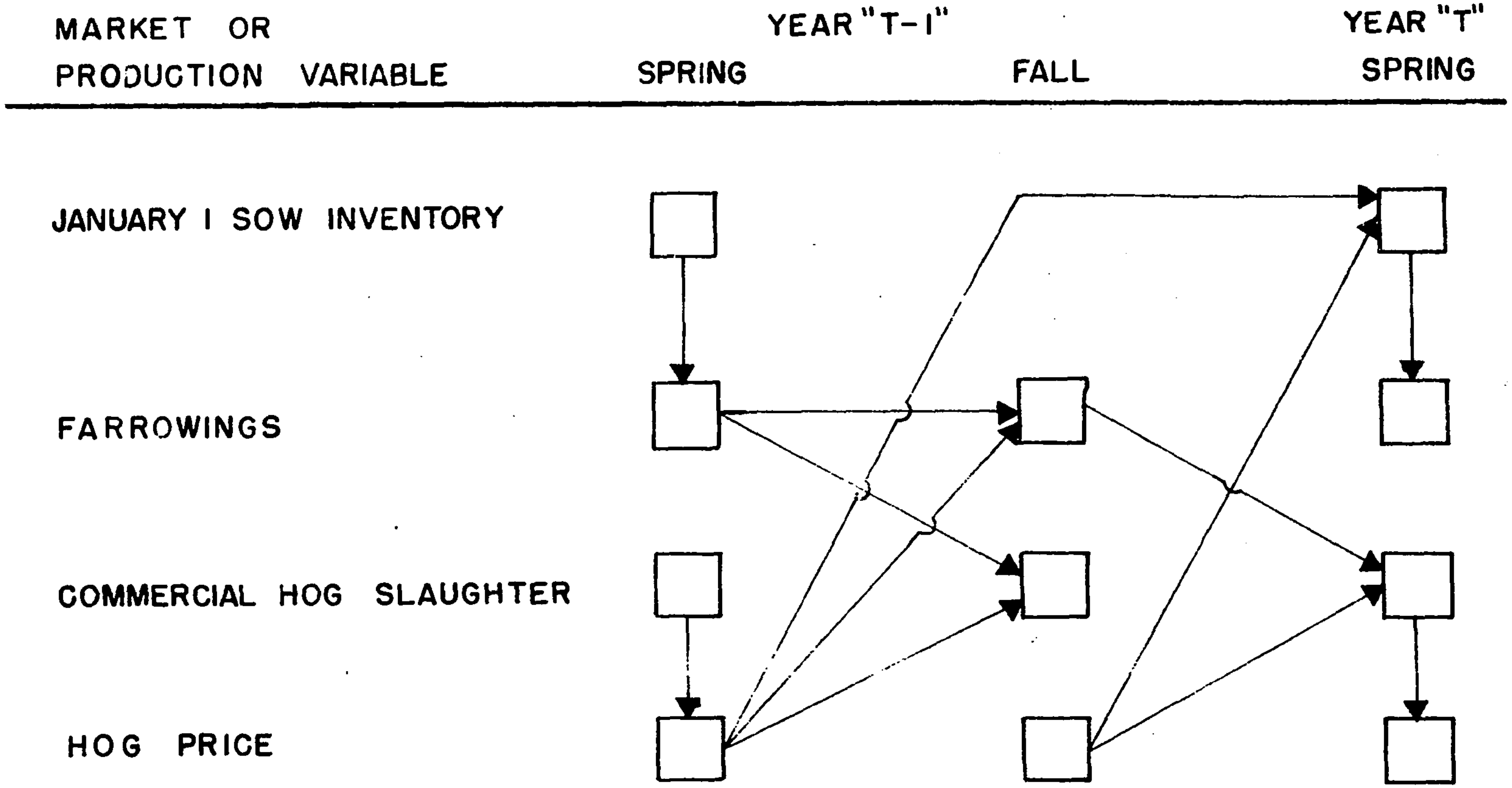


Figure 3. Causal ordering of selected endogenous variables in the hog sector of the U.S. livestock-meat economy

Commencing in the spring of the year "t-1", we show the inventory of breeding stock on hand January 1 as determining the number of sows farrowing in the spring of the year. Commercial slaughter during this period determines live-hog price. Spring farrowings are important in setting the level of fall farrowings as many producers follow a two-litter system. However, the price received for hogs during the first half of the year is important in establishing the magnitude of the change in fall farrowings. Due to the approximate six-month time period needed for raising a hog to slaughter weight, spring farrowings are the major determinant of commercial hog slaughter during the last half of the year. Spring hog prices condition the fall slaughter as spring price influences producer decisions to either retain more gilts for breeding purposes and reduce sow slaughter or to liquidate breeding stock. Fall hog slaughter, of course, sets the fall hog price. Both spring and fall hog prices influence the number of sows and gilts in the January 1 farm inventory which again is the major source of sows farrowing in the year "t". Commercial hog slaughter in the spring is a function of farrowings, live-hog price and the price of corn the preceding fall, plus a trend term.

In the beef cattle sector, the longer gestation period and growing and feeding periods lengthen the lag intervals. Also, any calf produced may be slaughtered immediately, put on feed, or held for breeding purposes. Young breeding stock may be slaughtered or held for the producing herd.

Let us now consider a closed system of the beef sector with slaughter- or feeder-animal price, January 1 farm inventories of cows, heifers, calves, and steers, and commercial cattle slaughter as the only variables. A change in the slaughter-steer and feeder-calf price is traced through five annual time periods in Figure 4.

Price in year "t-5" is one of the variables determining the number of steers, calves, and heifers held in the January 1 farm inventory in year "t-4". January 1 steer and cow numbers determine slaughter in year "t-4" and the price follows from the level of slaughter. The elements of the causal sequence shown for years "t-5" and "t-4" will not be traced out in the four remaining years for the sake of clarity. First, note that January 1 cow inventories in the year "t-3" are a result of the addition of heifers from the inventory in the year "t-4" and the subtraction of cows via slaughter in the year "t-4". January 1 calf numbers in year "t-2" are those held from the calf crop produced by cows in the beginning inventory of year "t-3". Similarly, heifer and cow numbers, respectively, follow in years "t-1" and "t".

With this introduction to the nature of the economic structure, we will proceed to develop the entire system of causal ordering in the beef and pork sectors for one year on a semi-annual basis. Each sector will be presented separately with the appropriate interaction points noted as such.

The Pork Sector

The economic structure of the pork sector is illustrated in Figure 5. As mentioned earlier, the notation used for the variables is identified in Table 1. The first numeral in the coding notation, i.e., 2 or 3,

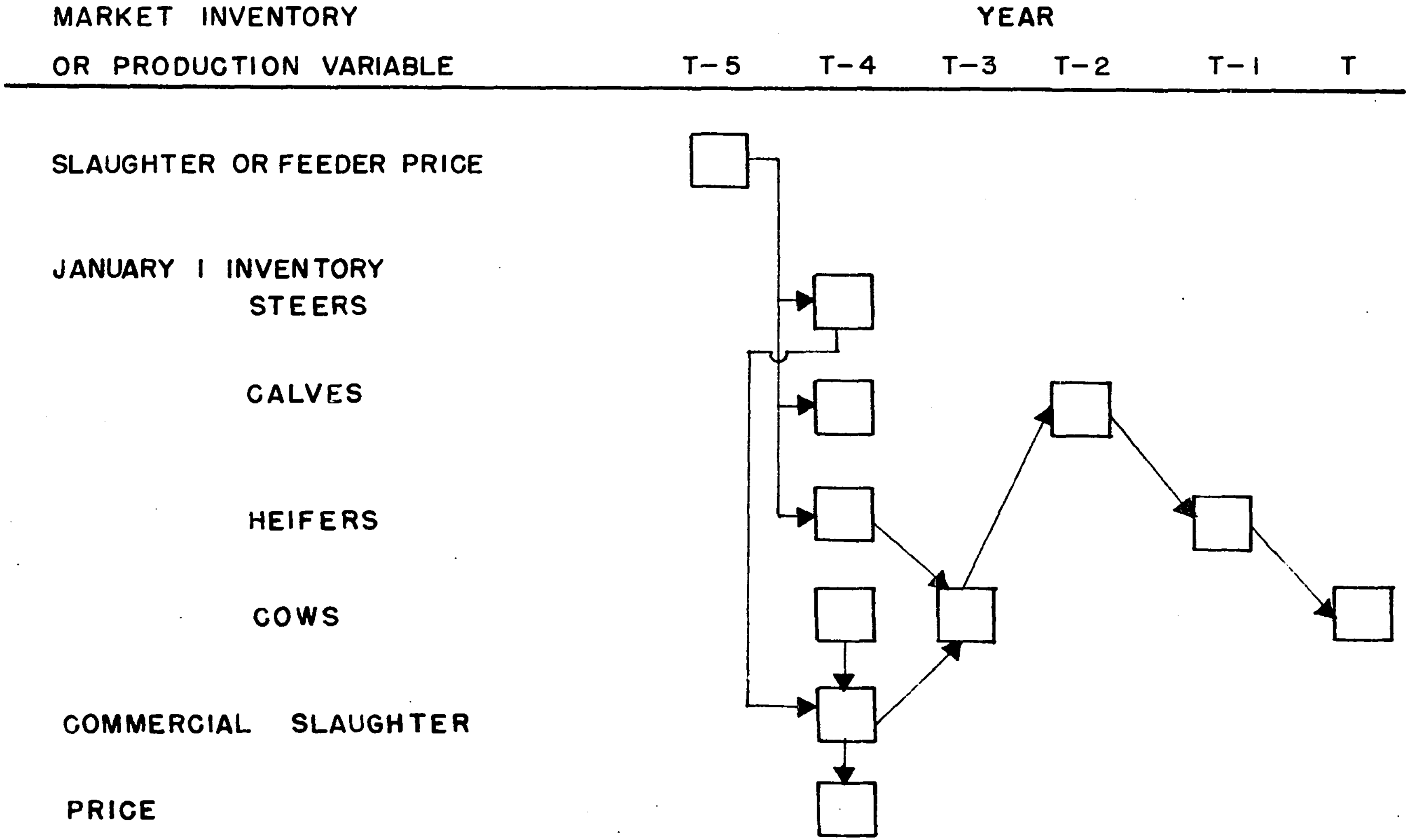


Figure 4. Causal ordering of selected endogenous variables in the beef sector of the U.S. livestock-meat economy

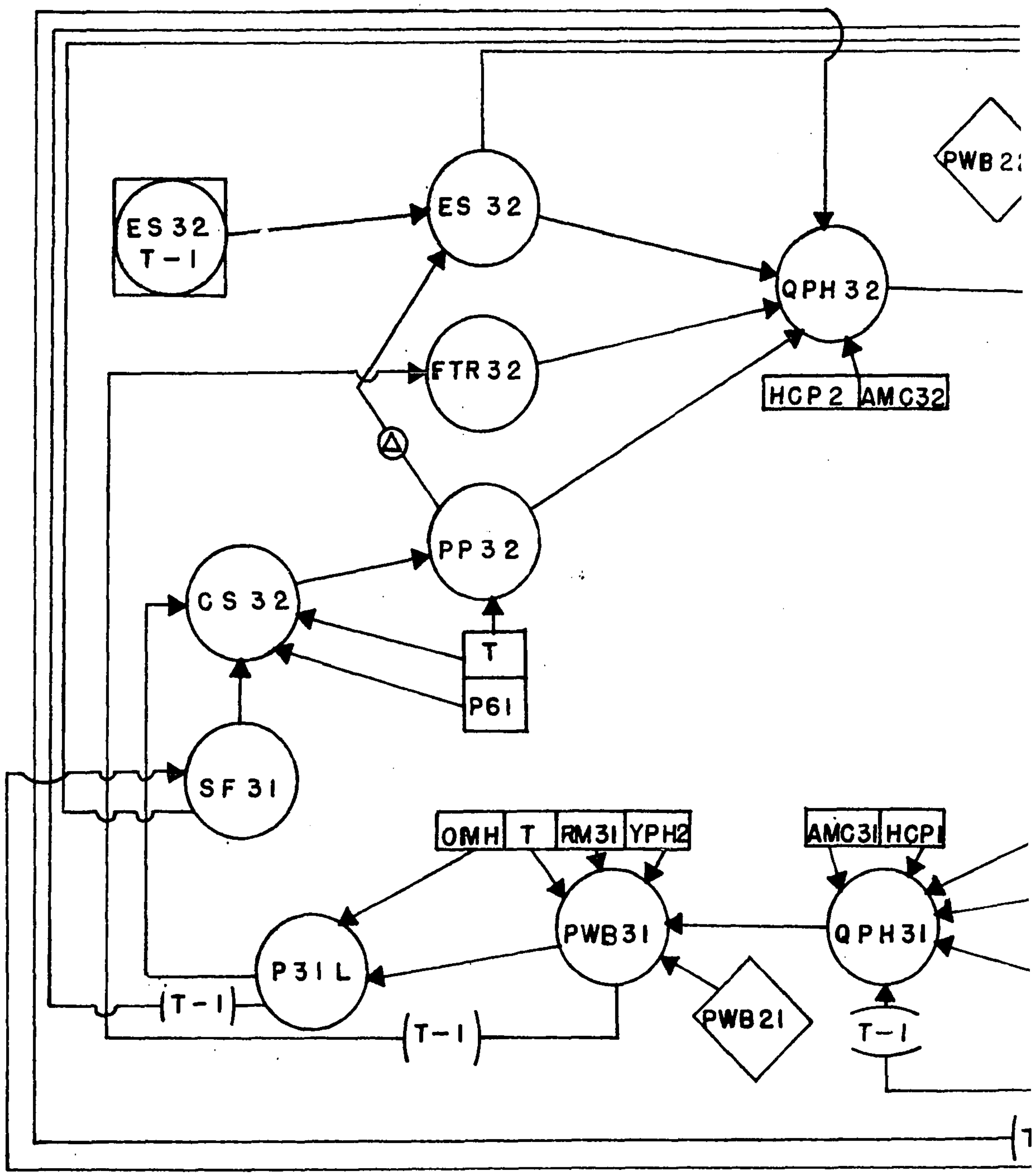
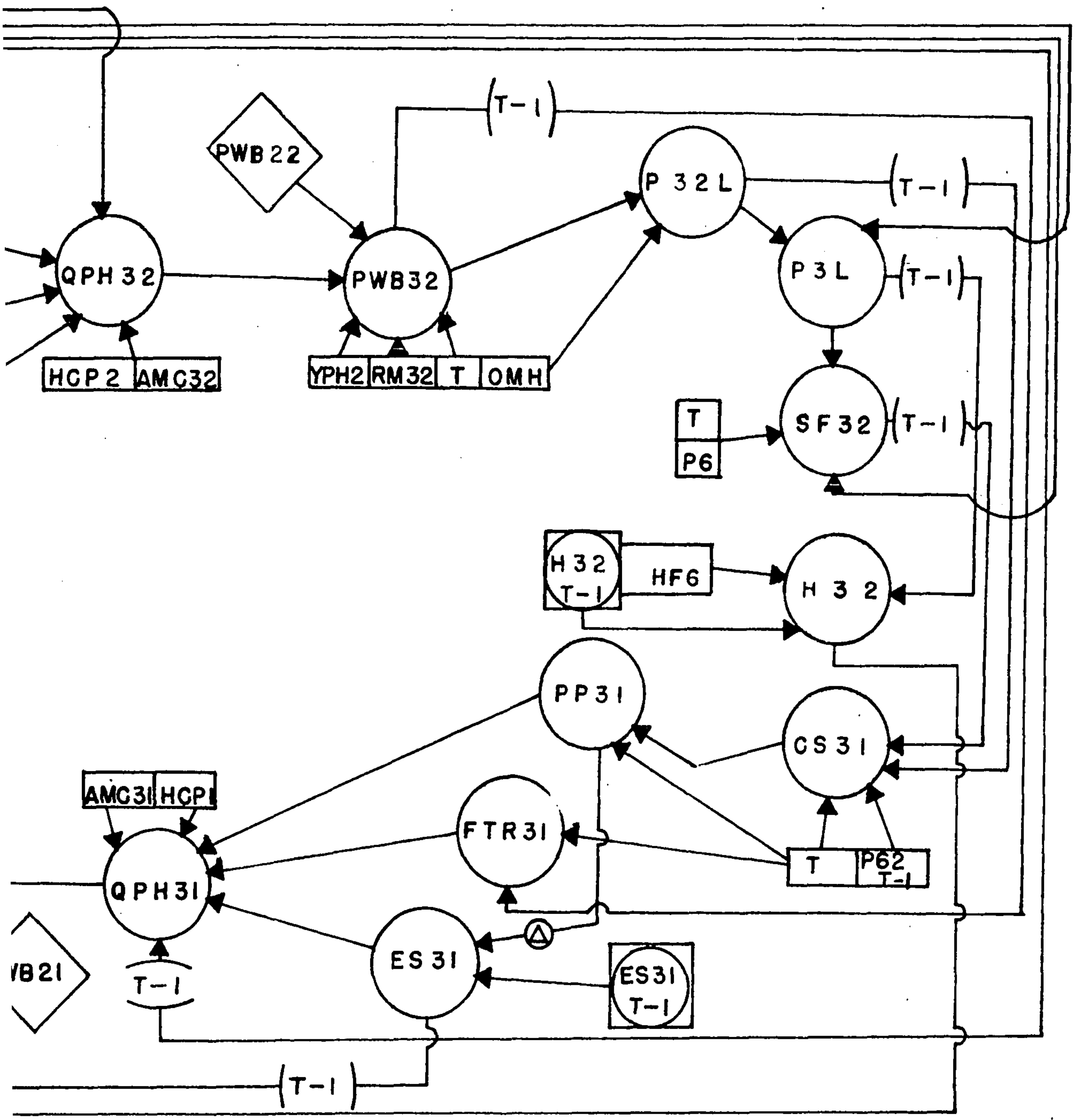


Figure 5. Schematic diagram of the economic structure of the pork sector c



e of the pork sector of the U.S. livestock-meat economy refers to beef or pork, respectively, while the second numeral, 1 or 2, refers to the January-June or July-December semi-annual period, except in the case of January 1 farm inventories where the second numeral denotes class of animal. For example, CS31 denotes commercial slaughter of hogs during the first half of the year whereas SF32 denotes sows farrowing during the second half of the year. However, in the coding notation H32, the first numeral refers to the hog sector as before, but the second numeral, 2, refers to the class of animal, sows and gilts.

In Figure 5, current endogenous variables appear as circles. Exogenous variables are noted by squares and appear inside the circular recursive flow of endogenous variables. In addition, ending stocks (ES3j) and January 1 sow inventories (H32) are influenced by their own value the previous period. This association is noted by a circle inside a square. The two interaction points with the beef sector are represented by a diamong shaped symbol. Time lags on an annual basis are indicated in the lines showing the circuitry of the system as are situations in which the causal variable takes the form of a first difference.

Let us enter the stock-flow diagram at the point of sows farrowing in the first six months of the year (SF31) which is determined by the number of sows and gilts on hand January 1. Spring farrowings and spring hog price are the endogenous variables affecting commercial hog slaughter the following fall along with the exogenous variable of corn price, plus a trend effect associated with larger litters. The level of commercial slaughter, plus a trend in the dressing percentage, establishes the level of fall pork production. Foreign trade in pork is usually negligible, but must be considered in order to maintain the consumption identity. Fall imports and exports are influenced by the wholesale price of pork the preceding spring along with some trend toward more foreign trade. Ending stocks shift from their year-earlier level in response to the change in pork production from the fall before. Thus, pork consumption takes the form of an identity: Ending stocks on June 30 (ES31), plus fall pork production (PP32), plus net foreign trade (FTR32), minus military consumption (AMC32), minus December 31 stocks (ES32). Military consumption is taken as exogenous. Consumption is then converted to a per capita basis.

The pork and beef sectors interact at the wholesale price level and represent the only simultaneous determination in the entire system. Wholesale pork price is a function of per capita pork consumption, the price of beef, its own retailing margin, per capita disposable income, and a trend component denoting shifts in consumer preference. It is important to note that the retailing margin is treated as an exogenous variable in the model, although we do not intend to infer that the quantity of pork available for consumption and the resulting price do not have any effect on the margin. However, the margin is also affected by exogenous elements such as wages, demand for more retailing services and so on. The decision to treat the margin as exogenous will be discussed in further detail in Chapter VII and VIII.

Live-hog price follows from wholesale price, although technological efficiency in the packing industry, of which output per man hour is assumed to be indicative, would affect the live-wholesale margin. Annual live-hog price is an unweighted average of the spring and fall price.

The magnitude of fall farrowings is not determined until the end of the year since the variable is used to explain commercial slaughter the following spring. Although spring farrowings are the major determinant of fall farrowings, the trend component indicates a move toward a year-round enterprise. The corn-hog ratio during the year also modifies fall farrowings as an upturn or downturn in this indicator of expected profitability of the enterprise may affect fall farrowings in the latter part of the fall period.

Similarly, the January 1 inventory of breeding stock is affected by the corn-hog ratio of the previous year. In addition, the change in stocks of corn on farms affects the inventory. Due to the effect of government price support programs, all corn prices and stocks are considered as exogenous.

The remainder of the causal ordering should be followed easily. Briefly, the sequence is spring slaughter, pork production, consumption, wholesale price and live price.

The Beef Sector

Two alternative forms of the structure of the beef sector are presented in Figures 6 and 7. The latter was finally chosen on the basis of its superior performance in the simulation model which will be discussed later.

Only two different forms of notation need to be introduced. Some endogenous variables are affected by the rate of change in a causal variable. The causal variable in this case is the second difference of that variable, $(X_t - X_{t-1}) - (X_{t-1} - X_{t-2})$. This form is noted as --Δ^2--. The notation --E-- refers to a second difference calculated on a semi-annual basis.

The original form of the structure of the beef sector is presented in Figure 6. Commencing with commercial cattle slaughter in the first half of the year, (CS21) is determined by the absolute level of January 1 steer numbers, the rate of change in beef-cow numbers, and the rate of change in the current spring feeder price. The rate of change in cow numbers is indicative of the build-up or liquidation of breeding stock whereas the rate of change in the feeder price is indicative of a diversion of feeder stock to slaughter during low price periods.

Although the current value of the causal variable (P21FC) comes into play, the recursiveness of the system is maintained in that the spring price is determined by lag variables.

In light of the detailed explanation of the pork sector, the causal chain should be easily followed through the determination of the fall feeder price. The only difference through this portion of price and output determination is the use of federally inspected cow slaughter (FIC2j) lagged six months as a causal variable in the net foreign trade in beef.

In the feeder-price sector, the annual average feeder price (P2FC) is instrumental in determining the January 1 inventory of cattle on feed (H26); a change in the latter from the year before, along with the feeder price the preceding fall, determines the spring feeder price. The fall feeder price sets the level of spring price as more feeder calves are sold

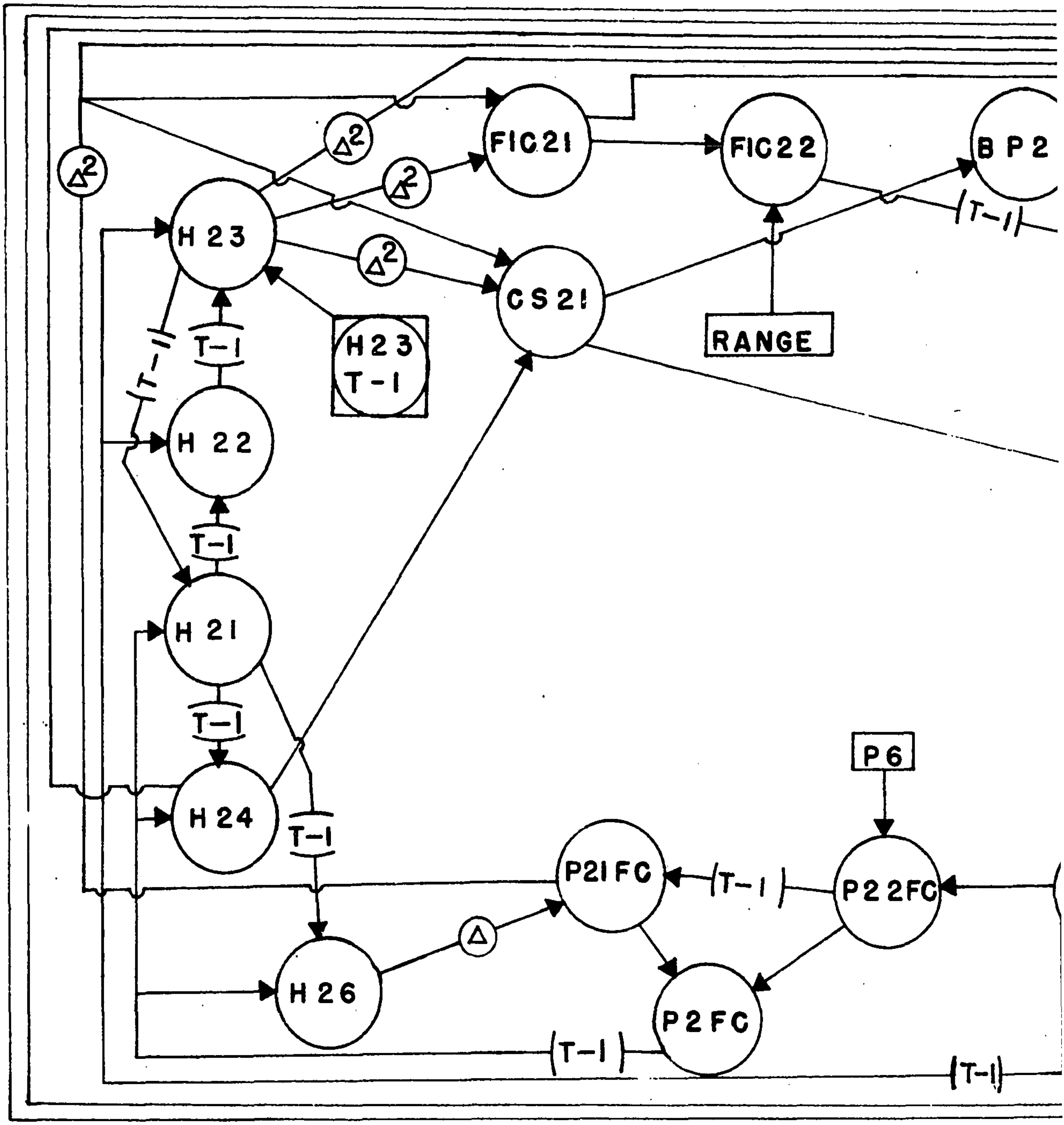
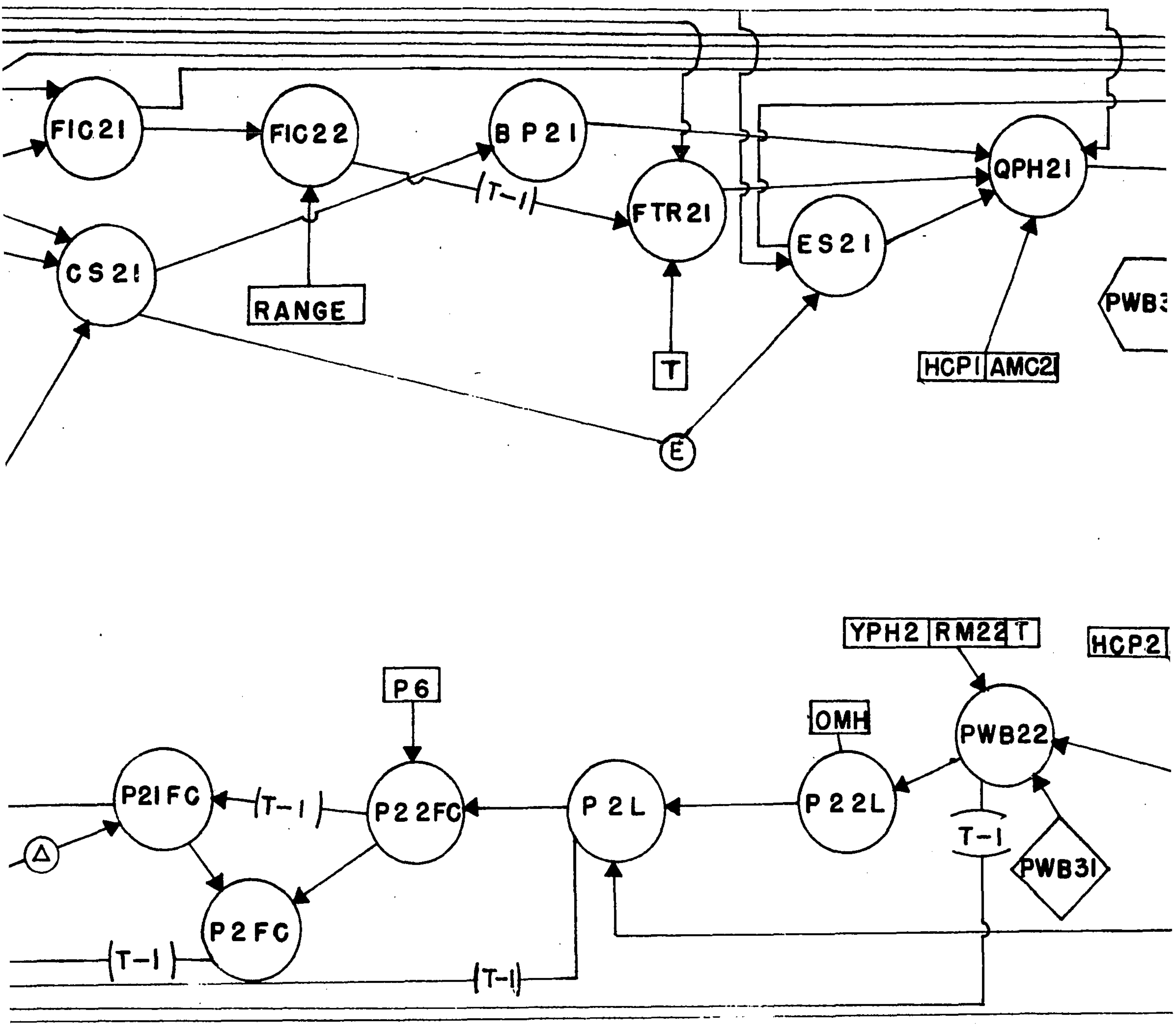
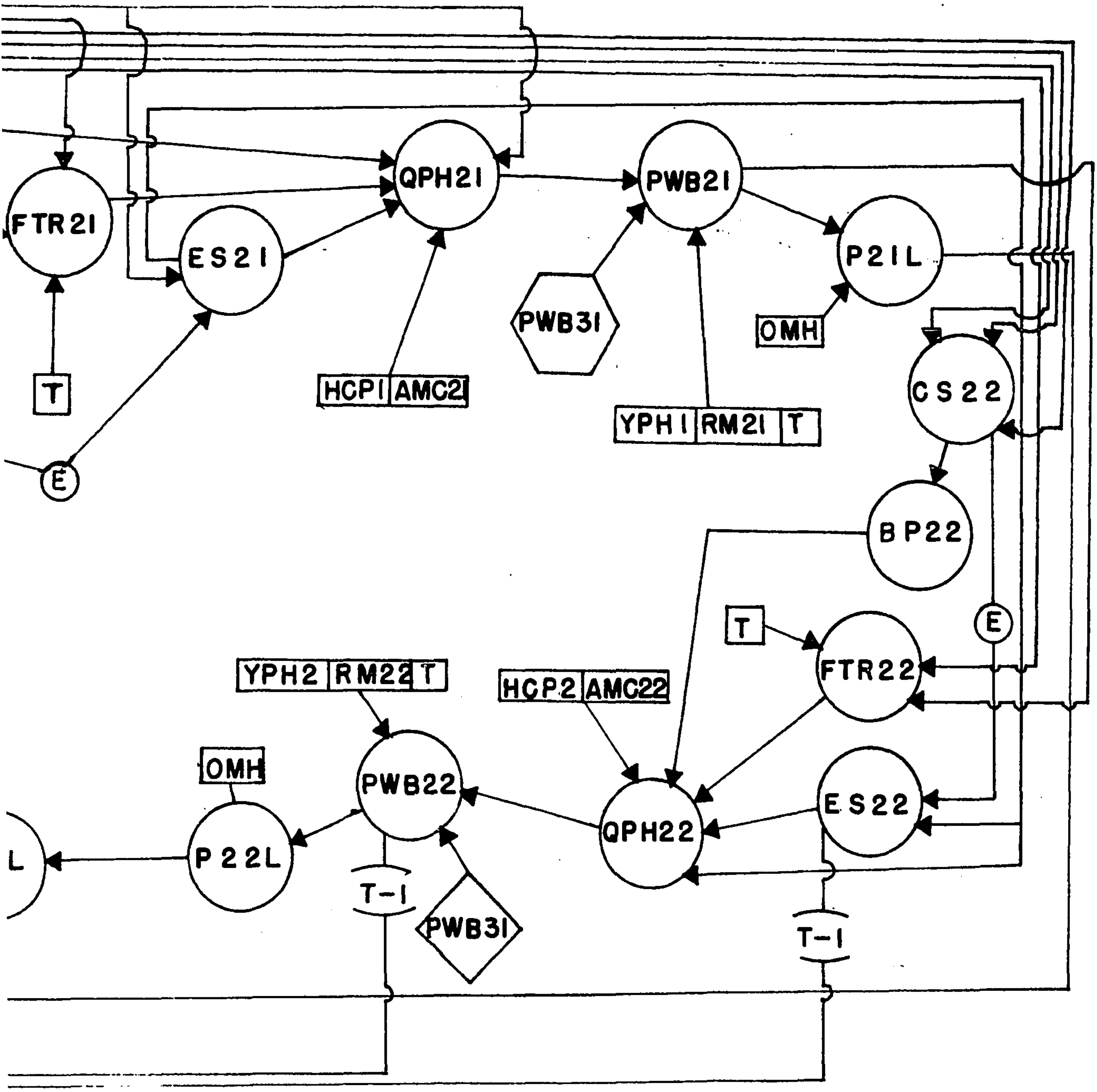


Figure 6. Schematic diagram of the economic structure of the beef sector of the



he economic structure of the beef sector of the U.S. livestock-meat economy



livestock-meat economy

in the last half of the year. The increase or decrease in cattle on feed January 1 reflects the change in demand for feeder cattle.

The annual feeder price of the preceding year is indicative of the profitability of the beef sector and is an important determinant of several January 1 inventory variables -- cattle on feed, steers, and calves. The number of cows and heifers of breeding age responds more quickly to price changes; the slaughter price (P2L), is the appropriate causal variable. Numbers of steers, heifers, and cattle on feed are in part determined by the number of calves less than one year of age the previous year. In addition to the price effect, January 1 cow numbers are adjusted from their previous level by the change in heifer numbers the previous year.

The principle differences in the alternative structure presented in Figure 7 occur in the determination of commercial slaughter, feeder-calf price and January 1 cow inventories. The basic causal variables of commercial cattle slaughter are the absolute levels of the January 1 inventory of steers, beef cows, and dairy cows. However, several modifying variables account for fifteen to twenty percent of the slaughter. Since slaughter in estimated on a liveweight basis, average slaughter weight, especially that of steers, is important. Also, a supply price, the average slaughter price on a July to June basis lagged two years, exerts a significant effect on the level of commercial slaughter. Although at first the two-year lag appears excessive, it has a plausible empirical basis. Decisions to breed more cows are usually made about July 1. If price the preceding year is favorable, more cows are bred during the summer of year "t-2". This results in a larger calf crop in year "t-1" of

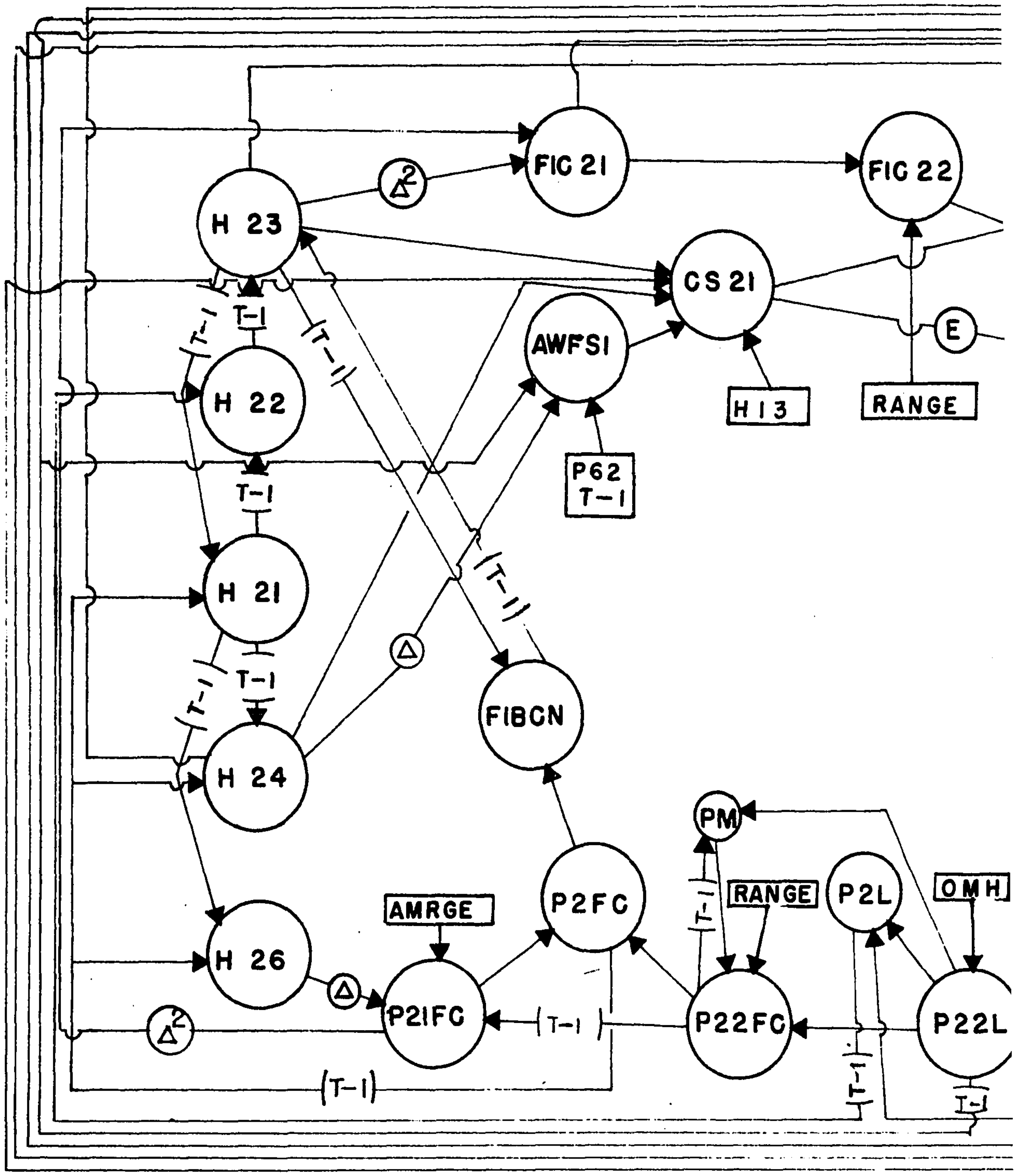
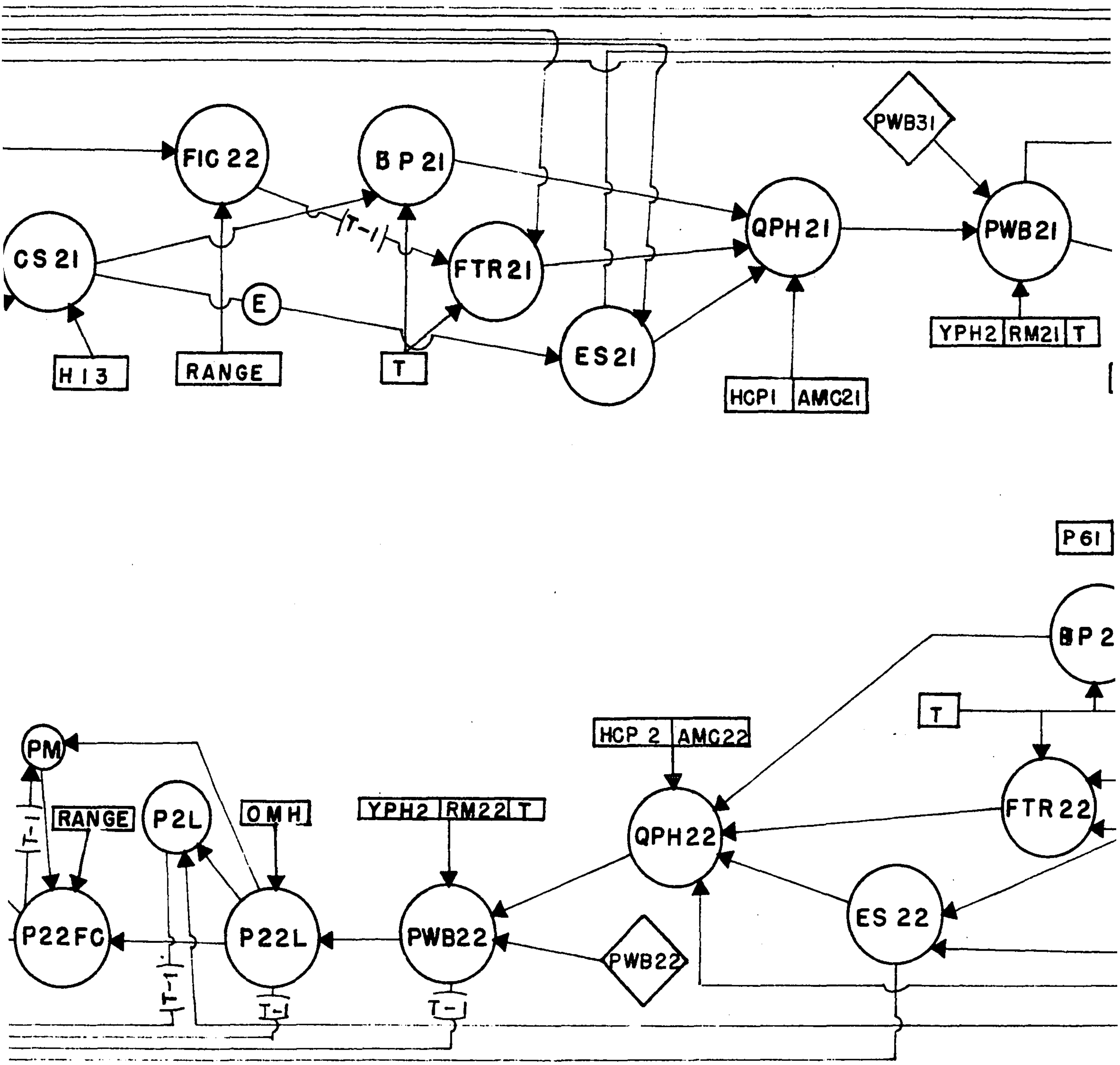
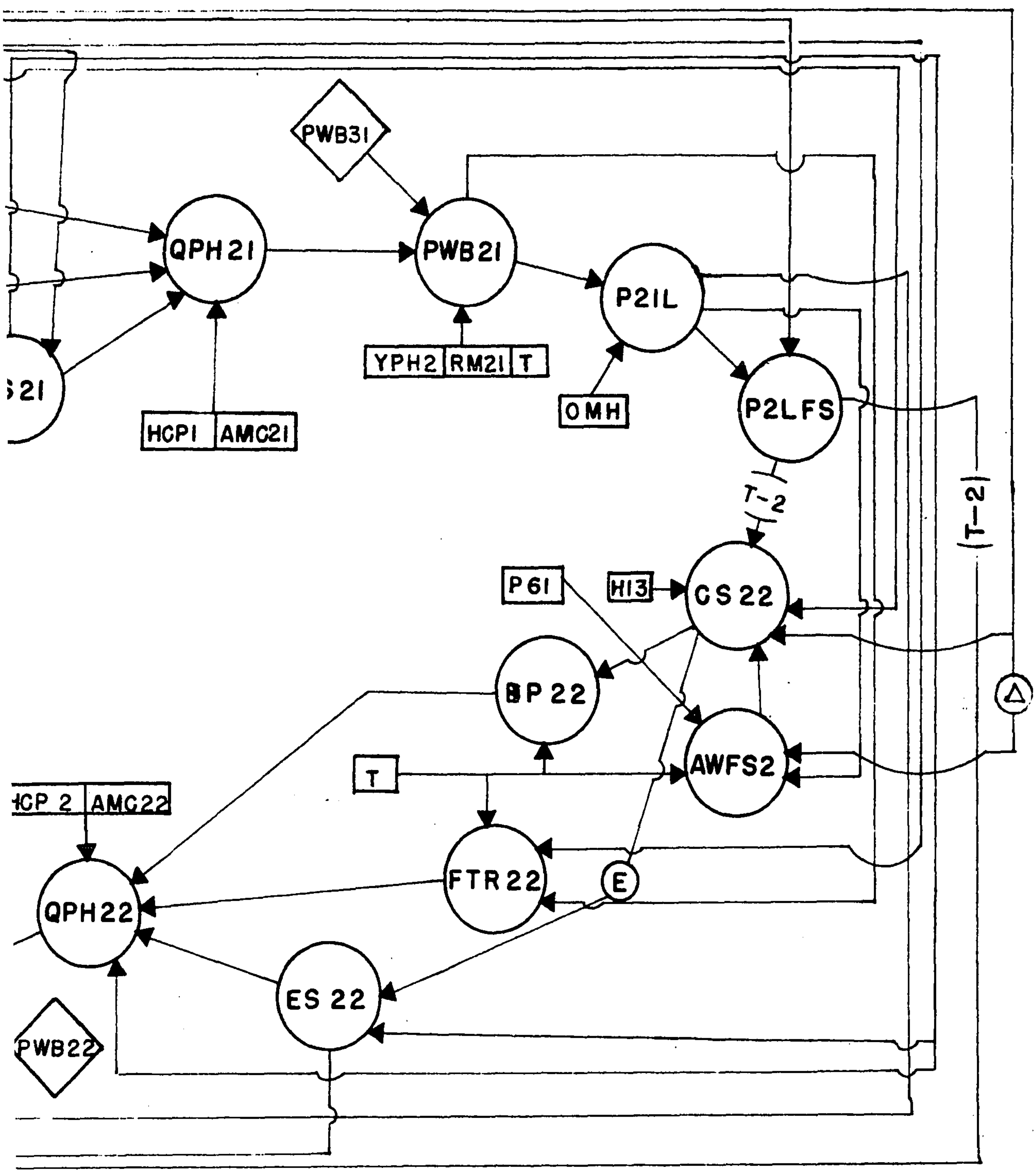


Figure 7. Schematic diagram of an alternative economic structure of the beef s



ıic structure of the beef sector of the livestock-meat economy



PWB31
QPH21
PWB21
P21L
P2LFS
S21
HCP1
AMC21
YPH2
RM21
T
OMH
T-2
(T-2)
P61
H13
CS22
BP22
AWFS2
T
FTR22
E
HCP 2
AMC22
QPH22
ES 22
PWB22

at economy

which part comes to slaughter in year "t". Before leaving the revised structure of commercial slaughter, it can be noted that the estimation of January 1 dairy-cow inventories involved all exogenous variables; hence, the variable itself is considered as exogenous to the beef sector.

Average steer weights may change as a result of cattle numbers, the beef-corn ratio of the preceding half-year, and a trend component. The trend, in this instance, stems from the increasing ratio of fed steers to total steers slaughtered.

The fall feeder price may still be considered a function of the slaughter-steer price; however, this price is also influenced by the feeding margin, PM, and range conditions. The feeding margin, illustrated in the structural diagram, is computed as a current margin; however, the margin in the spring appears to be more appropriate when steer prices are steady to rising (inasmuch as feeders probably do not calculate margins as closely when prices are favorable). Good range conditions support feeder prices in that the rancher's bargaining power is sustained by abundant feed supplies for wintering. Spring feeder price is calculated as in the original model with the addition of an effect associated with spring range conditions.

The beef-cow inventory on January 1 may be regarded as a basic stock variable with additions coming from heifers the previous year and deletions resulting from cow slaughter the previous year. Cow slaughter is given as federally inspected slaughter to maintain consistency in variable names throughout the study. However, at this stage, cow slaughter should be regarded as total cow slaughter (which is determined by the current feeder price). Inasmuch as cow slaughter is determined as an ex-post relation at the end of the year, the lag nature of the system is maintained.

CHAPTER IV: SIMULATION MODELS AND ECONOMETRIC CONSIDERATIONS

To study the performance of a particular market and to compare it with that of an alternative organization of this market, a model depicting the relevant prices, outputs, and inventories is needed. This model must be constructed so as to generate the time paths of variables over a period preferably the length of one or more cycles, when cycles exist. Simulation models have the necessary desirable properties. They also lend themselves to the use of high-speed electronic computers so that the great number of computations necessary do not present an unsurmountable obstacle.

Simulation Models

Although various econometric analyses have contained some elements of simulation, Orcutt (42, p. 893) differentiates simulation from conventional mathematical technique as follows: "The objective of mathematical technique is to determine deductively the way in which the model implicitly relates endogenous variables to initial conditions, parameters, and time paths of exogenous variables. On the contrary, a single simulation run gives a highly specific solution. Given completely specified initial conditions, parameters, and exogenous variables, only a unique time path is produced for the endogenous variables. Thus, an individual simulation run may be thought of as an experiment upon an economic model. The objective is to trace out the time paths and causal ordering of these variables whether they be optimum or not".

Cohen (17, p. 81) summarizes four advantages of computer simulations:

(a) A more complex and realistic model is feasible as analytic solutions are unnecessary, (b) assumptions may be modified as necessary, (c) more insights into dynamic theories are possible, and (d) it is well suited to use by non-mathmeticians. Shubik (47) also feels that simulation forces a more well-defined problem than other forms of analysis.

In his work using simulation models, Orcutt (42, p. 898) makes three classifications of variables -- output, input, and status variables. Output variables are the product of a component at the end of a specific time period. Examples of output variables might be quantity produced, sold, or stored. Input variables arise outside the component, e.g. the exogenous variables. Status variables describe the current state of the component. Examples of status variables might be number of firms in the industry, current size of the labor force and stocks on hand. The reaction of status variables to input and output variables generated during the previous time period(s) establishes behavior of the status variables and their resulting outputs.

The simulation model specifies the set of relationships directing the behavior of the status variables when stimulated by input and lagged output variables. These relationships may also be classified as identities or operating characteristics. Identities need no further elaboration. Operating characteristics may be specified as functional relations, or decision rules arrived at through a prior knowledge, by means of sample surveys, or by means of economic theory. Operating characteristics may be brought in and out of the model as conditions change. For example, one operating characteristic might be used when prices are falling while another may take over during times of rising prices.

Time periods for simulation studies should be relatively short. This is necessary so that variables may maintain fairly stable values throughout the time period. However, data limitations may necessitate longer periods.

Functional operating characteristics often may be established by least squares. However, as non-linearities, or rules for different situations often exist, arbitrary values may be assigned to the parameters of the model and adjusted from one simulation to the next until satisfactory values are reproduced for the historical period.

Since computers proceed through the program in sequential fashion, recursive econometric models require very little adaptation. However, one may often encounter situations where several outputs are determined simultaneously. In these cases it may be well to establish reduced-form equations so that the recursive chain of events might be maintained. As an alternative, Orcutt suggested a block-recursive model where various methods could be used to estimate the output variables of one block and feed them into another block as input variables.

Simulation models are generally validated by their ability to satisfactorily reproduce the actual values of the endogenous variables during a historical period. Although validation might be accomplished by merely graphing the predicted and actual values, several quantitative methods are available.

Orcutt (42, p. 898) suggests that a simple regression of the form

$$y = a + bx \qquad \text{(Eq. 4.1)}$$

be fitted to the predicted and actual data. A perfect simulation of the historical period would yield an "a" of zero and a "b" of one. The estimated value of these parameters could then be tested with the students' (t) distribution to see if they were significantly different from zero and one respectively.

Theil (50, p. 32 and p. 170) suggests a combination of two tests for forecast values to be used in conjunction with each other. First, a turning-point error may be evaluated where the following ratio is formed:

$$TPE = \frac{f_{12} + f_{21}}{f_{11} + f_{22}}, \qquad \text{(Eq. 4.2)}$$

where "f" refers to the direction that the individual observations take from the previous period. The first subscript refers to the predicted value which the second subscript refers to the actual value. A subscript of 1 denotes an increase from the previous period; a subscript of 2 denotes a decrease from the previous period.

Theil also suggests an index of dispersion, U, which measures the degree of deviation of predicted from actual values. It is calculated as,

$$U = \frac{\sqrt{1/n \sum (P-A)^2}}{\sqrt{1/n \sum P^2} + \sqrt{1/n \sum A^2}}, \qquad \text{(Eq. 4.3)}$$

where "P" refers to the value predicted by the simulation and "A" refers to the reported value. This statistic follows a parent coefficient,

$$Y = \frac{\sqrt{u_{20} + u_{02} - 2u_{11}}}{\sqrt{u_{20}} + \sqrt{u_{02}}}, \qquad \text{(Eq. 4.4)}$$

with variance,

$$\text{Var. } U \leq \frac{1}{n} Y^2 (1-Y^2)^2 \quad , \qquad \text{(Eq. 4.5)}$$

under the assumptions of independence and bivariate normality. The conditions of the individual simulation is question must determine the relative value to put on the turning-point error and the degree of dispersion. For many economic forecasts, given a reasonable degree of dispersion, the turning-point error may be more important than a minimum degree of dispersion.

Econometric Considerations

Validation of the simulation model through reproduction of the historical period and use of logical decision rules do not preclude all econometric considerations. In models that contain behavioral relations whose parameters are estimated by statistical methods, valid econometric procedures should be used.

Recursive versus simultaneous systems

The notion of recursive models for economic analysis was suggested by Wold and Jureen (64, p. 14 and p. 70) who define a recursive system as having two essential properties: (a) development of the variables is known up to time, t-1, and the variables at time, t, are obtained one by one, and (b) each equation expresses a unilateral causal dependence. Or, in matrix form, the coefficient matrix is represented as a lower-triangular matrix. Wold and Jureen conclude that recursive systems are a most natural tool for dynamic analysis as they lend themselves to models that are constructed as a chain of causation and require no further specification. Ordinary least squares are regarded as giving unbiased and consistent estimates for the parameters of recursive models when the system is recursive (64, p. 203).

Seven years later in 1960, Strotz and Wold (49, p. 416) reviewed the controversy of recursive versus simultaneous systems. They defined causality as follows:

> .....z is a cause of y if, by hypothesis, it is or "would be" possible by controlling z indirectly to control y, at least stochastically. But it may or may not be possible by controlling indirectly to control z. A causal relation is therefore essentially asymetric in that in any instance of its realization it is asymetric.....

Wold and Strotz concluded that if causal interpretation of an interdependent system is possible, it is to be provided in terms of a recursive system. Thus, an underlying latent recursive model exists for most simultaneous systems but is not used possibly due to too long a time period. In fact many simultaneous relations involving annual data may be lag relations in a semi-annual or quarterly model.

In another article, Wold argued that a causal-chain model, where some type of simultaneous system could be used to construct a model on the basis of behavioral relations, might synthesize the recursive and interdependent systems (63). This model would accept other relations and approximations that might break the pattern of the triangular coefficient matrix and yet maintain the stimulus-response interpretation. Wold finally assessed the recursive, interdependent or causal-chain models as follows:

> What in particular is a serious limitation is that every equilibrium assumption is an approximation that ignores a potential driving force of the model. To assume instantaneous equilibrium between

> demand and supply is to ignore changes in stocks; to equilibriate savings and investments is to ignore the unplanned changes in money holdings and inventories, and so on. In reality, according to observed facts, such disequilibrium gaps are often quite considerable and to disregard them in model construction is in conflict with the basic arguments in dynamic economic theory. This comment goes some way to explain why it is that the applied work with interdependent systems has given meager results when it comes to actual forecasting.....

The lag-causal ordering of the economic structure of the beef and pork sectors suggest the possibility of a recursive model. Formation of the matrix of endogenous variables results in a lower diagonal matrix if proper consecutive ordering is followed when variables have current time subscripts (see Table 2). Lagged endogenous variables are treated as exogenous variables.

A six-month time period is the maximum length of the period to be estimated due to the nature of the lag between sows farrowing and commercial hog slaughter in the pork sector. The semi-annual time period allows a lag relation to be maintained for some relations that would be simultaneous if the time period were one year.

Use of ordinary least squares

The simulation model allows introduction of identities and logical behavioral relations. However, many relationships in the program may be estimated statistically. In the recursive system specified by the triangular coefficient matrix of the endogenous variables, the covariance matrix of the residuals is also assumed to be a diagonal matrix. Wold and Jureen (64, p. 203) assert that intercorrelation of these off-diagonal residuals can be reduced to negligible proportions if the relationships are arranged as a series of lag relationships.

Table 2. Matrix of endogenous variables in the beef and pork sectors of the livestock-meat economy of the United States

	H23	H22	H21	H24	H26	P21FC	AWFS1	CS21	FIC21	BP21	FTR21
H23	1										
H22		1									
H21			1								
H24				1							
H26					1						
P21FC					X	1					
AWFS1				X			1				
CS21	X			X			X	1			
FIC21	X					X			1		
BP21								X		1	
FTR21											1
ES21								X			
QPH21										X	X
H32											
SF31											
CS31											
PP31											
FTR31											
ES31											
QPH31											
PWB21											
PWB31											
P21L											
P31L											
CS32											
PP32											
FTR32											
ES32											
QPH22											
AWFS2				X							
CS22	X			X							
BP22											
FTR22									X		
ES22								X			
QPH22											
FIC22									X		
PWB22											
P22L											
P22FC											
PWB32											
P32L											
SF32											
FIBCN	X						X				

Table 2 (Continued)

	ES21	QPH21	H32	SF31	CS31	PP31	FTR31	ES31	QPH21	PWB21	PWB31
H23											
H22											
H21											
H24											
H26											
P21FC											
AWFS1											
CS21											
FIC21											
BP21											
FTR21											
ES21	1										
QPH21	X	1									
H32			1								
SF31			X	1							
CS31					1						
PP31					X	1					
FTR31							1				
ES31							X	1			
QPH31						X	X	X	1		
PWB21		X							X	1	
PWB31									X	X	1
P21L										X	
P31L											X
CS32											
PP32											
FTR32											
ES32											
QPH22	X							X			
AWFS2											
CS22											
BP22											
FTR22										X	
ES22											
QPH22											
FIC22											
PWB22											
P22L											
P22FC											
PWB32											
P32L											
SF32				X							
FIBCN											

Table 2 (Continued)

	P21L	P31L	CS32	PP32	FTR32	ES32	QPH32	AWFS2	CS22	BP22	FTR22
H23											
H22											
H21											
H24											
H26											
P21FC											
AWFS1											
CS21											
FIC21											
BP21											
FTR21											
ES21											
QPH21											
H32											
SF31											
CS31											
PP31											
FTR31											
ES31											
QPH31											
PWB21											
PWB31											
P21L	1										
P31L		1									
CS32		X	1								
PP32			X	1							
FTR32					1						
ES32				X		1					
QPH22				X	X	X	1				
AWFS2	X							1			
CS22								X	1		
BP22									X	1	
FTR22											1
ES22									X		
QPH22										X	X
FIC22											
PWB22							X				
P22L											
P22FC											
PWB32							X				
P32L											
SF32		X									
FIBCN											

Table 2 (Continued)

	ES22	QPH22	FIC22	PWB22	P22L	P22FC	PWB32	P32L	SF32	FIBCN
H23										
H22										
H21										
H24										
H26										
P21FC										
AWFS1										
CS21										
FIC21										
BP21										
FTR21										
ES21										
QPH21										
H32										
SF31										
CS31										
PP31										
FTR31										
ES31										
QPH31										
PWB21										
PWB31										
P21L										
P31L										
CS32										
PP32										
FTR32										
ES32										
QPH22										
AWFS2										
CS22										
BP22										
FTR22										
ES22	1									
QPH22	X	1								
FIC22			1							
PWB22		X		1						
P22L				X	1					
P22FC					X	1				
PWB32				X			1			
P32L							X	1		
SF32								X	1	
FIBCN						X				1

Other arguments have been advanced for the use of least squares techniques, even if the assumption of a diagonal covariance matrix is invalid. Waugh (60, p. 386) reviewed the use of least squares and simultaneous systems in operational uses of the past decade and concluded least squares often as not gave superior estimates. Christ (13, p. 835) noted that specification errors, other than simultaneity, often invalidated interdependent estimates. Klein (31, p. 866) endorsed least squares for cobweb models and also concurred with Fox's argument for least squares estimation of market demand relations of farm products where supply varies much more than demand.

For this study, it was decided to use single-equation least squares to estimate the functional relations of the model. Possible difficulties in the assumption of uncorrelated error terms of the recursive model, plus some autocorrelation in the time series data, were taken into account in making this decision. However, anticipated use of other types of decision rules and behavioral relations in the simulation model were additional considerations. These latter factors, combined with the advantage of computational simplicity, were felt to outweigh the disadvantages, particularly in light of the limited number of observations available in the post World War II period. All equations involving a high degree of multi-collinearity were re-estimated after eliminating the variable in question.

CHAPTER V: EMPIRICAL ESTIMATES OF FUNCTIONAL RELATIONS

The functional relationships suggested by the economic structure presented in Chapter III were estimated by least squares. The preliminary formulation of the economic structure of the beef sector that served as a basis for modifying certain functional relationships is presented first to show the independent variables finally selected for use in the revised model.

All the preliminary series of estimates were based on data from either the 1949-60 or the 1949-61 time period. However, in many cases, revised estimates using 1955-63 data were needed when initial simulation runs revealed what apparently was a change in some parameters after the Korean War.

With the exception of feeder-calf price, Chicago prices were used in order to avoid the spatial price variation problem, insofar as possible. Quantity variables were in general estimated on a live weight or carcass weight basis, with the exception of livestock inventory variables, which were estimated on a one-thousand-head basis. Although variable notation will be described in the discussion of each functional relation, the reader again is referred to Table 1 for a more detailed description of the variables.

In the discussion that follows, standard errors of the estimated coefficients are presented in parenthesis below the coefficient. One asterisk to the right of the coefficient denotes a "t" test indicating the estimated coefficient is significantly different from zero at the five-percent level (two asterisks indicate significance at the one-percent level).

Livestock Inventory Sector

All January 1 beef-cattle inventory equations are based on data covering the entire 1955-64 period. Beef-cow numbers on January 1 (H23) are estimated as a function of the lag value of the dependent variable, the first difference of the beef-heifer inventory lagged one year, and the average price of steers the preceding year. The accelerator coefficient associated with the lag value of the dependent variable is indicative of the growth of the beef industry during the post war years. Similarly, the magnitude of the coefficient associated with the change in heifer inventories the previous year indicates the average number of yearling heifers retained for the cow herd. The beef-cattle inventory equations are summarized as follows:

$$H23_t = -4{,}773.0 + \underset{(0.056)}{1.045^{**}}\, H23_{t-1} + \underset{(0.4572)}{0.7891}\,\Delta H22_{t-1} + \underset{(64.3)}{168.2^{*}}\, P2L_{t-1}\,, \quad R^2 = 0.976 \qquad \text{(Eq. 5.1)}$$

$$H21_t = 11{,}990.0 + \underset{(0.086)}{1.077^{**}}\, H23_{t-1} + \underset{(25.1)}{166.2^{**}}\, P2FC_{t-1}\,, \quad R^2 = 0.974 \qquad \text{(Eq. 5.2)}$$

$$H22_t = -3{,}418.0 + \underset{(0.0692)}{0.3361^{**}}\, H21_{t-1} + \underset{(45.5)}{142.4^{*}}\, P2L_{t-1}\,, \quad R^2 = 0.900 \qquad \text{(Eq. 5.3)}$$

$$H24_t = -4{,}017.0 + \underset{(0.0435)}{0.7061^{**}}\, H21_{t-1} + \underset{(13.13)}{81.26^{**}}\, P2FC_{t-1}\,, \quad R^2 = 0.987 \qquad \text{(Eq. 5.4)}$$

$$H26_t = -6{,}132.0 + \underset{(0.0555)}{0.5735^{**}}\, H21_{t-1} + \underset{(20.94)}{70.96^{*}}\, P2FC_{t-1} \,. \qquad R^2 = 0.958$$

(Eq. 5.5)

Thus, the inventory of beef calves less than one year of age (H21) is depicted as a function of the number of beef cows (H23) the preceding January 1 and the average price of feeder calves during the preceding year. The coefficient greater than one associated with beef-cow numbers is plausible inasmuch as male dairy calves are included in this inventory classification. The number of beef heifers one to two years old (H22) are determined by the number of beef calves the preceding January 1 and the price of slaughter cattle. Slaughter price gives a slightly better explanation of the variation in beef-heifer inventories than feeder price, whereas in the following equation in which the number of steers and bulls over one year of age on hand January 1 are estimated (H24), the feeder price for the preceding year is again the more appropriate price variable. Finally, the number of cattle on feed January 1 in the twenty-six major feeding states was found to be related to the same set of explanatory variables as steer and bull inventories. This is not surprising inasmuch as cattle on feed constitute a dual classification; they are also classified in the inventory as steers, heifers, or calves.

Only one January 1 inventory variable is necessary in the pork sector -- the number of sows and gilts six-months old or over (H32). The hog inventory relationship is estimated as a difference equation:

$$\Delta H32_t = -3{,}360.0 + \underset{(50.8)}{252.9^{**}}\, (P3L/P6)_{t-1} \underset{(0.800)}{-2.680^{**}}\, HF6_t \,. \qquad R^2 = 0.880$$

(Eq. 5.6)

The change in sow and gilt numbers is related to the corn-hog ratio and the change in January 1 stocks of corn on farms. While the effect of a change in the corn-hog ratio is a logical causal variable, caution must be exercised in interpreting the change in stocks of corn on farms. First, government stocks held on farms are included in the figure. Hence, a change in participation in price support programs could have an effect on the magnitude of this variable. Secondly, either a general decrease in animal units consuming corn, or a change in a specific class of animal consuming corn during the last half of the preceding year, could result in an increase in January 1 corn stocks. Finally, the size of the fall corn crop could affect the change in this variable. All of these possibilities of increasing (decreasing) corn stocks, and the related decreases (increases) in sow and gilt numbers, must be considered. A logical explanation of the change in January 1 corn stocks is offered by the alternatives of (a) a decline in livestock feeding or participation in government programs resulting in more corn on farms the following January 1, and (b) a less favorable outlook for hog production with a corresponding reduction in sow and gilt numbers.

Finally, the number of sows farrowing during the December-May period and the June-November period are included with the inventory variables, although these variables are not stock variables. However, the sows-farrowing variables function in the same manner as cattle inventories with reference to commercial slaughter. The functional relationships for sows farrowing in the spring and fall, respectively, are:

$$SF31_t = -165.0 + \underset{(0.0530)}{0.9206^{**}} \, H32_t \, , \qquad R^2 = 0.974 \qquad \text{(Eq. 5.7)}$$

and

$$SF32_t = -3{,}200.0 + \underset{(0.2173)}{0.7249^{**}}\ SF31_t + \underset{(39.0)}{210.4^{**}}\ T + \underset{(51.9)}{82.0}\ (P3L/P6)_t\ .$$

$$R^2 = 0.880 \qquad \text{(Eq. 5.8)}$$

The simple regression of sows farrowing in the spring (SF31) on the January 1 inventory is obvious. Fall farrowings (SF32) are determined to a great extent by spring farrowings with an additional influence coming from the corn-hog ratio as the year progresses. A trend toward year-round farrowing also occurred during the historical period. The former equation was fitted to 1953-61 data while the latter equation was fitted to 1955-62 data.

Livestock Slaughter and Meat Production

Commercial cattle slaughter can be estimated over the 1949-60 period as a function of the rate of change in beef-cow numbers, the number of steers on hand January 1, and the rate of change in feeder-calf prices during the first half of the year. The rate of change in a variable such as beef-cow numbers or feeder-calf prices is measured by the second difference of the variable. Since the spring feeder price is determined by lag variables, the recursive nature of the system is thereby maintained in the following equations for estimation of semi-annual commercial slaughter:

$$CS21_t = -3{,}926.0 \underset{(0.2526)}{-0.7601^{*}}\Delta^2\ H23_t + \underset{(0.181)}{1.398^{**}}\ H24_t + \underset{(25.24)}{83.12^{*}}\Delta^2\ P21FC_t\ ,$$

$$R^2 = 0.923 \qquad \text{(Eq. 5.9)}$$

and

$$CS22_t = -3{,}356.0 \underset{(0.2370)}{-0.9236^{**}} \Delta^2 H23_t + \underset{(0.169)}{1.43^{**}} H24 + \underset{(23.66)}{68.24^{*}} \Delta^2 P21FC_t .$$

$R^2 = 0.938$ (Eq. 5.10)

The negative coefficient associated with the rate of change in beef-cow numbers is logical in that slaughter of breeding stock is reduced as cattle numbers are being built up. Conversely, the sales response is represented by increased slaughter as the feeder price increases at an increasing rate. Also, more feeder calves are diverted to slaughter during periods of low prices. The January 1 number of steers on hand is important in setting the level of slaughter for the year. Finally, the sum of the coefficients of the steer inventory, approximately 2.84, is affected by a feeding period averaging less than one year in length.

Cow slaughter under federal inspection (FIC2j) can be estimated as a function of the rate of change of January 1 cow numbers and spring feeder prices during the first half of the year. However, federally inspected cow slaughter during the fall is determined by cow slaughter during the first half of the year and the fall range conditions, as indicated by the October 1 range condition report for the 17 Western states. Cow slaughter is the only federally inspected component necessary for the model. The two equations denoting the first and second half-year semi-annual estimates of cow slaughter under federal inspection on a liveweight basis are:

$$FIC21_t = 2{,}257.0 \underset{(0.1469)}{-0.3084^{*}} \Delta^2 H23_t + \underset{(10.58)}{21.84^{*}} \Delta^2 P21FC_t ,$$

$R^2 = 0.801$ (Eq. 5.11)

and

$$FIC22_t = 4{,}874.0 + \underset{(0.2690)}{0.9050^{**}} FIC21_t - \underset{(18.64)}{53.10^{*}} RANGE_t .$$

$R^2 = 0.790$ (Eq. 5.12)

The rate of change in feeder price represents the profitability of feeder-calf sales while the coefficient associated with the rate of change in cow numbers again represents the build-up or decrease in the breeding herd.

Estimates of commercial hog slaughter (CS3j) on a liveweight basis requires a separate equation for each period, since different lags are needed in the variables. The semi-annual equations are:

$$CS31_t = \underset{}{284.0} + \underset{(0.133)}{1.334^{**}} SF32_{t-1} - \underset{(25.09)}{57.57^{*}} P32L_{t-1} + \underset{(388)}{1198^{*}} P62 + \underset{(24.43)}{72.90^{*}} T1 ,$$

$$R^2 = 0.962 \qquad \text{(Eq. 5.13)}$$

and

$$CS32_t = 99.0 + \underset{(0.1152)}{0.7764^{**}} SF31_t - \underset{(19.81)}{16.10} P31L_t + \underset{(367.9)}{861.4^{*}} P61_t + \underset{(27.5)}{238.6^{**}} T1 .$$

$$R^2 = 0.941 \qquad \text{(Eq. 5.14)}$$

As one might expect, sows farrowing the previous half year determine the level of commercial hog slaughter. The coefficient for sows farrowing in the spring is less than that on fall farrowings as more gilts are retained for breeding purposes from spring farrowings. Conversely, more sows are slaughtered in the second half of the year. The fall hog-price (P32L) effect on spring slaughter is significant, but spring hog price has little effect on fall slaughter. Fall hog prices appear to affect the number of gilts retained for breeding purposes. High corn prices (P6j) in the preceding half year induce more slaughter during the current period in the following manner: Fewer sows are bred for another litter due to the high feed price, and are subsequently slaughtered during the next six months after the previous litter is weaned. The positive trend terms represent the increase in slaughter over time as litter size increases.

Regional estimates of commercial slaughter show the spatial structure of beef and pork production. The regional model uses the same explanatory variables for all regional estimates. Thus, consistency is maintained between the regional and national functions. Also, the use of regional explanatory variables would be erroneous inasmuch as commercial slaughter is reported by location of slaughter, not by origin of the animal slaughtered.

Regional estimates of cattle slaughter were not prepared using the second difference model; therefore, only regional equations for hog slaughter are presented in this chapter. Regional equations for cattle slaughter are part of the alternative beef sector model reported in the following chapter.

The regional commercial hog slaughter equations are presented in Table 3. The original equations were estimated for each of twenty-six regions. The equations for the North Central states, exclusive of Iowa and the remaining thirty-four states, have been aggregated from the minor regions. Thus, standard errors are not available for these aggregated coefficients. The negative trend coefficients for Colorado and California indicate a shift to inshipment of dressed pork. The low degree of explained variation in the California equation could also be due to short-term shifts from live-hog slaughter to dressed-pork imports. Although the percentage of explained variation in the Iowa equation is high, the lack of statistical significance of the coefficients associated with the six-month lagged price of hogs and corn indicates that slaughter in Iowa is

Table 3. Estimated change in regional commercial hog slaughter, millions of pounds liveweight, in the United States associated with a one unit change in specified explanatory variables, 1949-60 [a]

Region	Sows farrowing ($SF3j_{t-k}$)	Hog price ($P3jL_{t-k}$)	Corn price ($P6j_{t-k}$)	Time (Tj)	Constant term	R^2
<u>January - June</u>						
A	0.2725**	2.9088	164.12	32.52**	-525.0	0.937
	(0.0375)	(7.0403)	(108.92)	(6.85)		
B	0.0118**	-2.0833**	27.25**	-2.69**	36.0	0.970
	(0.0019)	(0.3544)	(5.48)	(0.34)		
C	0.0174	-6.006	92.45	-4.00	152.0	0.591
	(0.0185)	(3,4834)	(53.90)	(3.39)		
N	0.7289	-23,2455	514.85	4.78	175.0	- b
X	0.3031	-29.1542	399.44	42.26	445.0	- b
<u>July - December</u>						
A	0.1941*	3.5739	-39.35	70.60**	-470.0	0.839
	(0.0556)	(9.5193)	(176.00)	(3.18)		
B	0.0080*	-0.5211	19.70	-0.81	1.0	0.912
	(0.0029)	(0.4953)	(9.20)	(0.69)		
C	0.0167	-0.4679	58.73	-0.15	26.0	0.761
	(0.0105)	(1.7974)	(33.40)	(2.49)		
N	0.4547	-5.3224	306.80	85.70	77.0	- b
X	0.1029	-13.3204	515.55	83.20	464.0	- b

[a]Subscript in explanatory variable refers to half-year period where j=1 for the Jan.-June period and j=2 for the July-Dec. period; and k=1 for the Jan.-June period and k=0 for the July-Dec. period.

[b]Not computed.

not influenced by short-term price changes whereas these short-term price changes do affect slaughter in other regions.

Beef and pork production are associated with commercial slaughter. The highly significant trend terms result from (a) an improved dressing yield that would be associated with superior technology at the packing plant, and (b) a higher percentage of fed cattle and more meat-type hogs. These equations, which were estimated as one function for both semi-annual periods, are summarized by the forms:

$$BP2j_t = 103.0 + \underset{(0.0258)}{0.5011^{**}}\, CS2j_t + \underset{(4.10)}{31.50^{**}}\, Tj \;, \qquad R^2 = 0.980 \qquad \text{(Eq. 5.15)}$$

and

$$PP3j_t = 256.0 + \underset{(0.0146)}{0.5258^{**}}\, CS3j_t + \underset{(1.325)}{9.576^{**}}\, Tj \;. \qquad R^2 = 0.989 \qquad \text{(Eq. 5.16)}$$

Ending Stocks of Meat

December 31 and June 30 stocks of beef and pork form part of the consumption identity. Equations for estimating these variables were fitted initially to the data of the 1949-60 period. Since a substantial reduction in pork inventories took place about 1955, the explained variation in the ending stocks was quite low. Thus these equations for estimating the ending stocks of pork were re-estimated using data for the 1955-62 period.

Since a separate equation is needed for each semi-annual period, the two equations are:

$$ES31_t = 134.0 + \underset{(0.2601)}{0.4770^*} ES31_{t-1} + \underset{(0.0364)}{0.1152^{**}} \Delta PP31_{t-1} , \qquad R^2 = 0.681$$

(Eq. 5.15)

and

$$ES32_t = 68.0 + \underset{(0.1610)}{0.6245^{**}} ES32_{t-1} + \underset{(0.2433)}{0.1020^{**}} \Delta PP32_{t-1} . \qquad R^2 = 0.799$$

(Eq. 5.16)

The time subscript notation must be observed carefully: ES31 refers to June 30 stocks while ES32 refers to December 31 stocks. The t-1 subscript on the pork production variable refers to the annual first difference in the six-month period immediately preceding the ending-stock date.

Whereas the percentage of explained variation in the pork-stocks equations is still not as high as in other equations, the performance of the equations is acceptable. However, this lag model gave quite unsatisfactory results in estimating beef stocks. After trying several alternative models, the one found to be most satisfactory is the difference equation model,

$$ES2j_t = \underset{(0.00491)}{0.04829^{**}} \Delta^2 CS2j_{t-1} . \qquad R^2 = 0.799$$

(Eq. 5.17)

The same lag notation applies as in the case of the pork-stocks equations. However, the first and second differences used are semi-annual differences, e.g., the December 31 to June 30 change in beef stocks (ES21) is a function of the change in the difference in commercial cattle slaughter between the first and second halves of the year t-1 and the second half of the year t-1 and the first half of the year t.

Foreign Trade in Meat

Instead of estimating imports and exports separately, the foreign trade equations are estimated on a net trade balance basis, i.e., imports minus exports. This method allows more variation in the dependent variable since there is a low degree of variation in the export variables. If import and export functions had been estimated independently, estimation of the export equations would have been difficult. Several models using both domestic and various foreign meat prices have shown that the foreign price coefficients are statistically not significant. Since there has been no significant seasonal difference in foreign trade, only one equation is needed for either beef or pork. The final net foreign trade equations estimated without any foreign price variable are:

$$FTR2j_t = \underset{}{-142.0} + \underset{(3.518)}{8.660^{*}}\ PWB2j_{t-1} \underset{(0.02976)}{-0.09880^{**}}\ FIC2j_{t-1} + \underset{(2.52)}{16.45^{**}}\ Tj\ ,$$

$R^2 = 0.744$ (Eq. 5.18)

and

$$FTR3j_t = -156.0 + \underset{(0.846)}{2.321}\ PWB3j_{t-1} + \underset{(0.580)}{3.930^{**}}\ Tj\ . \qquad R^2 = 0.678$$

(Eq. 5.19)

Both beef and pork equations use the wholesale price of beef (or pork) at Chicago, PWB2j (or PWB3j), and trend as explanatory variables. The trade balance equation for beef (FTR2j) also uses federally inspected cow slaughter on a liveweight basis as a causal variable. In both equations, an increase in domestic wholesale price during the preceding six-month period generates increased imports the following six-month period. Beef imports varied inversely with the level of domestic cow slaughter.

Consumer Demand Equations

A demand equation was estimated for both beef and pork on a semi-annual basis. These equations were originally estimated with per capita consumption as the dependent variable under the assumption that the consumer is a price taker and a quantity adjuster. Explanatory variables used in each equation were the wholesale price of beef, wholesale price of pork, per capita disposible income, own retail margin, time and a dummy variable for a possible semi-annual intercept shift. Inspection of the residual term also suggested use of another dummy variable in the beef consumption equation during the Korean War period. The income and retail-margin variables were used in the form of deviations from trend to cope with the multi-colinearity problem in the trend variable. The wholesale-retail margin used is not the margin reported in the Marketing and Transportation Situation. It was calculated on the basis of Chicago price to maintain spatial consistency. Marketing costs vary by region because of different labor and transportation costs and the level of services demanded. If a regional shift in consumption occurs, the national average margin will change even though marketing charges did not change.

The consumer demand equations, in their original quantity dependent form, are:

$$QPH2j_t = 48.8 - \underset{(0.0424)}{0.5227^{**}} PWB2j_t - \underset{(0.1130)}{0.5821^{**}} (RM2j-\overline{RM2j}) + \underset{(0.0231)}{0.5386^{**}} Tj$$

$$+ \underset{(0.005525)}{0.004080} (Y/H-\overline{Y/H})_t + \underset{(0.03047)}{0.08435^{*}} PWB3j_t - \underset{(0.264)}{1.096^{**}} W1 + \underset{(0.790)}{1.963^{*}} WK ,$$

$$R^2 = 0.990 \qquad \text{(Eq. 5.20)}$$

and

$$QPH3j_t = 39.0 - \underset{(0.0264)}{0.3203^{**}} PWB3j_t - \underset{(0.1603)}{0.1761} (RM3j - \overline{RM3j})_t +$$

$$\underset{}{0.01960^{**}} (Y/H-\overline{Y/H})_t + \underset{(0.0251)}{0.1300^{**}} PWB2j_t \underset{(0.01678)}{-0.02871} Tj \underset{(0.242)}{-1.120^{**}} W1 .$$

$$R^2 = 0.923 \qquad \text{(Eq. 5.21)}$$

The price relationship in both equations is highly significant. The retail margin and the time variables in the pork equation are significant at the ten-percent level. The standard error of the coefficient of the income variable in the beef consumption equation was larger than the coefficient; therefore, the effect of the income variable was incorporated in the constant term at its mean value.

When the equations are transformed to own-price dependent, the coefficient for per capita beef consumption (QPH2j) is -1.91 while the coefficient for per capita pork consumption (QPH3j) is -3.12, which suggest the importance of accuracy in estimating commercial slaughter -- the major variable in the consumption identity. An error of one pound in the estimation of per capita consumption, for example, would result in a two- to three-dollar error in wholesale price.

Brandow (7, p. 17) recently estimated demand relations for several agricultural products. For the 1955-57 period, he estimated the elasticity of demand for beef with respect to its own retail price as -0.95, and the cross elasticity of demand for beef with respect to the retail price of pork as +0.10. Using 1955-57 averages of per capita consumption and wholesale price and the appropriate coefficients in equation 5.20, the elasticity of demand for beef with respect to its own wholesale price is

-0.50, and the cross elasticity of demand for beef with respect to the wholesale price of pork is +0.09.

The elasticity of demand for pork with respect to its own retail price was calculated by Brandow as -0.75 for the 1955-57 period. His estimate of the cross elasticity of pork with respect to the retail price of beef was +0.13. The elasticity of demand for pork with respect to its own wholesale price calculated for the same three years using equation 5.21 is -0.45 while the cross elasticity of demand with respect to wholesale beef price is +0.17.

Margin Equations

Cattle and hog prices were estimated as a function of the wholesale price and output per man hour (OMH) in the meat packing industry. Choice-steer prices were used as the live-price level indicator in order to maintain quality consistency. The price of U.S. No. 1,2,3 hogs weighing 200-220 pounds was considered representative of the hog market.

The live-to-wholesale margin equations, shown below, are functions developed from 1949-60 data on a semi-annual basis. The two equations are:

$$P2jL_t = -1.50 + \underset{(0.0162)}{0.6897^{**}} PWB2j_t \underset{(0.00462)}{-0.01450^{**}} OMH_t , \qquad R^2 = 0.990 \quad \text{(Eq. 5.22)}$$

and

$$P3jL_t = -2.97 + \underset{(0.0312)}{0.5749^{**}} PWB3j_t \underset{(0.00710)}{-0.02840^{**}} OMH_t . \qquad R^2 = 0.953 \quad \text{(Eq. 5.23)}$$

Inspection of the data shows that output per man hour in the meat packing industry increased about five pounds per year from 1949 through 1961. Due to this high correlation with time ($r = 0.97$) the variable is serving as proxy for a trend component. An alternative model using output per man hour in a deviation from trend form yielded a coefficient that was not statistically significant. The negative coefficient is interpreted, therefore, as a widening of the live-to-wholesale margin over time.

Fall feeder-calf price was related to the average annual steer price, the price of corn during the year, and its own year-to-year change. Inclusion of the first difference of the dependent variable was necessary to adjust the previous coefficients for the trend in feeder price.

The original form of the fall feeder equation is:

$$P22FC_t = 0.26 + \underset{(0.175)}{1.557^{**}} P2L - \underset{(3.50)}{11.46^{*}} P6_t + \underset{(0.0912)}{0.2687^{*}} \Delta P22FC_t . \quad R^2 = 0.940 \qquad \text{(Eq. 5.24)}$$

The \$1.55 change in feeder price for every \$1.00 change in steer price reflects the sensitivity of the feeder market to the changing conditions in final demand and supply. An algebraic solution gives the final form of the fall feeder price equation as:

$$P22FC_t = 0.35 + 2.130\ P2L_t - 15.68\ P6_t - 0.3675\ P22FC_{t-1} . \qquad \text{(Eq. 5.25)}$$

Since the bulk of light feeder calves move to market in the fall, the price level for the marketing year is largely determined in the fall. Some seasonal price rise usually occurs in the spring. However, the spring feeder market is also affected by the change in the number of cattle on feed January 1. If the number of cattle on feed January 1 increases, marketings of fed cattle during the first half of the year will be higher than the year before. These heavier marketings tend to force down steer prices and feeder prices. The functional estimates of the spring feeder price equation is:

$$P21FC_t = 0.75 + \underset{(0.165)}{1.073^{**}} P22FC_{t-1} \underset{(0.002964)}{-0.006721^{*}} H26_t \quad . \qquad R^2 = 0.848 \qquad \text{(Eq. 5.26)}$$

CHAPTER VI: ALTERNATIVE BEHAVIORAL RELATIONS

Initial series of simulations over the historical period 1955-64 revealed unsatisfactory results with reference to three functional relations. In the estimating relationships for beef-cow inventories, the coefficient associated with the lag dependent variable failed to yield satisfactory estimates with respect to (a) the cyclical downturn of the 1956-58 period was not predicted and (b) a too rapid increase in cow numbers.

A second difficulty centered around the commercial cattle slaughter equation. The second-difference model performed well as long as the estimated time paths of the components of the second differences followed the identical direction of the actual time path. However, only a moderate deviation from reported data produced a large divergence in the second-difference variables, which resulted in a large error in predicted cattle slaughter. This problem may be better illustrated by the example shown in Table 4 where the second difference is calculated for two sets of data having a moderate divergence in time paths.

Finally, the fall feeder price equation yielded some unrealistic estimates of feeder price. Part of this difficulty may have been due to the formulation of the relationship based on its own first difference; but another factor was the need for a different type of relationship to predict relatively stable feeder prices in the early 1960's in spite of a variable slaughter price.

The reformulation of these three equations will be considered separately. The new behavioral relations required two additional

Table 4. An illustration of the divergence in second differences calculated from data showing only a small variation in time paths

Time Series A	Δ	Δ^2	Time Series B	Δ	Δ^2
50	--	--	50	--	--
70	+20	--	65	+15	--
90	+20	0	90	+25	+10
120	+30	+10	120	+30	+5

behavioral relations to estimate inputs for the reformulated relationships. These revisions represent the alternative economic structure of the beef sector outlined in Chapter III.

Revised Behavioral Relations

Beef-cow inventories

Inspection of the classification of January 1 livestock inventories reveals that an animal may be (or likely will be) classified in one of the categories at only one period of its life span, except in the case of cows, two years old and over, where the same classification may apply for several years. Hence, the beef-cow inventory classification may be viewed as a reservoir of breeding stock to which additions are made from the heifer inventory the previous year, and from which deletions are made in the form of cow slaughter and deaths. We already have an estimating equation for heifer inventories.

Commercial cow slaughter is not reported but rather cow slaughter occurring under federal inspection, which includes both beef and dairy cows. Examination of data concerning dairy cows and discussions with professional workers in dairy marketing (53) yielded evidence that the component of federally inspected cow slaughter attributable to dairy cows was a fairly constant percentage of the previous January 1 dairy-cow inventory -- approximately twenty-two percent. Therefore, federally inspected beef-cow slaughter (FIBCN) was estimated by subtraction of twenty-two percent of the January 1 dairy-cow inventory (H13) from federally inspected cow slaughter.

A behavioral relation was developed for estimation of beef-cow inventories using the synthesized variable of federally inspected beef-cow slaughter. The following residual was calculated:

$$R23_t = H23_t - (H22_{t-1} + H23_{t-1}) \quad . \qquad \text{(Eq. 6.1)}$$

The residual expression assumes that all of the beef heifers on hand January 1 the previous year are held for the cow herd the following year. The residual was then plotted against the synthesized federally inspected cow-slaughter variable for the 1955-64 period. The scatter diagram suggested an intercept shift starting January 1, 1960. This shift was explained by a corresponding shift to feeding a larger number of heifers commencing in 1958 (which were classified as beef heifers one- to two-years old on January 1, 1959). The following least-squares functional relation was then estimated:

$$R23_t = -3{,}197.0 + \underset{(0.032)}{1.036^{**}}\, FIBCN_{t-1} - \underset{(50.0)}{1103}\, W \quad . \qquad R^2 = 0.995$$

(Eq. 6.2)

Since R23 is a variable of negative values, the negative intercept term includes the portion of cow slaughter not federally inspected, plus death loss and any other discrepancies arising from fewer heifers being held for the cow herd. The final form of the behavioral relation for estimation of January 1 beef-cow inventories is:

$$H23_t = H23_{t-1} + H22_{t-1} - 3{,}197.0 + 1.036\ FIBCN_{t-1} - 1103\ W\ , \qquad \text{(Eq. 6.3)}$$

where W is given a value of one in 1960 and future years.

The reformulation of the model necessitated the development of an estimator of federally inspected beef-cow slaughter in one-thousand-head units on an annual basis. The revised model was estimated by a similar "residual" procedure.

Under the initial assumption of 14 percent average beef-cow culling rate (of the January 1 inventory) during the 1955-64 period, and approximately 60 percent of cow slaughter occurring under federal inspection, a quantity equal to 8.4 percent of the January 1 beef-cow inventory (H23) was subtracted from the synthesized federally inspected slaughter variable. Graphic analysis revealed the feeder-calf price during the year and trend to be the relevant explanatory variables associated with the residual. Thus, the "fitted" portion of the estimator became,

$$\text{Residual } FIBCN_t = 4{,}316.0 - \underset{(15.0)}{125.9^{**}}\ P2FC_t - \underset{(25.0)}{210.6^{**}}\ T\ , \qquad R^2 = 0.98 \qquad \text{(Eq. 6.4)}$$

with the resulting behavioral relation being,

$$FIBCN_t = 4{,}316.0 + 0.0840\ H23_t - 125.9\ P2FC_t - 210.6\ T\ . \qquad \text{(Eq. 6.5)}$$

The negative sign on the current feeder-calf price is consistent with a favorable feeder price that would result in a lower cull rate of cows intended for slaughter. The trend variable has a negative sign, not only because of reduced cow slaughter during the upswing of the cycle (during the latter part of the period covered), but also because of a lower percentage of slaughter occurring under federal inspection. The estimate on a head basis is not needed until the end of the year. The recursive nature of the system is thereby maintained. Since the estimate of federally inspected cow slaughter on a liveweight basis is an ex-ante relationship (being a function of different lag variables), complete consistency between the two should not be expected.

Commercial cattle slaughter

We recall, first, that commercial slaughter on a liveweight basis comes from cull breeding stock, and fed and non-fed younger animals. Furthermore, variations in commercial slaughter from year to year are due to a sales response to a lagged price and to variations in the average weight of marketings. Using the coefficient associated with steer and bull inventories from the former model, the average ratio of estimated dairy-cow slaughter to January 1 dairy-cow inventories, and the average ratio of estimated beef-cow slaughter to January 1 beef-cow inventories, part of commercial slaughter can be assigned to these three variables. The resulting residual which may have either a positive or negative value and can be fitted to explanatory variables by means of least squares. Subtraction of the specific components of slaughter from reported commercial slaughter to obtain the residuals for each half year can be accomplished with the following two equations:

$$R21_t = CS21_t - 0.1125\ H13_t - 0.0630\ H23_t - 0.5500\ H24_t \quad , \qquad \text{(Eq. 6.6)}$$

and

$$R22_t = CS22_t - 0.1125\ H13_t - 0.0770\ H23_t - 0.5000\ H24_t \quad . \qquad \text{(Eq. 6.7)}$$

In equations 6.6 and 6.7, R21 and R22 denote the residual commercial slaughter (CS2j) for the January-June and July-December periods in millions of pounds liveweight. The coefficient of dairy-cow inventories (H13) is based on the 22.5 percent slaughter rate with that of beef cows based on the 14-percent slaughter rate. Fifty-five percent of the beef-cow coefficient was allocated to the second half of the year on the basis of the seasonal pattern of cow slaughter. Although the total coefficient associated with the steer and bull inventory was based on the coefficient in the second-difference equation, the first six months is favored slightly on the basis of past seasonal patterns of steer slaughter. The residual regression equations are:

$$5.3\ R21_t = -\ 3{,}460.0 + \underset{(59.6)}{295.9^{**}}\ P2LFS_{t-2} - \underset{(0.3510)}{0.8592}\triangle H13_{t+1} - \underset{(0.693)}{2.530^{**}}\ NW21_t\ ,$$

$$R^2 = 0.885 \qquad \text{(Eq. 6.8)}$$

and

$$5.4\ R22_t = -2{,}645.0 + \underset{(19.9)}{236.5^{**}}\ P2LFS_{t-2} - \underset{(0.201)}{1.005^{**}}\triangle H13_{t+1} - \underset{(0.100)}{1.168^{**}}\ NW22_t\ .$$

$$R^2 = 0.974 \qquad \text{(Eq. 6.9)}$$

Before discussing the coefficients obtained, the variable $NW2_j$, needs to be explained. Briefly, it is a normalized value of the average weight of steers slaughtered under federal inspection. The average slaughter weight of steers slaughtered under federal inspection was multiplied by the ratio of (a) that portion of commercial slaughter assigned to steer and bull inventories (0.55 H24 or 0.50 H24) and (b) that portion of commercial slaughter assigned to dairy and beef-cow inventories (0.1125 H13 plus either 0.063 H23 or 0.0077 H23) for each time period. Since this ratio ranged from 1.2 to 1.9, the resulting product of the ratio and average slaughter weight was normalized through multiplication by the ratio formed through division of the sum of the average slaughter weights by the sum of the products of average slaughter weights and the ratios of steer slaughter to cow slaughter.

The variable P2LFS is the average price of choice slaughter steers at Chicago computed on a July to June basis. Through prior graphic analysis of the residual, the July to June price appeared to be the relevant price variable for the residual component of the slaughter. It follows logically that the average price over the twelve months prior to the summer breeding season influences decisions on the number of cows to breed. The calves born the following spring are not slaughtered until the year t+2. The forward first difference of dairy-cow numbers ($H13_{t+1}$) takes into account the change in the slaughter rate from the average rate. With its negative coefficient, a larger than average reduction of dairy-cow numbers during the year results in an increased commercial cattle slaughter whereas an increase in dairy-cow numbers reduces cattle slaughter. Steer weights were weighted by their slaughter share to allow for their proper share of total slaughter. The negative coefficient supports the hypothesis that under normal conditions and behavior, steers are fed to heavier weights when cattle numbers (and resulting slaughter) are relatively low. This model gives extremely accurate estimates over the historical period. The importance of having a high degree of accuracy was established in the discussion of demand relations. The final combined commercial slaughter equations are:

$$5.5 \quad CS21_t = 0.1125\ H13_t + 0.0631\ H23_t + 0.5500\ H24_t + 295.9\ P2LFS_{t-2} - 0.8592\ \Delta H13_{t+1} - 2.530\ NW21_t - 3{,}460.0 \,, \qquad \text{(Eq. 6.10)}$$

and

$$5.6 \quad CS22_t = 0.1125\ H13_t + 0.0770\ H23_t + 0.5000\ H24_t + 236.5\ P2LFS_{t-2} - 1.005\ \Delta H13_{t+1} - 1.168\ NW22_t - 2{,}645.0 \,. \qquad \text{(Eq. 6.11)}$$

Regional estimates for five regions have been developed, following the same model, by allocating most of the slaughter to steer and cow inventories (national inventory levels), given the sum of the regional coefficients must equal the national coefficient, and then regressing the resulting residuals on the same set of explanatory variables. Regional equations developed earlier using the second-difference approach guided the allocation of the inventory coefficients between regions.

The regional commercial cattle slaughter equations were estimated on an annual basis only instead of a semi-annual basis. This procedure was because of the error in arbitrarily splitting the inventory coefficients into half-year components on a regional basis. The use of common explanatory variables for all regions held the discrepancy between the sum of the regional estimates and the sum of the national six-month estimates to less than two percent (usually less than one percent). The regional allocation on an annual basis gives an insight into the spatial aspects of beef production. Commercial slaughter is reported by location of slaughter rather than the origin of the animal slaughtered.

The five regions consist of three individual states, Iowa, Colorado, and California, and two multi-state regions -- the eleven remaining North Central states (Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota Missouri, North Dakota, South Dakota, Nebraska, and Kansas), and the remaining thirty-four states in the continental United States. The letters A,B,C,N, and X denote these regions respectively. The combined final equations are presented in Table 5. (The R^2's refer only to that portion estimated by means of least squares.)

The relative magnitudes, differences in sign, and tests of statistical significance of some of the regional coefficients obtained by least squares are worthy of comment. Although the lag price effect is significant in only two regions, it approaches significance at the five-percent level in the other three regional equations. The forward first difference of dairy-cow numbers is significant only for Iowa; although its sign is positive in the Colorado equation, its large standard error denotes lack of significance. The normalized average-weight variable is significant for all regions except California; its positive sign in the Iowa and Colorado equations is surprising. Evidently the large build-up in cattle feeding in these regions, especially in the mid-1950's, made for a consistent weight increase, regardless of the stage of the cycle.

Inventories of dairy cows January 1 (H13) are a function of milk consumption and productivity per cow. Per capita milk consumption is a

Table 5. Estimated change in regional commercial cattle slaughter (millions of pounds liveweight) in the United States associated with a one unit change in specified explanatory variables, 1949-1960

Region	Cattle on hand January 1			Dairy cows ($\Delta H13_{t+1}$)	Steer price ($P2LFS_{t-2}$)	Avg. wt. of steers (NW_t)	Constant term	R^2 [a]
	Dairy cows ($H13_t$)	Other cows ($H23_t$)	Steers ($H24_t$)					
A	0.0112	0.0056	0.1102	-0.4948* (0.1761)	57.4 (29.5)	1.957** (0.352)	-3993.0	0.962
B	0.0022	0.0098	0.0420	0.0501 (0.0568)	11.7 (9.4)	0.347 (0.112)	-612.0	0.946
C	0.0112	0.0084	0.1040	-0.1202 (0.1497)	58.0* (25.0)	-0.190 (0.296)	-413.0	0.635
N	0.0990	0.0390	0.4746	-0.4653 (0.4401)	140.6 (73.7)	-1.686* (0.875)	1668.0	0.750
X	0.1012	0.0770	0.3190	-0.4102 (0.4012)	203.4* (67.2)	-2.950** (0.798)	-817.0	0.904

[a]Denotes percent of variation explained in the residual after allowing for the effect of variables denoted as $H13_t$, $H23_t$ and $H24_t$.

function of its own price, and per capita disposable income (both in 1957-59 dollars), and a trend term indicating a shift in consumer tastes (19). Productivity per cow can be adequately described by a growth or logistic curve. Since dairy-cow inventories may be determined by variables all exogenous to the model, it is treated as an exogenous variable during the historical period; its method of projection is presented in the following chapter.

The revised model of commercial cattle slaughter requires a behavioral relationship for prediction of average weight of steers slaughtered under federal inspection (AWFSj). This relstionship is postulated as a function of the beef-corn ratio lagged one period, the first difference of the preceding January 1 steer numbers, and a trend component; thus,

$$AWFSj_t = 928.0 + \underset{(1.541)}{5.296^{**}} \left(\frac{P2jL}{P6j}\right)_{t-1} + \underset{(1.022)}{3.047^{**}}\ Tj + \underset{(0.00600)}{0.01652}\,\Delta H24_t \, .$$

$$R^2 = 0.896 \qquad \text{(Eq. 6.12)}$$

A favorable beef-corn ratio encourages feeding to heavier weights. The trend component indicates an increase in fed cattle slaughtered in relation to total steer slaughter. The positive sign of the first-difference coefficient is not inconsistent with the earlier hypothesis that slaughter weight decreased as cattle slaughter increased. First, steer numbers are a stock rather than a flow variable; second, they represent only one component of total cattle numbers.

Feeder-calf prices

A satisfactory model of measuring feeder-calf price was quite difficult to develop. Least-squares estimates performed quite inadequately in the simulation model. Probably the major reason that feeder prices have been difficult to estimate statistically is that there is considerable divergence of expectations. The final estimate of spring feeder price uses the same variables of the earlier model plus the average of April-May range conditions.

The coefficients associated with the fall feeder price and change in numbers of cattle on feed variables were assigned values approximately equal to those of the same variables in the least-squares equation. The coefficient associated with the April-May range condition was assigned a value suggested by inspection of the residual. The final synthesized equation for estimation of feeder-calf prices in the spring is:

$$P21FC_t = -19.55 + 1.10\ P22FC_{t-1} - 0.004\ H26_t + 0.25\ AMRGE_t\ . \qquad \text{(Eq. 6.13)}$$

The spring feeder price is essentially based on the fall feeder price but an increase in cattle on feed the first of the year has a price-depressing effect. Similarly, above average range conditions in the spring increase the demand for light calves to be placed on pasture.

The fall feeder-price estimate using data from the 1955-62 period is based on successive analysis of residuals after adding another variable to the live price variable suggested by earlier least-squares analysis. Two equations are developed. The appropriate equation to use is determined by whether or not the current live-steer price is more than $1.25 below the preceding fall price at the Chicago market. In this case, the estimating equation for fall feeder-calf price becomes,

$$P22FC_t = 1.25\ P22L_t + 0.20\ RANGE_t + 0.50\ PM - 33.50\ . \qquad \text{(Eq. 6.14)}$$

The coefficient on live price in equation 6.14 is greater than one due to the higher potential value of the feeder animal. Above average range conditions in the early fall (i.e., October 1) in the 17 Western states enable ranchers to withstand lower bids by feeder buyers, thus supporting feeder prices. The variable PM represents the price margin in feeding calves the preceding January-June period. The feeding margin is estimated by the following equation:

$$PM = 1.615\ P21L_{t} - 0.615\ P21FC_{t-1} \quad . \qquad \text{(Eq. 6.15)}$$

The price margin is based on a 400-pound calf fed to a 1050-pound choice steer in 360 days. When live price exceeds that of the year before, cattle feeders appear to consider the price margin during the first half of the year in buying feeders. If the current live price falls below that of the previous fall by more than $1.25, cattle feeders, being more price conscious would look at the current price margin, but they would attach a somewhat lower value to the coefficient of the price margin and a larger coefficient to the steer price. In this case, the price margin relation is,

$$PM = 1.615\ P22L_{t} - 0.615\ P22FC_{t-1} \quad , \qquad \text{(Eq. 6.16)}$$

and the fall feeder price relation is,

$$P22FC_{t} = 1.5\ P22L_{t} + 0.4\ PM + 0.2\ RANGE_{t} - 37.00 \quad . \qquad \text{(Eq. 6.17)}$$

Nonlinearities and Discontinuities

The early simulation runs also revealed the possibility of obtaining more accurate predictions of the historical period through the diversion of a behavioral relation into two or more linear segments approximating a quadratic or cubic function. For example, consider one of the January 1 inventory relations in the plane of the price variable as illustrated in Figure 8. The linear estimate is denoted by the solid line in Figure 8 while the broken line indicates the actual reaction to high or low prices. In this illustration, high prices lead to expectations that supplies are building up too fast, thus resulting in a more limited response to price. Similarly, low prices lead to expectations that supplies will soon be short. Also, there may be non-price limitations to the linear rate of response to price (e.g., ranchers try to maintain a minimum basic breeding herd in times of severe drought etc.).

This type of nonlinearity may be verified through successive changes in the value of the coefficient during several consecutive simulation runs -- a procedure that is quite easy to introduce in computer language. This refinement in behavioral relations is used in five different equations in the model.

Foreign trade in beef

Only one nonlinearity was introduced in the foreign trade equation for beef. The coefficient estimated by least-squares procedures for the lag wholesale price of beef was 8.6. If the wholesale price fell below $38.00 per 100 pounds, the coefficient was reduced to 6.0. At the lower

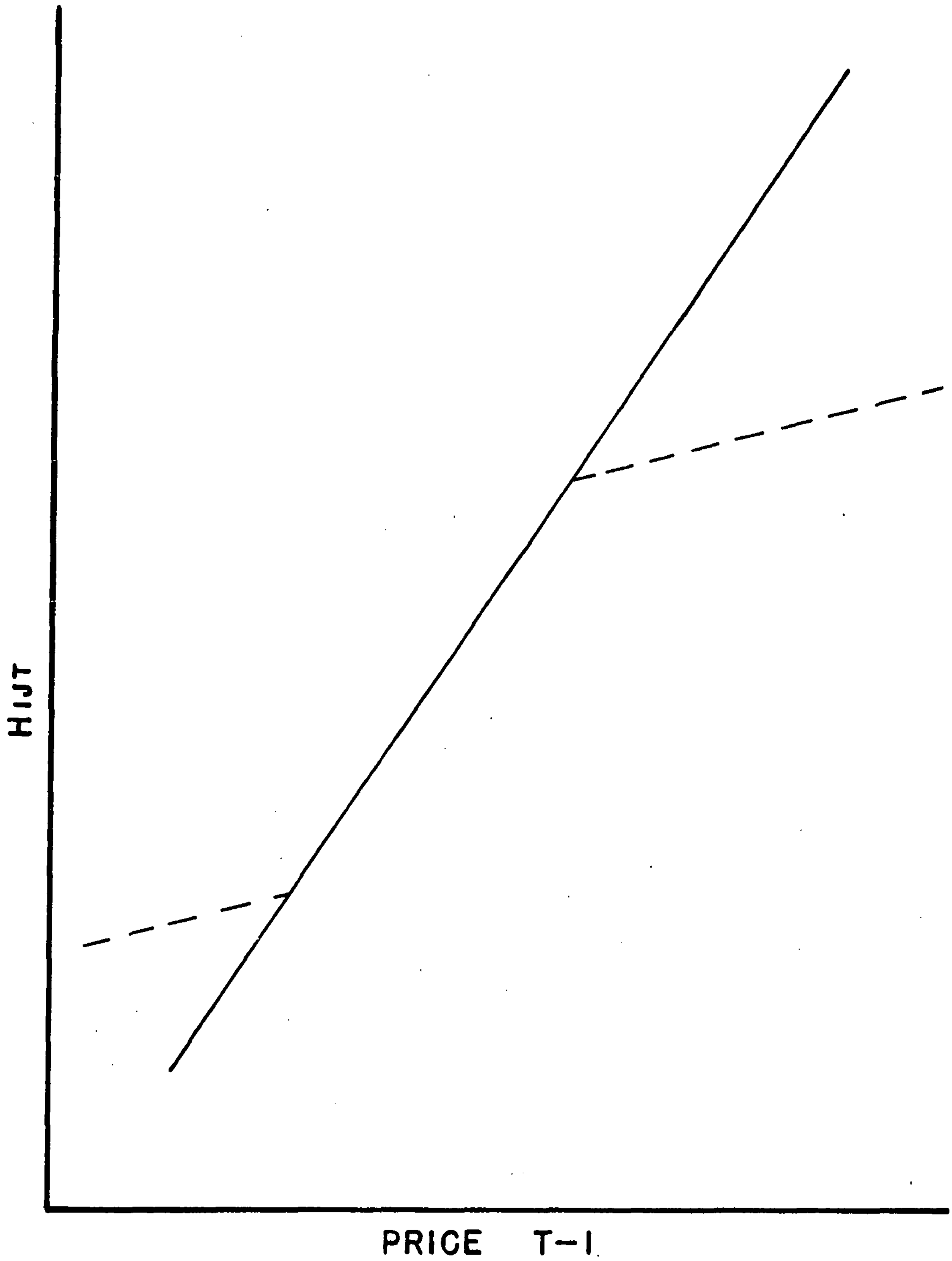


Figure 8. Diagram of a nonlinear inventory response curve

price level, importers respond differently than at higher prices; exporters also may be able to compete in foreign markets at the lower price.

Wholesale price of beef

The wholesale price of beef is for U.S.D.A. choice-grade carcasses. Initially, this price appeared to explain the combined effect of all grade differentials on per capita consumption. When transposed to a price-dependent basis, all per capita consumption generated plausible price changes as long as the average composition of high to low grades of beef was maintained in per capita consumption. However, during the peaks and troughs of the cattle cycle, the proportion of lower grade beef, as typified by cow beef, makes up a proportionately larger percentage of per capita beef consumption. This quality change will tend to reduce the price excessively. To simplify the behavioral relation, the per capita consumption effect was assumed to involve a shift of the entire relation in the consumption plane. Therefore, a particular ratio of federally inspected cow slaughter to commercial cattle slaughter was formed as a decision rule. If this ratio exceeded 0.25, one dollar was added to the constant term of the equation. If the ratio was below 0.16, one dollar was subtracted from the constant term of the equation.

Sows farrowing in the fall

Although fall farrowings are essentially determined by the level of farrowings in the spring, the corn-hog ratio, and a trend component, the relative expectations of profitability of the hog versus the beef enterprise, competes for production decisions, particularly in the Corn Belt.

If the hog enterprise appears to offer a greater chance of profit, the producer may breed more sows for fall pigs and cut down on the number of cattle he puts on feed that fall. Usually the ratio of live hog to steer prices is about 0.65. Consequently, if the ratio of hog price to steer price the first half of the year (P31L/P21L) exceeded 0.75, indicating current favorability of the hog enterprise, the intercept in the sows-farrowing relationship was increased by 200,000-head. Conversely, a ratio less than 0.50 leads to a subtraction of 200,000-head from the average intercept level.

January 1 inventories

Either the annual average feeder-calf price or the average annual slaughter-steer price the preceding year generates a change in the various categories of the cattle inventory. In the beef-heifer relation, a $1.00 increase in the average steer price results in a 142,000-head increase in beef heifers held on farms the following January 1. However, if the price falls below $23.00 or exceeds $28.00, the change in beef-heifer numbers falls to 135,000 head for each $1.00 change.

The average feeder-calf price affects the number of calves under one year of age, steers and bulls over one year of age, and cattle on feed January 1. The inventory response to feeder price near the mean value of $25.00 to $26.00 is 166,000 head for calves, 81,000 head for steers and bulls, and 71,000 head for cattle on feed. However, if feeder-calf prices fall below $22.00 or exceeds $35.00, producer's reaction to holding young calves falls slightly to 155,000 head per dollar change in feeder price. At prices less than $22.00, the inventory-price coefficient for steers and bulls on hand January 1 falls to 70,000-head, if the price is falling, but increases to 95,000-head, if feeder-calf prices are low but rising. When feeder price exceeds $35.00, the number of steer and bulls also increases to 95,000-head per dollar change in feeder price. More than half of the steers in the January 1 inventory are not on feed. Thus, if prices are low and falling, producers expect a lower demand for feeders and hold fewer yearlings for feedlot replacement, but if prices are either low and rising, or high, a greater demand for feeder animals is indicated.

In the case of cattle on feed, a feeder price below $24.50 reduces the inventory response slightly to 65,000-head while a feeder price above $35.00 cuts the inventory response of cattle on feed to 60,000-head per dollar change in feeder price. Note that the reaction in cattle on feed takes the opposite direction of that portion of steers over one year of age not on feed.

Sow and gilt inventories are increased 252,000-head for each dollar increase in the corn-hog ratio the previous year. However, if the ratio falls below 11 or rises above 20, the inventory response fall slightly to 240,000-head. In the case of the unfavorable corn-hog ratio, less breeding stock is held due to an anticipated continuation of unprofitable prices. When the ratio is extremely high, producers do not expect the favorable relation to induce and also reduce the breeding herd.

Limiting Values

A priori knowledge of the livestock-meat economy allows one to put minimum and maximum values on certain endogenous variables generated by the model. For example, it is known that the marketing channels require certain minimum amount of meat so that ending stocks should not fall below this minimum level. Also, with the exception of net foreign trade, negative values of any of the endogenous variables is illogical. This limit to minimum values is applied in two relationships of the model. If ending stocks of beef are predicted to be below 100-million pounds (which is designated as the minimum amount needed for normal trade), these stocks are set at 100-million pounds. This type of problem did not arise in the pork sector so no limit exists for pork stocks.

Sows farrowing in the fall have never exceeded spring farrowings. Therefore, if the fall estimate exceeded the spring estimate, it was set equal to the spring farrowing estimate. This situation did arise once near the end of the historical period due to the continued use of the trend term which likely dropped off substantially after 1960.

CHAPTER VII: THE COMPUTER MODEL OF THE BEEF AND PORK SECTORS

1955-64 Simulation of Market Performance Under Existing Market Structure

The behavioral relations developed in the previous chapters were re-written in computer language (Fortran) using the block diagram of the economic structure as a guide (see Figures 5 and 7). If the model were to be used for public forecasting rather than the study of alternative market conditions, a July 1 to June 30 production- and marketing-year program would be more desirable than a calendar-year program since many production decision, such as number of cows to cull, sows to breed for spring farrowing, or the number of calves to put on feed, are made during the summer months. Writing the program on a July 1 to June 30 basis required conversion of subscript notation in the behavioral relationships presented in earlier chapters to the new 12-month period.

The complete computer program written in Fortran is presented in Appendix A. The sequential flow of components on the July-June basis may be easily followed by reading down the list of variables in the stub of Table 6. Briefly, the components of the two consumption identities, per capita beef and pork consumption, for the second half of the year are calculated. The wholesale and derived live prices are then estimated as functions of consumption and exogenous variables. January 1 inventories of livestock are estimated next followed by estimates of the January-June consumption components and resulting prices. Regional commercial slaughter is delineated in the main program (see Appendix), but is not included in the flow shown in Table 6. The regional estimates are presented in Tables 7 and 8.

Table 6. Predicted and reported values of all price and output variables of the 1
July 1, 1955 to June 30, 1964

Market, production or stock variable	Unit	Predicted or Reported	1955	1
			July-Dece	
Commercial hog slaughter	mil. lbs.	P	9,237	8
	(live. wt.)	R	9,283	8
Commercial pork production	mil. lbs.	P	5,248	5
	(carcass wt.)	R	5,294	5
Net foreign trade in pork	do.	P	-3	
		R	25	
Ending stock of pork (Dec. 31)	do.	P	379	
		R	421	
Per capita consumption of pork	lbs.	P	31.5	
		R	31.7	
Avg. wt. of steers (F.I. slaughter)	lbs.	P	1,019	1
		R	1,010	1
Commercial cattle slaughter	mil. lbs.	P	12,675	13
	(live. wt.)	R	12,683	13
Commercial beef production	mil. lbs.	P	6,895	7
	(carcass wt.)	R	6,900	7
Net foreign trade in beef	do.	P	161	
		R	96	
Ending stocks of beef (Dec. 31)	mil. lbs.	P	186	
	(carcass wt.)	R	205	
Per capita consumption of beef	lbs.	P	41.6	4
		R	41.1	4
Federally inspected cow slaughter	mil. lbs.	P	3,375	3,
	(live. wt.)	R	3,610	3,
Wholesale price of choice beef	dol./cwt.	P	35.98	41
		R	37.34	41

of the beef and pork sectors of the livestock-meat economy, United States,

Year beginning July 1								
55	1956	1957	1958	1959	1960	1961	1962	1963
July-December								
37	8,921	8,594	8,933	9,631	9,020	9,167	9,621	9,976
83	8,890	8,432	8,642	10,011	8,951	9,186	9,440	9,969
48	5,100	4,947	5,145	5,531	5,229	5,326	5,584	5,989
94	5,050	4,823	4,993	5,773	5,217	5,380	5,590	5,978
-3	-13	14	39	33	29	45	46	43
25	-7	8	45	7	21	29	38	8
79	290	233	234	253	195	200	219	226
21	280	194	206	264	170	200	230	277
.5	30.4	28.9	29.5	31.5	29.8	29.2	30.3	31.1
.7	30.4	28.4	28.6	32.7	29.9	29.4	30.5	31.7
19	1,028	1,020	1,073	1,089	1,090	1,093	1,099	1,097
10	1,016	1,024	1,070	1,087	1,090	1,108	1,072	1,110
75	13,014	13,019	11,940	12,307	12,841	13,334	13,309	14,014
33	13,229	12,728	12,035	12,049	13,038	13,254	13,297	14,345
95	7,128	7,193	6,716	6,963	7,293	7,604	7,654	8,070
00	7,154	6,971	6,664	6,852	7,373	7,576	7,533	8,238
51	79	131	371	452	450	699	753	761
96	54	198	493	527	376	573	795	904
36	151	154	228	224	217	216	220	232
05	244	134	174	202	170	200	189	281
6	42.0	42.0	39.3	40.9	42.2	44.5	44.2	46.1
1	41.3	41.2	40.0	40.8	42.3	43.6	43.9	47.7
5	3,786	2,754	2,451	2,244	2,484	2,556	2,362	2,564
.0	3,814	3,211	2,268	1,848	2,218	1,958	2,397	2,309
8	41.45	40.83	44.59	43.68	43.42	41.48	46.66	41.34
4	41.50	41.77	44.08	43.94	42.94	40.24	46.04	40.73

Table 6 (Continued).

Market, production or stock variable	Unit	Predicted or Reported	1955	1956
Steer price (choice)	do.	P	21.49	25.1
		R	21.84	24.6
Feeder-calf price	do.	P	19.60	20.3
		R	20.30	19.6
Wholesale price of pork	do.	P	36.47	42.9
		R	39.66	40.2
Hog price (U.S. No. 1 to 3)	do.	P	14.41	17.9
		R	14.94	16.4
Sows farrowing	1,000 head	P	5,513	5,26
		R	5,599	5,18
Federally inspected beef cow slaughter (annual)	1,000 head	P	3,655	3,55
		R	3,500	3,70
			January 1 in	
"Other " cows	do.	P	25,190	24,50
		R	25,371	24,53
"Other" heifers	do.	P	6,194	5,99
		R	6,206	5,92
"Other" calves	do.	P	18,852	18,16
		R	18,869	18,40
Steers and bulls	do.	P	11,227	10,66
		R	11,245	10,70
Cattle on feed (26 states)	do.	P	5,997	5,94
		R	5,929	6,12
Sows and gilts	do.	P	8,487	7,88
		R	8,506	8,06

ed	Year beginning July 1								
ed	1955	1956	1957	1958	1959	1960	1961	1962	1963
	21.49	25.18	24.69	27.22	26.52	26.26	24.83	28.31	24.56
	21.84	24.64	25.26	26.74	27.06	25.56	24.52	28.84	23.90
	19.60	20.35	25.94	33.75	29.03	26.07	25.67	30.89	23.71
	20.30	19.69	25.20	33.09	30.75	26.59	27.62	28.44	26.14
	36.47	42.90	45.48	43.50	38.70	46.23	45.83	42.37	39.19
	39.66	40.29	46.75	48.49	38.15	43.41	42.66	44.18	41.18
	14.41	17.93	19.29	18.06	15.16	19.31	18.90	16.75	14.75
	14.94	16.44	19.38	20.54	13.72	17.68	17.74	18.05	16.55
	5,513	5,268	5,007	5,635	6,197	5,691	6,021	6,230	6,199
	5,599	5,181	5,112	5,887	6,128	5,855	5,953	6,170	5,911
	3,655	3,552	3,007	1,753	1,449	1,759	1,766	1,379	1,436
	3,500	3,700	3,050	1,700	1,050	1,900	1,500	1,350	1,650
	<u>January 1 inventories</u>								
	25,190	24,507	24,187	25,191	26,139	27,027	28,077	29,488	31,400
	25,371	24,534	24,165	25,112	26,344	27,102	28,305	29,970	31,779
	6,194	5,992	6,017	6,749	7,010	7,180	7,140	7,700	7,811
	6,206	5,926	5,903	6,557	7,036	7,069	7,333	7,909	8,313
	18,852	18,167	18,413	19,411	20,331	20,771	21,539	23,020	24,344
	18,869	18,405	18,275	19,407	20,425	20,705	22,050	23,330	24,417
	11,227	10,662	10,770	11,600	12,226	12,592	12,811	13,525	14,475
	11,245	10,704	10,871	11,538	12,250	12,684	12,764	13,876	14,325
	5,997	5,949	5,854	6,712	7,215	7,495	7,667	8,257	9,023
	5,929	6,122	5,898	6,601	7,173	7,645	7,865	8,896	8,750
	8,487	7,883	8,223	8,776	7,590	7,575	7,825	7,827	7,347
	8,506	8,064	8,103	8,819	7,531	7,808	7,816	8,027	n.a.

Table 6 (Continued).

Market, production or stock variable	Unit	Predicted or Reported	1955	19
			January-Ju	
Sows farrowing	1,000 head	P	7,648	7,
		R	7,655	7,
Commercial hog slaughter	mil. lbs.	P	9,162	8,
	(live wt.)	R	9,339	8,
Commercial pork production	mil. lbs.	P	5,218	4,
	(carcass wt.)	R	5,234	4,
Net foreign trade in pork	do.	P	-13	
		R	20	
Ending stocks of pork (June 30)	do.	P	369	2
		R	365	2
Per capita pork consumption	lbs.	P	31.0	28
		R	31.4	27
Feeder-calf price	dol./cwt.	P	18.71	22.
		R	19.44	21.
Avg. wt. of steers (F.I. slaughter)	lbs.	P	1,024	1,0
		R	1,043	1,0
Commercial cattle slaughter	mil. lbs.	P	12,561	12,5
	(live wt.)	R	12,454	12,4
Federally inspected cow slaughter	do.	P	2,493	2,4
		R	2,646	2,7
Commercial beef production	mil. lbs.	P	6,870	6,9
	(carcass wt.)	R	6,936	6,8
Net foreign trade in beef	do.	P	83	1
		R	41	
Ending stocks of beef (June 30)	do.	P	124	1
		R	135	1

Year beginning July 1								
55	1956	1957	1958	1959	1960	1961	1962	1963
January-June								
648	7,093	7,406	7,914	6,822	6,809	7,039	7,041	6,599
655	7,194	7,281	7,996	6,790	7,029	7,020	7,027	6,600
162	8,466	8,053	9,034	9,941	9,016	9,563	10,064	10,245
339	8,472	8,050	9,299	9,707	9,201	9,543	9,869	
218	4,871	4,673	5,208	5,704	5,236	5,543	5,826	5,940
234	4,756	4,625	5,358	5,646	5,350	5,640	5,889	
-13	10	23	27	23	49	56	56	56
20	-8	30	36	26	19	46	11	
369	270	240	310	339	242	285	302	291
365	277	210	313	351	240	295	320	
l.0	28.6	26.8	29.0	31.2	28.6	29.6	30.7	31.0
l.4	27.8	26.5	29.8	30.9	28.9	30.1	30.8	
.71	22.27	30.62	33.39	29.37	27.50	26.50	31.32	22.72
.44	21.52	30.26	34.55	29.16	27.91	26.95	27.90	
)24	1,032	1,051	1,080	1,087	1,095	1,091	1,120	1,109
)43	1,033	1,040	1,075	1,097	1,113	1,092	1,116	
61	12,517	11,150	11,601	12,295	12,803	12,695	13,149	13,251
54	12,408	11,398	11,207	12,293	12,826	12,923	13,544	
93	2,467	2,250	1,728	1,876	2,072	1,976	2,023	1,560
46	2,739	2,373	1,702	1,909	1,773	1,853	1,848	
70	6,910	6,288	6,578	6,988	7,306	7,315	7,605	7,719
36	6,881	6,319	6,381	7,001	7,354	7,398	7,813	
83	123	252	348	393	400	659	756	723
41	61	356	469	330	392	573	707	
24	106	100	174	190	188	159	183	153
35	113	108	168	145	155	123	186	

Table 6 (Continued).

Market, production or stock variable	Unit	Predicted or Reported	1955
Per capita beef consumption	lbs.	P	41.5
		R	41.8
Wholesale price of choice beef	dol./cwt.	P	34.52
		R	34.37
Wholesale price of pork	do.	P	34.86
		R	36.30
Steer price (Choice)	do.	P	20.39
		R	20.10
Hog price (U.S. No. 1 to 3)	do.	P	13.31
		R	14.62

Year beginning July 1								
955	1956	1957	1958	1959	1960	1961	1962	1963
41.5	41.3	37.5	39.0	40.8	42.0	43.0	44.3	44.5
41.8	41.2	38.1	38.3	40.7	42.0	43.2	45.0	
4.52	37.24	46.90	46.51	44.16	42.52	43.77	41.44	41.39
4.37	36.98	46.01	46.55	45.01	42.03	43.40	41.09	
4.86	43.10	50.27	44.47	39.37	42.81	40.06	35.42	35.61
6.30	43.56	50.10	41.42	39.74	42.17	41.33	39.27	
0.39	22.21	28.82	28.48	26.77	25.55	26.33	24.63	24.53
0.10	22.24	28.42	28.87	27.07	25.04	26.53	24.32	
3.31	17.93	21.95	18.47	15.36	17.17	15.41	12.58	12.55
4.62	18.37	21.49	16.76	15.52	17.81	16.98	15.68	

Table 7. Predicted and reported values of regional commercial cattle slaughter in billions of pounds, liveweight, United States, 1955-1963

Region		Calendar year								
		1955	1956	1957	1958	1959	1960	1961	1962	1963
		(billion pounds)								
Iowa	P	1.7	2.1	2.2	2.2	2.5	2.7	2.9	3.0	3.4
	R	1.9	2.1	2.2	2.3	2.4	2.7	3.0	3.1	3.5
Colorado	P	0.8	0.9	0.8	0.8	1.0	1.1	1.2	1.2	1.2
	R	0.8	0.9	0.8	0.8	1.0	1.1	1.2	1.2	1.2
California	P	2.4	2.5	2.5	2.2	2.4	2.5	2.6	2.6	2.7
	R	2.4	2.6	2.4	2.2	2.3	2.5	2.6	2.6	2.8
11 North	P	11.6	11.6	11.6	10.8	11.0	11.3	11.6	11.6	12.0
Central States	R	11.4	11.9	11.6	10.8	10.8	11.5	11.6	11.4	12.1
Other 34	P	8.5	8.2	8.2	7.0	7.1	7.5	7.7	7.6	7.7
States	R	7.7	8.2	8.1	7.1	6.7	7.5	7.7	7.9	8.2

Simulation of the historical period

The nine-year period, July 1, 1955 to June 30, 1964, was chosen as the historical period to simulate. The lag variables specifying the initial conditions are free of the influence of World War II and the Korean War. The period covers approximately one complete cattle cycle and two hog cycles. All lag values of endogenous variables up to July 1, 1955 were read into the computer as initial conditions plus values of all exogenous variables for the nine-year period as shown in the economic structure.

Table 8. Predicted and reported values of semi-annual regional commercial hog slaughter in billions of pounds, liveweight, United States, 1955-1964

Region		Year beginning July 1								
		1955	1956	1957	1958	1959	1960	1961	1962	1963
		(billion pounds)								
July - December										
Iowa	P	1.65	1.57	1.55	1.70	1.86	1.71	1.79	1.90	1.95
	R	1.61	1.52	1.43	1.62	2.00	1.74	1.75	1.75	1.96
Colorado	P	0.08	0.07	0.07	0.06	0.07	0.06	0.06	0.06	0.06
	R	0.08	0.07	0.07	0.06	0.07	0.07	0.07	0.07	0.07
California	P	0.24	0.23	0.21	0.21	0.22	0.20	0.19	0.20	0.21
	R	0.26	0.25	0.21	0.20	0.22	0.18	0.19	0.18	0.18
11 North Central states	P	4.83	4.59	4.38	4.56	4.90	4.49	4.54	4.74	4.87
	R	4.90	4.61	4.36	4.44	5.05	4.41	4.59	4.84	5.00
Other 34 states	P	2.43	2.45	2.38	2.39	2.58	2.56	2.59	2.72	2.89
	R	2.43	2.44	2.36	2.32	2.67	2.55	2.59	2.60	2.75
January - June										
Iowa	P	1.52	1.46	1.42	1.62	1.79	1.68	1.80	1.89	1.91
	R	1.55	1.39	1.35	1.73	1.80	1.74	1.78	1.92	
Colorado	P	0.09	0.07	0.06	0.07	0.08	0.06	0.06	0.06	0.07
	R	0.08	0.07	0.06	0.06	0.08	0.07	0.08	0.08	
California	P	0.27	0.22	0.20	0.21	0.23	0.18	0.19	0.20	0.21
	R	0.28	0.22	0.20	0.21	0.20	0.19	0.22	0.19	
11 North Central states	P	4.65	4.30	4.06	4.55	4.99	4.50	4.76	4.98	5.02
	R	4.78	4.30	4.07	4.71	4.85	4.53	4.75	4.96	
Other 34 states	P	2.61	2.40	2.30	2.57	2.83	2.58	2.73	2.91	3.01
	R	2.65	2.49	2.37	2.59	2.78	2.67	2.71	2.72	

The predicted values generated for the forty-three endogenous variables at the national level and the reported values are presented in Table 6. The predicted and reported values of each variable can be compared on a time-series basis by reading across the rows of the table. The sequential estimation of the value of each variable may be followed through the nine-year period by reading down each column commencing with the first column heading - July 1, 1955. The predicted and reported values of regional commercial slaughter of cattle and hogs appear in Tables 7 and 8 respectively.

Validation of the model

Indices of dispersion and turning-point errors were calculated for all series except beef and pork production since these variables are almost identical to commercial slaughter in both direction of movement and degree of variation. These two statistics are presented in Table 9.

For many of the production and inventory variables, a divergence of one or two percent would represent a substantial deviation in absolute value. Also, the degree of accuracy is more important for the major components of the consumption identity than the minor components. A high degree of accuracy in estimating commercial cattle and hog slaughter, beef and pork production, and net foreign trade in beef assures one of acceptable accuracy in the estimate of per capita consumption as these variables essentially determine consumption. While ending stocks and net foreign trade in pork enter into the computation of the consumption identity, their value makes up a relatively small percentage of per capita consumption.

Table 9. Index of dispersion and turning-point errors

Market, production or stock variable	Index of dispersion	Turning point error
Commercial cattle slaughter	0.0086	2/15
Commercial hog slaughter	0.0095	7/10
F.I. cow slaughter (live wt. basis)	0.0545	1/16
Net foreign trade in beef	0.0956	3/14
Net foreign trade in pork	0.3499	8/ 9
Ending stocks of beef	0.1143	0/17
Ending stocks of pork	0.0414	3/14
Avg. wt. F.I. steer slaughter	0.0054	3/14
Per capita consumption of beef	0.0063	2/15
Per capita consumption of pork	0.0094	1/16
Wholesale beef price	0.0080	0/17
Wholesale pork price	0.0284	1/16
Choice steer price	0.0088	0/17
U.S. No. 1 to 3 hog price	0.0430	3/14
Feeder calf price	0.0266	4/13
F.I. cow slaughter (1,000 head, annual basis)	0.0436	4/ 5
<u>January inventories</u>		
"Other" cows	0.0044	0/ 9
"Other" heifers	0.0152	2/ 7
"Other" calves	0.0054	1/ 8

Table 9 (Continued).

Market, production or stock variable	Index of dispersion	Turning point error
Steers or bulls	0.0056	0/ 9
Cattle on feed	0.0177	1/ 8
Sows and gilts	0.0085	1/ 8
Sows farrowing	0.0101	2/15

The requisite for predicting per capita consumption within one pound of reported value is discussed in Chapter V. Inspection of the per capita consumption series in Table 6 shows that a prediction with error of more than one pound occurred only once for per capita beef consumption and once for per capita pork consumption.

The performance of the model in reproducing the historical period was deemed satisfactory considering the degree of accuracy needed for each variable. The indexes of dispersion are below 0.01 for commercial slaughter and per capita consumption of beef and pork, sows farrowing, and all January 1 inventories, except beef heifers and cattle on feed whose indices of dispersion are less than 0.02. The seven turning-point errors in the predictions of commercial hog slaughter would be unacceptable if forecasting were the prime objective. The simulation of commercial hog slaughter was accepted however, since the deviation from the reported values was low despite the error in direction of change. If the computer model had been programmed to react to forecast values, correct prediction of the direction of change would be crucial. In this simulation model, where the computer does not react to forecast values, the turning-point error is not serious as long as the estimate does not deviate from the corresponding reported value greatly.

Most of the dispersion error in wholesale pork and live-hog price was due to overestimates of production the last two years of the simulation. This estimate of over production probably was due to the continued operation of the trend term in the fall sows-farrowing equation. Although the leveling off of the trend in sows farrowing in the fall during the early

1960's cannot be statistically verified yet due to lack of data, we do know that continued operation of the trend term in the fall sows-farrowing equation would soon yield estimates of fall farrowings in excess of spring farrowings. Although this trend may soon stabilize farrowing throughout the year, the possibility of fall farrowings exceeding spring farrowings is not likely.

Wholesale beef price and steer price have low dispersion indices. Feeder prices are relatively more variable than steer prices. In all cases, the turning-point error of the price variables is low.

Although the index of dispersion of net foreign trade in pork and ending stocks of beef are 0.34 and 0.11 respectively, this amount of error in the estimates of these variables is allowable since they are not major components of the consumption identity. Most of the error in the estimates of net foreign trade in pork occurred in the 1958 and 1959 estimates when the transition to a higher level of imports occurred.

The error in federally inspected cow slaughter on a liveweight basis is not considered too great inasmuch as the turning-point error is low. The use of cow slaughter as a decision rule in the wholesale beef price equation makes the directional change as important as the moderate dispersion error.

The most serious error in the system occurs in the case of federally-inspected beef-cow slaughter on an annual numbers basis. Estimation of this variable with a high degree of accuracy is a crucial part of the estimation of January 1 beef-cow numbers. Yet, the simulation of reported beef-cow numbers is nearly perfect. Therefore, the estimated parameters of the beef-cow slaughter equation must be stable.

Operation of the model as a closed system

The model may be operated as a closed system by holding all values of the exogenous variables, including time, at their initial values, namely, the 1955 levels, in this case. This type of simulation allows one to observe the dynamic interaction of the endogenous components of the system in isolation.

The model was simulated as a closed system over fifteen years. The time paths generated are presented for six selected variables: January 1 beef-cow and sow and gilt numbers (Figures 9 and 10), commercial cattle and hog slaughter (Figures 11 and 12), and wholesale prices of beef and pork (Figures 13 and 14). These six variables comprise the primary structure of the system.

A four-year cycle for hogs and a four- to five-year cycle for cattle are derived for the endogenous system. The results reveal that the price-output mechanism tends to be self corrective, i.e., an increase in inventories leads to an increase in commercial slaughter thereby lowering prices which in turn lead to lower inventories. However, the slight increase in amplitude of succeeding production and price cycles is indicative of a slightly explosive tendency in the system.

Exogenous influences lengthen the period of the cattle cycle more so than the hog cycle. These exogenous effects also appear to hold the explosive elements of the system in check. The balance between the negative and positive trends in consumer preference in pork and beef, respectively,

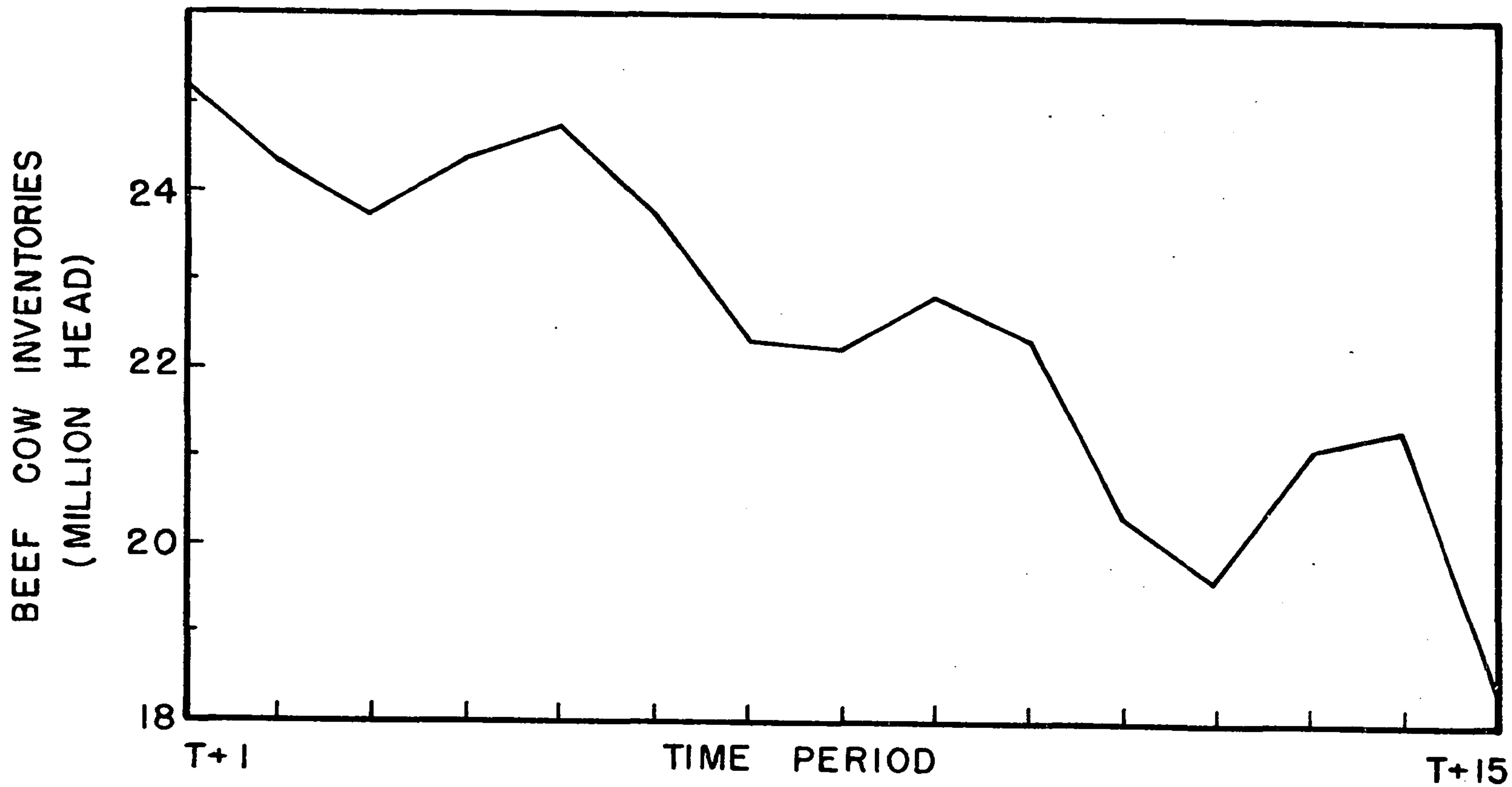


Figure 9. Estimated January 1 beef-cow inventories in the United States under conditions of a closed economy

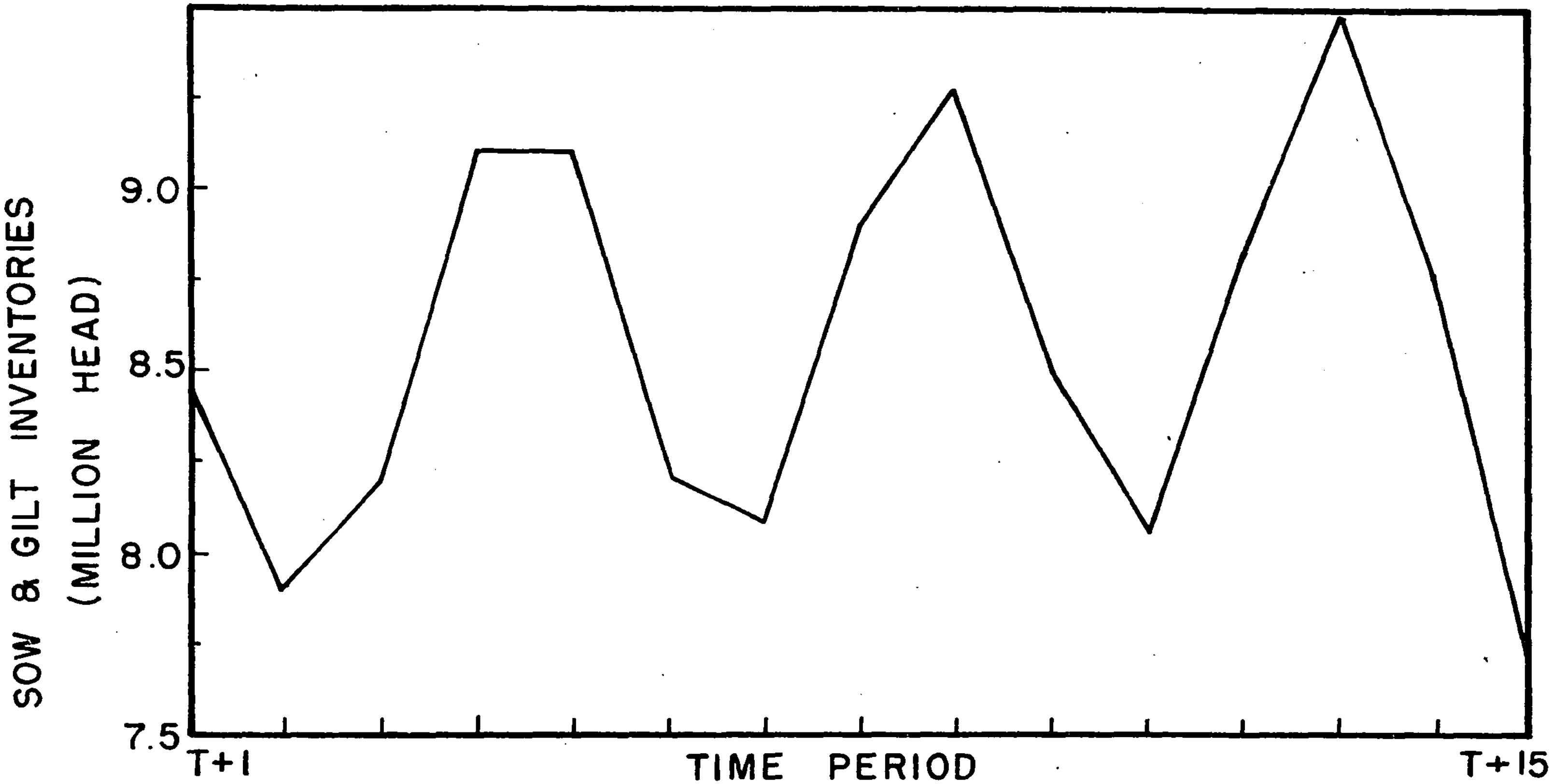


Figure 10. Estimated January 1 sow and gilt inventories in the United States under conditions of a closed economy

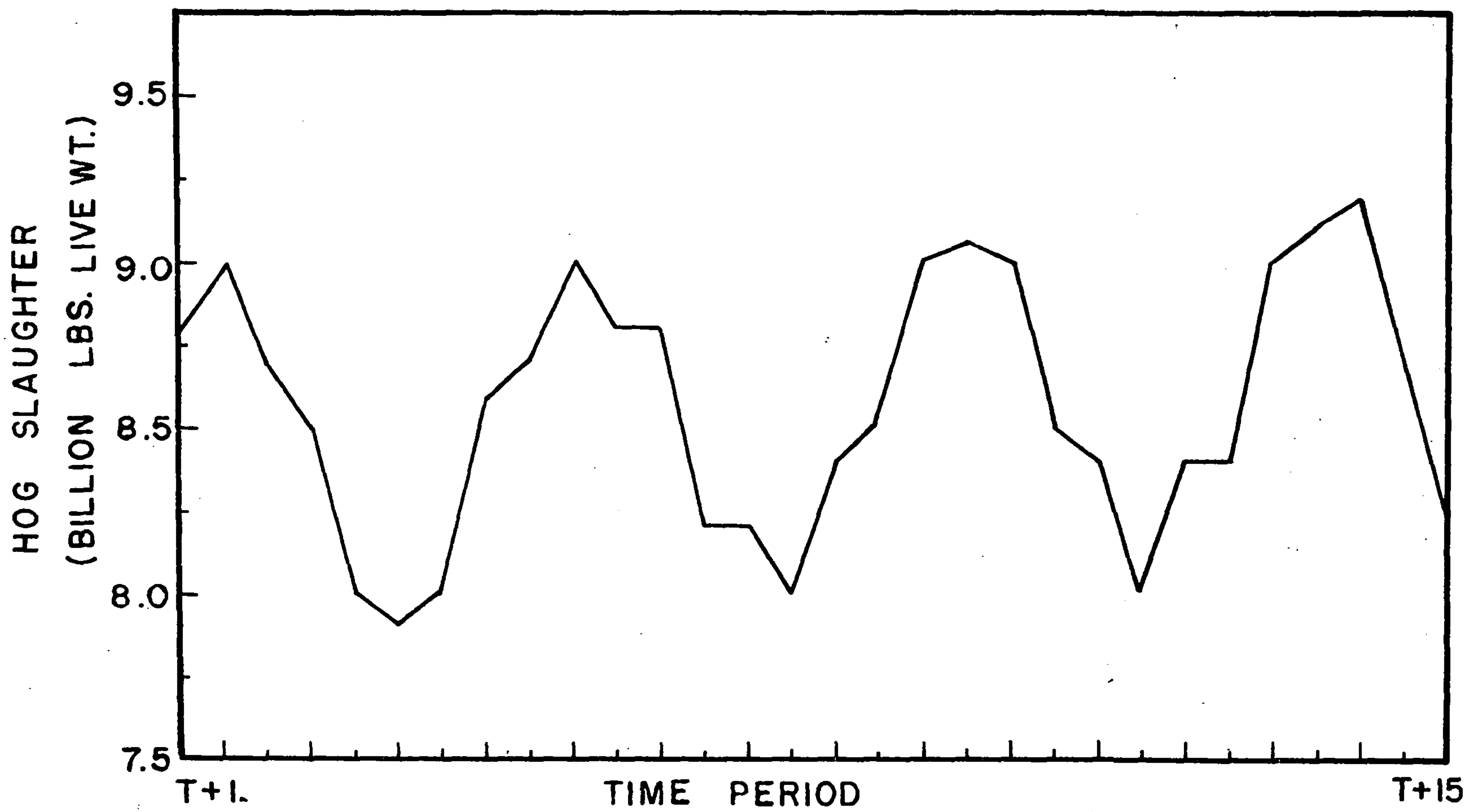


Figure 11. Estimated semi-annual commercial hog slaughter in the United States under conditions of a closed economy

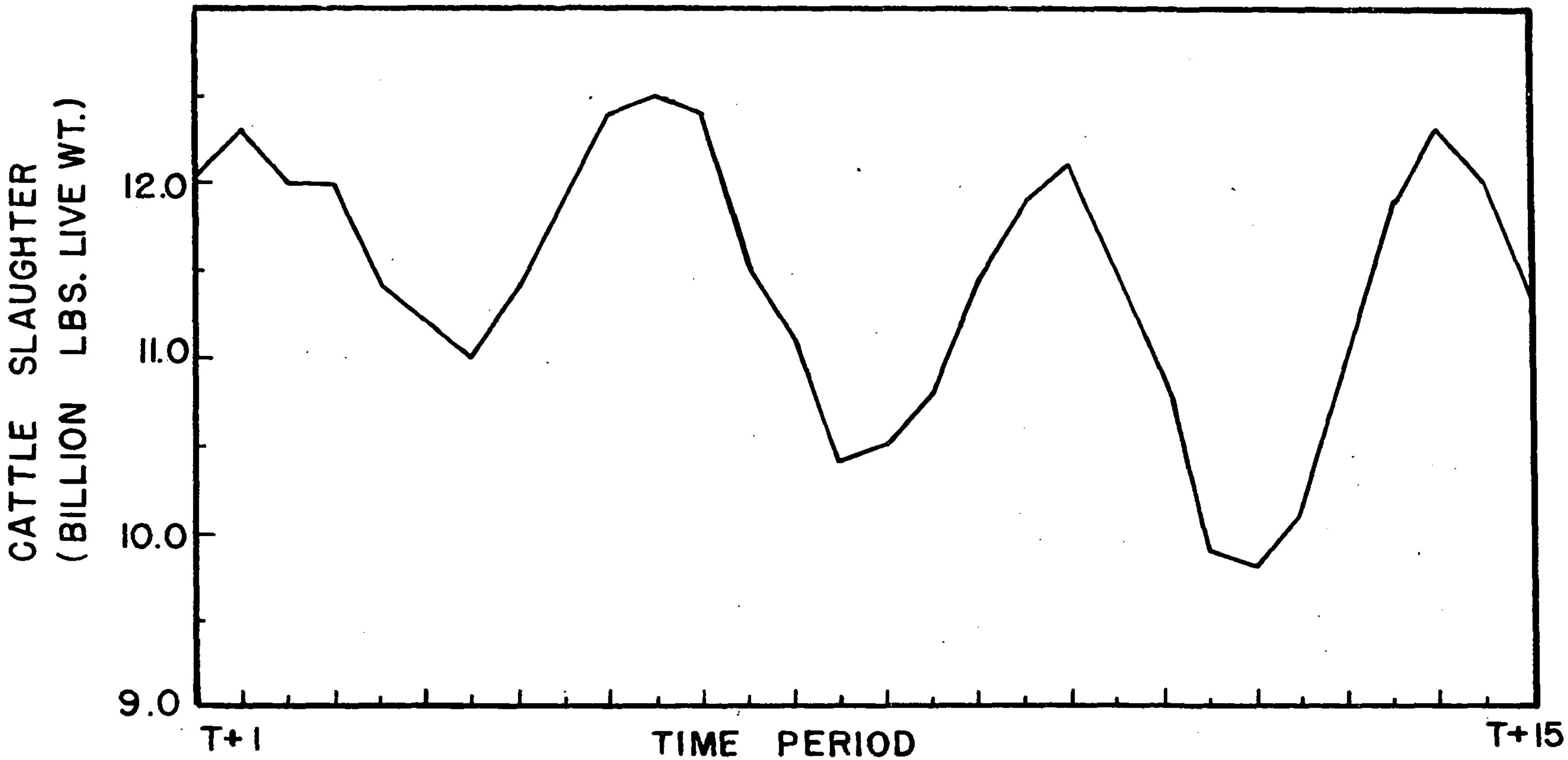


Figure 12. Estimated semi-annual commercial cattle slaughter in the United States under conditions of a closed economy

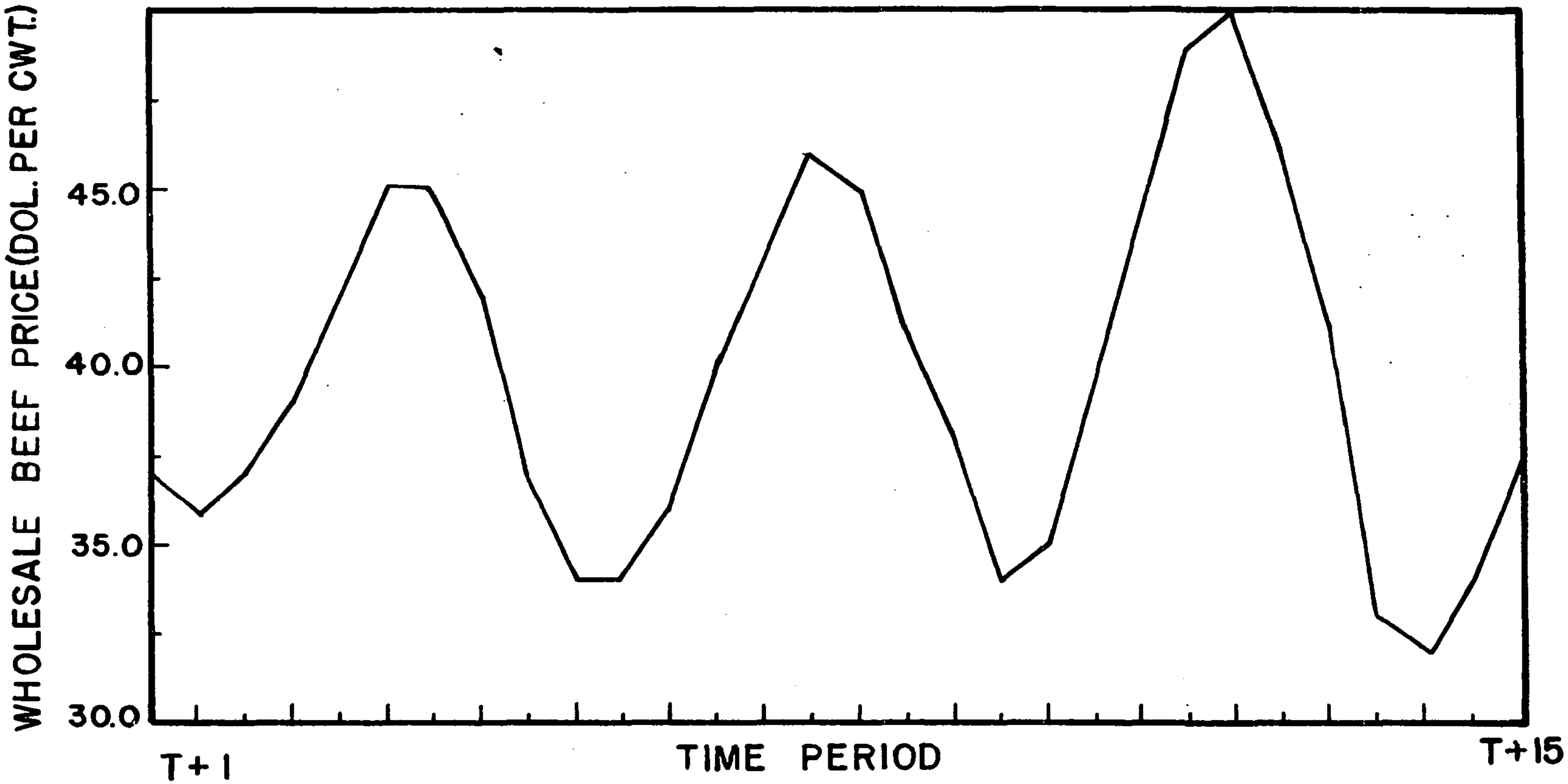


Figure 13. Estimated wholesale price of beef at Chicago under conditions of a closed economy

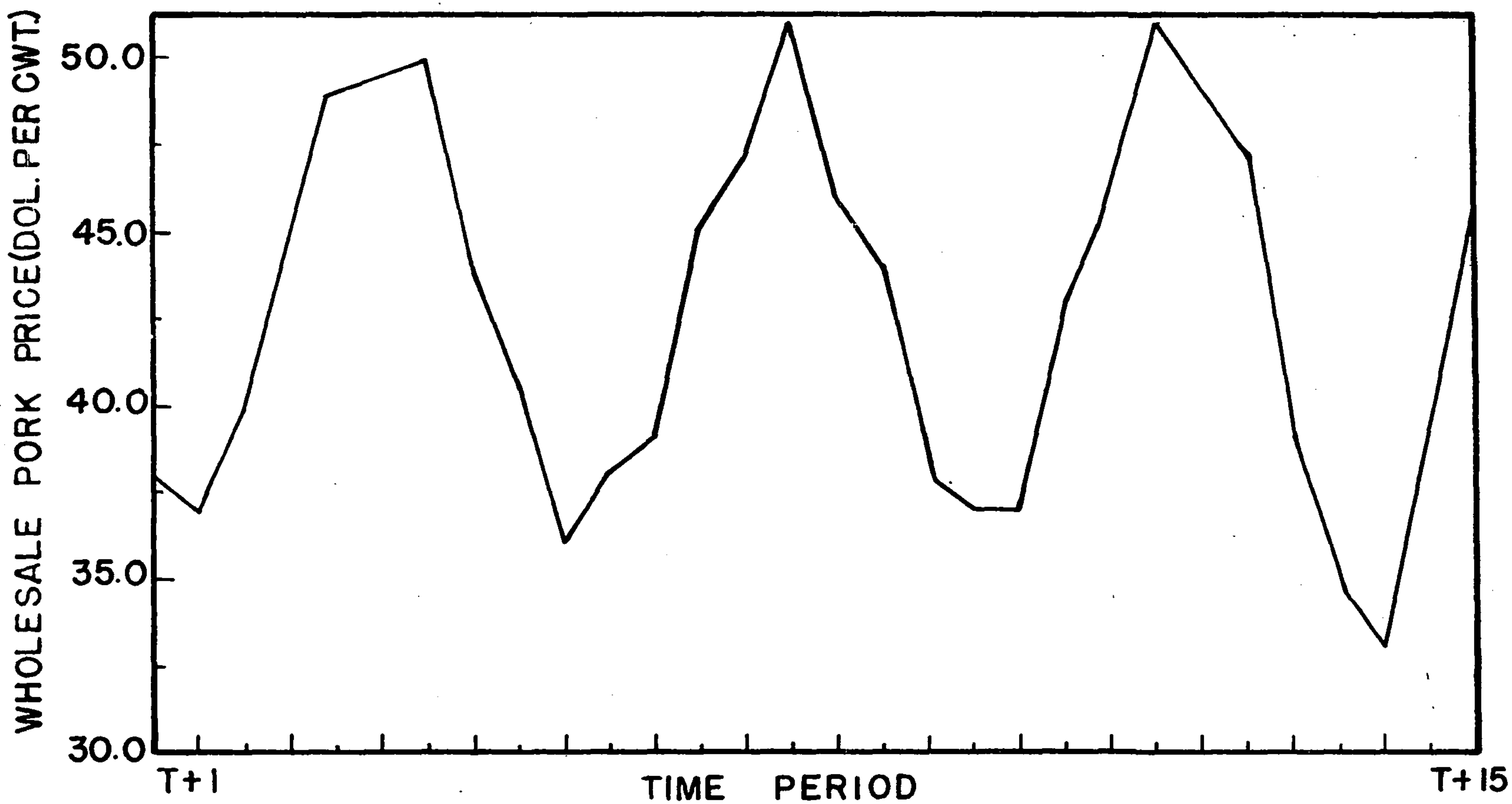


Figure 14. Estimated wholesale price of pork at Chicago under conditions of a closed economy

could account for part of this stabilization of explosive elements as could the variation in weather conditions or the business cycle.

1964-75 Projected Market Performance Under Existing Market Structure

The structure of the beef-pork economy that existed over the 1955-64 period is projected to 1975 (July 1, 1974 - June 30, 1975). The purpose of making the projections is to compare market performance under the current market structures and the alternative market structures. In making these projections, the reported values of the endogenous variables prior to July 1, 1964 are read into the computer as initial data.

Projection of exogenous variables

January 1 dairy-cow numbers are projected to 1975 by dividing projected milk consumption by the projected productivity per cow. Methods of projection of per capita milk consumption and productivity per cow were discussed in Chapter VI. Milk prices are assumed to remain at 1964 levels in terms of 1957-59 dollars. Finally, the projected dairy-cow numbers are expected to decline monotonically to fifteen-million head in 1975.

Corn prices at Chicago are assumed to remain near current levels. An annual average price of $1.20 is assumed for the projection period with a $0.10 seasonal variation. Stocks of corn on farms January 1 are assumed to remain constant.

The projected civilian population for 1975 prepared by the Bureau of the Census is interpolated to obtain semi-annual estimates for the intervening years through use of a logistic growth curve. Output per man hour in the meat packing industry, the consumer price index, the retailing margins and per capita disposable personal income are projected on the basis of their historical trends. The 1975 income projection of $2,900 is somewhat lower the projections of the National Planning Association (12); however, it is deemed necessary to use the trend line projection as the structural equations that involve income are in the form of deviation from trend.

Military consumption of beef and pork is assumed to remain near current levels (324-million pounds of beef and 188-million pounds of pork). October 1 and April-May range condition in the 17 Western states are projected at their mean values of 78 and 77, respectively.

Modifications of the model

The problem of extending trend values indefinitely was mentioned in the simulation of the historical period with reference to the estimation of sows farrowing in the fall. Although the projection of the historical period can not be changed in general, several changes can be justified in individual components in order to keep within the realm of plausibility. Accordingly, several modifications in trend variables and coefficients are introduced into the modified model.

The trend coefficients in the wholesale beef and pork price equations are allowed to decline to zero by 1975, assuming that shifts in consumer preference will stabilize by that time. Similarly, the trend coefficient in the fall sows-farrowing equation is reduced from 210 to 50 for the projection period, subject to the restriction that fall farrowings cannot exceed spring farrowings. The final trend adjustment involves reversing the trend coefficient in average steer slaughter weights from a +5 pounds per year to a -5 pounds per year under the assumption that cattle feeders will market cattle at lighter weights in the future.

Initial simulation runs revealed the necessity of placing a lower limit on the annual estimate of federally inspected beef-cow slaughter equal to five percent of the January 1 beef-cow inventory. During the historical period, the slaughter rate did not go below this level. This limit is introduced in order to maintain an average cow slaughter over the period of projection consistent with biological limitations.

During the simulation of the historical period, the reduction in January 1 beef-cow inventories due to non-federally inspected slaughter of cows and death losses (of both heifers and cows) were incorporated in the constant term (see equation number 6.3). However, when the simulated inventory levels exceed the reported levels, the constant term is too small to adequately allow for non-federally inspected cow slaughter and death losses. During the historical period, data on non-federally inspected cow slaughter are not available. In 1955 and 1960, federally inspected slaughter of all cattle was about 75 percent of commercial slaughter (55). The initial assumption was that 60 percent of cow slaughter occurred under federal inspection. We might expect that fewer cows than steers are slaughtered under federal inspection since only a small portion of cow beef is graded and a larger portion of cow beef moves in intra-state commerce because of the demand by local sausage kitchens. During periods of increased cow slaughter, a higher percentage is slaughtered under federal inspection as more cow beef must move in inter-state commerce. Therefore, equation 6.3 is modified as follows: If federally-inspected beef-cow slaughter (FIBCN) is less than 2.2 million head, the coefficient of federally-inspected beef-cow slaughter is set at 2.0 (assuming that only 50 percent of cow slaughter takes place under federal inspection). On the other hand, if federally-inspected beef-cow slaughter is relatively large (over 3.3 million head), the coefficient on the federally-inspected component is set at 1.67 (assuming 60 percent of cow slaughter takes place under federal inspection). If federally-inspected cow slaughter falls between 2.2 and 3.3 million head, the coefficient in the inventory equation is set at 1.8 (assuming a federally-inspected component of 55 percent). In addition, 8 percent of the January 1 beef-cow inventory the year before is subtracted to account for death loss of cows and heifers, plus non-fed heifer slaughter.

Although the retailing margins are determined to a great extent by wages and other exogenous influences, the margins projected on their own trend need additional provision for variation in quantities sold. The early projections show that per capita pork consumption would stay close to thirty pounds; however, per capita beef consumption might vary between forty and fifty-five pounds. Therefore, the following procedure is employed to induce some variation in the retailing margin for beef: If per capita consumption falls between 47.5 and 50.0 pounds, the trend value of the retail margin is used. However, $2.50 per 100 pounds is added (subtracted) for each 2.5-pound decrease (increase) in per capita beef consumption above or below the 47.5 to 50.0-pound range. This decision rule is based on the retailing margins calculated for the historical period.

Projected values of selected endogenous variables

Projected values of 11 selected production and price variables and the six January 1 inventory variables are presented in Table 10. These variables have been selected as the primary variables. The secondary variables, although necessary for the per capita consumption identities and as explanatory variables in certain behavioral relations, are omitted in an attempt to avoid over-burdening the reader with statistical data.

The projections trace out two full hog cycles. The cattle cycle, as measured by January 1 beef-cow numbers, shows a two-year decline followed by a build-up in numbers through 1975. However, a "slowdown" occurs after three years of increases. The increase from January 1, 1969 to January 1, 1970 is less than 200,000 head due to a substantial increase in beef-cow slaughter.

Per capita pork consumption fluctuates around the 30-pound level on a semi-annual basis. Annual per capita beef consumption increases to the 100- to 105-pound level according to the projections. Estimated net foreign trade in beef increases from 8.3 percent of estimated beef production in the year commencing July 1, 1965 to 10.6 percent in 1975.

Despite the gradual reduction in the positive and negative trend components of the wholesale beef and pork equations, the pork price did not increase as much as the beef price. Since all prices are in current dollars, the rather high absolute levels of beef and live-cattle prices are plausible in light of the high consumption levels.

The projections of regional commercial slaughter of beef and pork are presented in Tables 11 and 12. Iowa's market share of cattle

Table 10. Projected values of selected price and output variables of the beef and p
July 1, 1964 to June 30, 1975

Market, production, or stock variable	Unit	1964	1965	1966	196
		July-December period			
Commercial hog slaughter	mil. lbs. (live. wt.)	9,868	9,917	10,019	10,6
Commercial cattle slaughter	do.	15,007	14,097	13,474	13,4
Net foreign trade in beef	mil. lbs. (carcass wt.)	658	743	875	9
Per capita pork consumption	lbs.	30.6	29.7	29.6	3
Per capita beef consumption	lbs.	48.0	44.9	43.0	4
Wholesale price of beef	dol./cwt.	37.74	40.56	46.57	4
Wholesale price of pork	do.	39.04	43.25	46.18	4
Choice-steer price	do.	22.01	23.88	27.95	2
U.S. No. 1-3 hog price	do.	14.52	16.80	18.34	1
Feeder-calf price	do.	19.40	23.70	34.45	3
Sows farrowing	1,000 hd.	5,861	5,746	5,926	6,24
		January 1 inventories			
"Other" cows	do.	30,912	29,883	30,782	32,73
"Other" heifers	do.	7,740	8,444	8,900	8,63
"Other" calves	do.	25,427	24,637	24,988	26,36
Steers and bulls	do.	14,665	15,982	15,723	17,03
Cattle on feed	do.	9,209	9,849	10,043	9,99
Sows and gilts	do.	7,053	6,955	7,461	7,74

the beef and pork sectors of the livestock-meat economy, United States,

Year beginning July 1								
1966	1967	1968	1969	1970	1971	1972	1973	1974
iod								
10,019	10,618	11,123	11,071	11,120	11,509	11,942	12,248	12,358
13,474	13,433	15,168	15,803	15,639	15,748	17,366	18,368	19,009
875	955	954	944	994	1,091	1,120	1,140	1,184
29.6	30.9	31.8	31.2	30.8	31.3	31.8	32.1	31.9
43.0	43.1	47.2	48.0	46.8	47.0	50.4	51.9	52.9
46.57	47.63	42.97	47.49	49.03	50.71	51.11	50.00	53.15
46.18	42.73	38.25	41.83	43.94	43.97	41.88	40.84	42.77
27.95	28.61	25.32	28.37	29.36	30.44	30.65	29.81	31.91
18.34	16.21	13.50	15.41	16.48	16.36	15.02	14.27	15.24
34.45	34.90	24.35	26.76	35.94	35.73	33.41	30.61	36.47
5,926	6,243	6,259	6,105	6,158	6,369	6,528	6,546	6,544
ies								
0,782	32,733	33,719	33,898	35,979	37,826	39,863	42,320	44,871
8,900	8,637	8,989	10,009	9,783	10,324	11,143	11,593	12,574
4,988	26,362	28,472	28,347	29,743	32,025	33,887	36,097	38,899
5,723	17,035	17,144	18,054	18,553	20,435	21,964	22,432	24,068
0,043	9,992	11,210	11,769	12,355	12,741	14,007	15,503	16,836
7,461	7,747	7,341	7,141	7,363	7,623	7,685	7,521	7,534

Table 10 (Continued)

Market, production, or stock variable	Unit	1964	1965	1966	1
		January-June period			
Sows farrowing	1,000 hd.	6,328	6,238	6,704	6
Feeder-calf price	dol./cwt.	19.32	23.20	36.82	
Commercial hog slaughter	mil. lbs. (live wt.)	9,881	9,669	9,894	10
Commercial cattle slaughter	do.	13,794	12,315	12,264	14
Net foreign trades in beef	mil. lbs. (carcass wt.)	727	725	829	
Per capita beef consumption	lbs.	45.3	40.7	40.9	
Per capita pork consumption	lbs.	29.8	28.6	28.7	
Wholesale price of beef	dol./cwt.	39.04	47.99	49.56	
Wholesale price of pork	do.	38.67	46.20	46.52	
Choice-steer price	do.	22.83	28.93	29.94	
U.S. No. 1-3 hog price	do.	14.16	18.35	18.39	

	Year beginning July 1								
	1966	1967	1968	1969	1970	1971	1972	1973	1974
od									
	6,704	6,967	6,593	6,409	6,614	6,853	6,910	6,759	6,771
	36.82	38.30	21.61	26.90	36.89	37.46	31.39	27.39	34.49
	9,894	10,511	10,762	10,519	10,602	10,962	11,325	11,465	11,479
	12,264	14,052	14,946	14,509	14,552	16,195	17,142	17,916	18,383
	829	902	923	941	962	1,065	1,091	1,124	1,174
	40.9	44.8	46.7	45.3	44.9	48.2	49.9	51.1	51.8
	28.7	29.9	30.1	29.1	28.8	29.2	29.6	29.5	29.2
	49.56	41.99	44.02	49.17	49.38	50.39	47.65	50.24	52.14
	46.52	40.06	40.39	45.73	46.81	46.14	43.94	45.43	47.38
	29.94	24.65	25.97	29.46	29.53	30.15	28.19	29.90	31.14
	18.39	14.54	14.58	17.51	17.99	17.47	16.06	16.77	17.75

Table 11. Projected values of regional commercial cattle slaughter in billions of pounds, liveweight, United States, 1964-1974

	Calendar year										
Region	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
	(billion pounds)										
Iowa	3.1	3.3	3.8	3.6	4.2	4.2	4.5	4.5	5.4	5.8	5.7
Colorado	1.3	1.4	1.5	1.4	1.6	1.6	1.7	1.7	1.9	2.0	2.1
California	2.6	2.7	2.6	2.5	2.9	3.1	3.0	3.0	3.3	3.5	3.6
11 North Central States	11.7	11.9	11.4	11.4	12.4	12.9	12.6	12.8	13.8	14.5	15.1
Other 34 States	7.4	7.5	6.2	6.3	7.2	8.0	7.3	7.4	8.1	8.6	9.3

slaughter increased from 12 percent in 1964 to 16 percent in 1974. Colorado shows a one-percent increase in its slaughter share, California's slaughter share remains constant at 10 percent, while the share of commercial cattle slaughter in the remaining regions fell two to three percent.

In the case of regional hog slaughter, Iowa's market share increases from 19 to 21 percent during the 10-year period. The other 11 North Central states show a corresponding two-percent reduction in market share whereas the market share of the other three regions remains essentially constant.

Table 12. Projected values of regional commercial hog slaughter in billions of pounds, liveweight, United States, July 1, 1964 to June 30, 1975

	Year beginning July 1										
Region	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
	(billion pounds)										
July - December											
Iowa	1.95	1.96	2.03	2.18	2.30	2.30	2.34	2.45	2.57	2.64	2.69
Colorado	0.06	0.05	0.05	0.05	0.06	0.05	0.05	0.05	0.05	0.05	0.05
California	0.20	0.20	0.19	0.20	0.21	0.19	0.20	0.20	0.20	0.20	0.20
11 North Central states	4.75	4.72	4.74	5.04	5.27	5.18	5.17	1.34	5.54	5.66	5.67
Other 34 states	2.91	2.98	3.00	3.13	3.30	3.34	3.36	3.46	3.58	3.69	3.74
January - June											
Iowa	1.85	1.86	1.95	2.06	2.09	2.08	2.13	2.22	2.30	2.33	2.37
Colorado	0.06	0.05	0.05	0.05	0.06	0.05	0.04	0.04	0.05	0.04	0.04
California	0.20	0.19	0.18	0.19	0.20	0.18	0.17	0.17	0.18	0.18	0.17
11 North Central states	4.78	4.65	4.75	5.04	5.12	4.96	4.98	5.14	5.30	5.33	5.31
Other 34 states	2.96	2.90	2.95	3.15	3.28	3.22	3.25	3.35	3.48	3.55	3.57

CHAPTER VIII: ALTERNATIVE MARKET STRUCTURE MODELS

Different market structures give rise to a series of different market strategies. The effect of these alternative market strategies on the parameters of the existing economic structure will be developed in this chapter. Four of the alternative market strategies would require enabling legislation whereas five likely could be achieved under existing legislation. The procedure for making the strategies operational in the computer model will also be outlined.

Alternative Market Strategies Under Existing Legislation

The alternative market strategies to be explored involve changes in the wholesale and retail margins and a producer short-term supply control.

Wholesale-to-retail margins

Three margin strategies are considered for meat retailers. They may follow a fixed mark-up over cost (wholesale price), variable mark-up (percentage mark-up), or a semi-variable mark-up, which would take the form of a simple regression equation,

$$(Pr - Pw) = a + bPw, \qquad \text{(Eq. 8.1)}$$

where P_r refers to retail price and P_w refers to wholesale price. Both prices are on a carcass weight basis. In the aggregate, this semi-variable margin strategy could be interpreted in several ways. Part of the retail firms would follow a fixed mark-up policy and the remainder a variable mark-up policy or all retail firms might follow a mark-up policy in which a portion of it is fixed and the rest of the margin varies with wholesale price, or some combination of the two situations may occur.

Several forms of market organization could give rise to the postulated margin strategies. Initially, the fixed margin might depict the behavior of an oligopolistic retailing sector while the variable margin would depict the behavior of a fragmented retailing structure. In the oligopolistic case, the large firms would cover their overhead costs by an absolute amount regardless of the wholesale price level. Wholesale prices would have to make the full adjustment to clear the market. In the latter fragmented case, fixed overhead costs might not be covered in periods of low market-clearing prices. The adjustment to market conditions would be shared by both the retailer and the meat packer.

Allen (2, p. 128-130) contends that a fixed-mark-up policy might exist in a fragmented retailing industry where each small establishment catered to a local neighborhood market. In this case, the retailer would essentially be a small monopolist (or oligopolist) in the area he serves. He would also have a differentiated product by virtue of his specialized retailing service to his customers.

On the other hand, a retailing industry tending toward a smaller number of large firms with many retail outlets may find variable or semi-variable margins operationally more feasible due to (a) machine accounting operations on its many pre-packaged products and (b) the inability to establish fixed margins on each item.

Thus, it appears that any of the three strategies concerning mark-up policies could be followed by a structure of the retailing industry ranging from small fragmented firms to a relatively large oligopoly structure. In this aggregate analysis, the semi-variable mark-up will be associated with a mixture of mark-up strategies involving all four types of conduct.

Over the 1955-64 period, the wholesale-retail margin calculated for Chicago averaged 38 percent of the wholesale price and $16.00 in absolute terms. In simulating the fixed-margin strategy over the historical period, the retail margin was still treated as exogenous. It was entered as $16.00, adjusted by the consumer price index, which resulted in a range of $15.68 to $23.60.

In the case of the variable and semi-variable margins, a simultaneous convergent loop solution can be obtained by the computer. The retailing margin becomes an endogenous portion of the computer program in these cases. A 38-percent mark-up is used for the completely variable mark-up while the form of the semi-variable mark-up is

$$RM_{ijt} = 8.00 + 0.19\ PWB_{ijt} \quad . \qquad \text{(Eq. 8.2)}$$

Live-to-wholesale margin

Cattle and hog producers might capture a larger share of the live-to-wholesale margin by entering into contracts with packers. Various forms of contracts might exist where the increased portion of the margin accruing to the producer could be justified by the savings in procurement costs and more efficient production scheduling of the packer.

A contract calling for an average of $1.00 per hundredweight above the central market price over the contract period will be considered as one possible contractual arrangement. This contract could be established through producer associations or other farm bargaining groups. It is assumed in this case that the packer could save $1.00 per hundredweight in the gross margin through lower procurement costs and more efficient plant operation.

The modifications of market parameters in the computer model are focused on the coefficient associated with wholesale price in the live-to-wholesale margin equation. Since the coefficient is a functional relationship, $1.00 is added to the constant term and the new coefficient solved at the mean values of live and wholesale prices, which raises the coefficient in the wholesale price of beef equation from +0.6896 to +0.7122 and the coefficient associated with the wholesale price of pork from +0.575 to +0.597. If we assume that only one-third of the production is covered by the contract(s), only one-third of the increase in the coefficients is added to the aggregate margin relationships.

Producer short-term supply control

The withholding of livestock from the market through organized producer efforts has been attempted on two occasions. Both the short- and long-run results of an effective market boycott of this type are subject to conjecture. If producers of seventy-five percent of the cattle and hogs organize and achieve full cooperation of their membership in a thirty-day withholding action, it likely would be termed a successful experiment in setting the stage for generating the short- and long-run effects of temporary supply restriction. Since the immediate effects would transpire during the thirty-day withholding period and the ensuing sixty days thereafter, we will attempt to work out the short-run effects outside the computer model and then generate any long-run effects on the computer.

Let us assume that a thirty-day withholding action by such a producer group began on January 1, 1955 and continued throughout the month, and that the stock withheld were marketed during February and March. Details of the price consumption relations are shown in Appendix B. However, the lower price necessitated by the excess marketings during February and March more than offset the price increases of January. In the short run, this would be termed unsuccessful from the producer standpoint. The average wholesale price of beef and pork was $40.98 and $42.37, respectively, during the first six months of 1955. Live steer and hog prices were $24.88 and $17.89. The six-month average price generated by the withholding action is estimated at $32.68 and $35.50 per hundredweight for beef and pork, respectively, at the wholesale level; and $19.12 and $13.96 for cattle and hogs, respectively, at the live-animal level.

Since prices for the first half of 1955 are part of the initial conditions for simulating the historical period, the four specified values were used to replace the reported values. Thus, the simulation can trace out the long-run effects of the thirty-day withholding action involving 75 percent of all cattle and hogs.

Alternative Market Strategies Requiring Enabling Legislation

Four possible market strategies would need enabling legislation in order to avoid legal restraint. Two strategies involve changes in foreign trade laws, one would require establishment of a regulatory agency, and one would currently violate anti-trust laws.

Live-to-wholesale margins

Annual reports of the meat packing industry (3) have indicated returns to investment below that of other manufacturing industries. For example, in 1962 packers' ratios of net earnings to assets were 4.1 percent compared with an average ratio of 8.7 percent for the food and kindred products industries. Over the ten-year period 1953-62, the extra gross income needed to raise packer returns on investment to eight percent was calculated and divided by the total weight of commercial cattle, calf, hog and sheep slaughter. The extra gross revenue per hundredweight ranged from 16 cents to 30 cents with the average being 23.5 cents per hundredweight of livestock slaughtered. Thus, an increase of 25 cents in the live-to-wholesale margin over the historical period would have increased packer earnings on investment to a level near that of other manufacturing industries engaged in food processing.

If the firms in the meat packing industry were to increase their gross margin on livestock purchased by 25 cents per hundredweight, group action would be necessary. Unilateral action would be impossible, unless the packer bought livestock in an isolated area. Otherwise, competing packers would force the price up. Moreover, new packing firms would enter the industry as margins increased. However, collusion among packers that would widen the margin through lowering prices paid for livestock would invite prosecution under either the Packer and Stockyards Act or the Sherman Act. Therefore, enabling legislation would be necessary to allow structural changes in the industry that would result in a widening of the wholesaling margin. The effects over time of this market strategy by the packing industry on livestock purchases can be simulated by changing the constant term in the live-wholesale margin equations. Twenty-five cents was subtracted from the constant terms of the beef and pork live-to-wholesale margin relationships.

Foreign trade limitations

Producer concern over increased imports of beef could lead to restrictive legislation. Two types of import restrictions are introduced into the simulation procedures. One type of control could involve limiting net imports of beef to a percentage of current domestic beef production. Another form of control might involve placing an absolute limit on net imports.

The two alternative strategies can be traced out by slight modifications of the computer model. A percentage-control model is simulated for both the historical and projection periods by placing an upper limit on the net foreign trade in beef (FTR2j), the limit being four percent of current beef production.

Cattle producers have suggested limiting imports of beef to the average of the 1958-62 period. In the projection period, the limit of 488-million pounds is placed as an upper limit on the net foreign trade in beef. This quantity was the average net foreign trade in beef on a semi-annual basis during the five-year period, 1958-62.

Consumption control

Livestock producers have not been willing to accept supply controls as a means of achieving price stability or improving price levels. If consumers desire stable consumption and prices, a market control program such as the one outlined in subsequent paragraphs might combine aspects of forward pricing with consumption stability. Legislation establishing market control authority would be necessary.

The consumption control program might work as follows: A target level of per capita consumption of beef and pork would be established on the basis of fairly recent market experience. No production controls would be applied. Production in excess of domestic requirements would be sold on the world market while imports would be limited to periods of deficit domestic production. Wholesale meat prices for domestic use would be guaranteed, but export meat would be sold at world prices. Under this arrangement, retail margins will be assumed to remain fixed in terms of constant dollars.

During the 1955-64 period, per capita consumption of beef averaged 41.5 pounds on a semi-annual basis while per capita pork consumption averaged 30 pounds. The wholesale price of both beef and pork at Chicago averaged about $42.00 during the historical period. Under the consumption control alternative, per capita consumption of beef and pork and the guaranteed domestic price would be set at the average levels for the period with the price varying with the consumer price index. Imports would not affect the domestic price. However, exports would be sold at the Liverpool price. In this case the wholesale price would be a weighted average of that portion sold in the domestic market and that portion sold at Liverpool, minus a six-cent ocean freight rate and a twenty-percent tariff. The net export prices for both the historical and projection periods are listed in Appendix C. The net export price averaged about 45 to 50 percent of the domestic price.

In the simulation of market controls to 1975, pork consumption is left at the 30-pound level for a six-month period. However, per capita consumption of beef is allowed to increase one-half pound per year commencing with a 45-pound per capita beef consumption for each six-month period. The per capita beef consumption in 1975 rises to 100 pounds.

CHAPTER IX: EMPIRICAL RESULTS OF THE ALTERNATIVE MODELS

Fourteen of the endogenous variables in the national model will be used to present the simulated market performance under the postulated market strategies. In addition, the effects of the alternative strategies on commercial cattle and hog slaughter in Iowa will be shown.

In order to keep the number of tables needed at a minimum, the time paths generated for each of the nine alternative models are presented in groups slightly different from the organization in Chapter VIII. The results of the alternative margin strategies are tabled together as one group and the results of the foreign trade and consumption control simulation runs are tabled together as a second group similar to the organization of the previous chapter. However, the results of the actions initiated by the processor or producer groups, irrespective of the enabling legislation needed, are presented as a third group.

Results of both the historical and projected periods are presented in the same table. The column headings denote the alternative models. The estimates appearing under the heading, historical structure, are the predicted values of the 1955-64 period rather than the reported values. Reported values may be found in the appropriate tables of Chapter VII. Predicted values are shown instead of reported values to allow comparisons with the historical period as well as between alternative simulations.

Results of Alternative Margin Strategies

Comparisons between the results obtained under the alternative market strategies -- variable, semi-variable or fixed retail margins -- are of interest as well as comparisons with the predicted value of the historical period. This is especially true of the simulations over the projection period where the variation introduced into the margin for projection of the historical structure contains both fixed and variable elements.

The range in per capita beef consumption from 1964 to 1975 was 14.2 pounds under the variable-margin assumption, 14.1 pounds under the semi-variable-margin assumption, and 14.5 pounds under the fixed-margin assumption. In the case of per capita pork consumption, the range over the 1964 to 1975 period was 3.4 pounds under the variable-margin assumption, 3.7 pounds under the semi-variable-margin assumption, and 4.9 pounds under the fixed-margin assumption.

The mean values of both wholesale and live-animal price in both the historical and projection periods were almost identical. However, their ranges were quite different. During the simulation of the historical period, wholesale beef prices varied by 10.9 cents per pounds. Under the variable-margin strategy, the range in beef prices was reduced to 10.5 cents. However, the semi-variable margin and fixed-margin strategies increased the range in wholesale beef price in the 1955 to 1964 period to 13.7 cents per pound and 15.1 cents per pound, respectively. The variation in choice-steer prices under the alternative margin strategies followed the range in wholesale beef prices. The range in Choice grade steer prices under the variable-margin strategy was only 7.6 cents per pound during the historical period compared with 10.8 cents under the fixed-margin strategy.

From 1955 to 1964, wholesale pork prices varied by 15.4 cents under the market structure existing during that period. The variable-margin strategy reduced this range in wholesale pork price to 13.5 cents per pound, but the semi-variable and fixed-margin strategies increased the range to 16.5 cents and 19.3 cents per pound, respectively. Similarly, live-hog prices showed a range of only eight cents under the variable-margin assumption and an 11-cent range under the fixed-margin assumption.

In the projection to 1975 under the alternative margin assumption, the mean values of the wholesale prices of beef and pork did not differ appreciably, but the range in wholesale prices during this eleven-year projection period were even more pronounced than in the simulations of the historical period. Wholesale beef price ranged from 9.8 cents under the variable-margin strategy, 11.4 cents under the semi-variable-margin strategy, to 20.4 cents under the fixed-margin strategy. Choice grade steer prices ranged 6.6 cents per pound under the variable margin whereas their range was 13.3 cents per pound under the fixed-margin assumption.

The range in wholesale pork price under the variable-margin assumption was only 7.4 cents whereas wholesale pork price under the fixed-margin assumption ranged 18.5 cents during the 1964 to 1975 projection. The range in live-hog prices was also doubled by the fixed margin. The range under the variable margin was 4.5 cents per pound compared with a range of 9.6 cents per pound under the fixed-margin assumption.

Feeder-calf prices likewise showed more variation under the fixed margin than under the variable margin. However, the average feeder-calf price was about one dollar higher during the historical period under the fixed margin than the variable margin whereas the average value was about one dollar lower during the projection period under the fixed margin than the semi-variable margin.

January 1 inventories of beef cows and steers declined more at the bottom of the last cycle in 1958 under the fixed margin than the variable margin. The fixed inventory levels increased at a somewhat slower rate under the fixed margin, but cow inventories were about the same in 1964 for all marketing strategies. In the projection period, the build-up in beef-cow numbers was five-million-head lower under the fixed margin and historical simulations than the variable margins. Likewise, the build-up in steer numbers was three- to four-million-head lower under the fixed-margin and historical-period simulations.

Total sow farrowings were seven-percent greater over the projection period under the variable and semi-variable margins than under the fixed margins. However, the range was about the same in all cases.

The mean values of the retailing margins were about the same in the historical period. However, the range in the variable margin was approximately 4.5 cents in the case of both beef and pork as opposed to 2.25 cents for the fixed margin. In the projection period, the variation introduced in the retail margin yielded a high average margin (23 cents) for beef under the historical structure with nine-cent variation. Mean values in the projection period for wholesale-to-retail margin for beef under the variable, semi-variable, and fixed-margin strategies were 18 cents, 17.1 cents, and 22 cents with ranges of 3.8 cents, 2.4 cents,

Table 13. Estimated commercial slaughter of cattle and hogs in billions of pounds, liveweight, under alternative margin strategies, United States, 1955-1975

		Cattle				Hogs			
Year	Half year	Historical structure	Variable margin	Semi-variable margin	Fixed margin	Historical structure	Variable margin	Semi-variable margin	Fixed margin
					(billion pounds)				
1955	2	12.7	12.7	12.7	12.7	9.2	9.2	9.2	9.2
1956	1	12.6	12.6	12.4	12.4	9.2	9.2	9.2	9.2
	2	13.0	13.0	12.8	12.7	8.9	8.9	8.9	8.9
1957	1	12.5	12.5	12.4	12.4	8.5	8.5	8.4	8.4
	2	13.0	13.0	12.9	12.8	8.6	8.5	8.5	8.4
1958	1	11.1	11.1	10.8	10.7	8.1	8.0	7.9	7.8
	2	11.9	11.9	11.6	11.4	8.9	8.8	8.8	8.7
1959	1	11.6	11.1	11.0	11.0	9.0	9.1	9.1	8.9
	2	12.3	11.8	11.8	11.9	9.6	9.5	9.6	9.7
1960	1	12.3	11.7	12.0	12.4	9.9	9.7	9.9	10.1
	2	12.8	12.4	12.6	12.9	9.0	9.0	9.1	9.3
1961	1	12.8	12.6	12.8	13.0	9.0	9.0	9.1	9.2
	2	13.3	13.2	13.3	13.4	9.2	9.2	9.2	9.1
1962	1	12.7	12.8	12.7	12.2	9.6	9.7	9.6	9.4
	2	13.3	13.4	13.3	12.9	9.6	9.7	9.7	9.5
1963	1	13.1	13.5	13.3	12.7	10.0	10.2	10.1	9.9
	2	14.0	14.3	14.1	13.5	10.0	10.0	10.0	10.0
1964	1	13.2	13.1	13.1	13.2	10.2	10.3	10.3	10.3
	2	15.0	15.0	15.0	15.0	9.9	9.9	9.9	9.9
1965	1	13.8	13.9	13.9	13.8	9.9	9.9	9.9	9.9
	2	14.1	14.3	14.3	14.0	9.9	10.0	10.0	9.8
1966	1	12.3	12.6	12.6	12.2	9.7	9.9	9.9	9.5
	2	13.5	13.8	13.9	13.4	10.0	10.4	10.5	10.0
1967	1	12.3	14.3	14.4	12.8	9.9	10.4	10.5	9.9
	2	13.4	15.5	15.6	14.1	10.6	11.1	11.2	10.7
1968	1	14.0	16.1	16.5	15.5	10.5	11.0	11.1	10.6
	2	15.2	17.0	17.4	16.4	11.1	11.3	11.4	11.2
1969	1	14.9	16.2	16.4	16.0	10.8	11.0	11.0	10.8
	2	15.8	17.1	17.2	16.8	11.1	11.3	11.2	10.8
1970	1	14.5	15.7	15.4	14.6	10.5	10.9	10.7	10.1
	2	15.6	16.8	16.5	15.6	11.1	11.4	11.4	10.7
1971	1	14.5	16.2	16.1	14.1	10.6	11.0	11.0	10.1
	2	15.7	17.5	17.5	15.5	11.5	11.8	12.0	11.4
1972	1	16.2	17.8	18.2	16.4	11.0	11.4	11.5	11.0
	2	17.4	19.1	19.4	17.7	11.9	12.3	12.4	12.2
1973	1	17.1	18.9	19.3	18.8	11.3	11.7	11.8	11.7
	2	18.4	20.0	20.4	19.9	12.2	12.5	12.5	12.3
1974	1	17.9	19.3	19.3	18.2	11.5	11.7	11.8	11.4
	2	19.0	20.5	20.5	19.0	12.3	12.6	12.6	11.8
1975	1	18.4	19.7	19.4	16.6	11.5	11.8	11.8	10.8

Table 14. Estimated commercial cattle and hog slaughter in Iowa in billions of pounds, liveweight, under alternative margin strategies, 1955-1975

Year	Half year	Cattle[a] Historical structure	Cattle[a] Variable margin	Cattle[a] Semi-variable margin	Cattle[a] Fixed margin	Hogs Historical structure	Hogs Variable margin	Hogs Semi-variable margin	Hogs Fixed margin
					(billion pounds)				
1955	2	1.69	1.69	1.69	1.69	1.65	1.65	1.65	1.65
1956	1					1.52	1.52	1.52	1.51
	2	2.08	2.08	1.85	1.84	1.57	1.58	1.57	1.56
1957	1					1.46	1.45	1.44	1.43
	2	2.19	2.15	2.14	2.10	1.55	1.54	1.52	1.50
1958	1					1.42	1.39	1.39	1.38
	2	2.21	2.22	2.05	2.00	1.70	1.67	1.67	1.67
1959	1					1.62	1.64	1.66	1.62
	2	2.52	2.26	2.04	2.54	1.86	1.82	1.85	1.88
1960	1					1.79	1.76	1.79	1.82
	2	2.74	2.60	2.68	2.81	1.71	1.70	1.72	1.75
1961	1					1.68	1.68	1.69	1.69
	2	2.94	2.92	2.91	2.79	1.79	1.80	1.80	1.76
1962	1					1.80	1.82	1.82	1.78
	2	2.97	2.96	2.89	2.84	1.90	1.92	1.91	1.86
1963	1					1.89	1.90	1.90	1.88
	2	3.44	3.43	3.39	3.25	1.95	1.96	1.96	1.96
1964	1					1.91	1.93	1.94	1.94
	2	3.06	3.06	3.06	3.06	1.95	1.95	1.95	1.95
1965	1					1.85	1.88	1.88	1.84
	2	3.30	3.50	3.50	3.29	1.96	2.00	2.00	1.94
1966	1					1.86	1.94	1.95	1.85
	2	3.81	4.04	4.07	3.76	2.02	2.14	2.15	2.02
1967	1					1.95	2.06	2.08	1.96
	2	3.55	4.57	4.72	4.12	2.19	2.29	2.32	2.21
1968	1					2.06	2.14	2.16	2.08
	2	4.17	4.66	4.85	4.50	2.30	2.35	2.36	2.30
1969	1					2.09	2.15	2.14	2.07
	2	4.25	4.82	4.73	4.61	2.30	2.36	2.34	2.22
1970	1					2.09	2.16	2.14	2.00
	2	4.52	4.94	4.88	4.26	2.34	2.42	2.41	2.25
1971	1					2.13	2.20	2.23	2.08
	2	4.52	5.32	5.58	4.69	2.45	2.53	2.56	2.45
1972	1					2.22	2.30	2.34	2.25
	2	5.41	6.14	6.06	5.77	2.56	2.64	2.68	2.63
1973	1					2.30	2.36	2.39	2.33
	2	5.78	6.07	6.25	6.23	2.64	2.70	2.70	2.64
1974	1					2.33	2.39	2.39	2.27
	2	5.74	6.37	6.35	5.28	2.68	2.75	2.74	2.55
1975	1					2.37	2.43	2.43	2.24

[a]Regional cattle slaughter is estimated on an annual basis.

Table 15. Estimated per capita consumption of beef and pork in pounds, carcass weight equivalent, under alternative margin strategies, United States, 1955-1975

Year	Half year	Beef: Historical structure	Beef: Variable margin	Beef: Semi-variable margin	Beef: Fixed margin	Hogs: Historical structure	Hogs: Variable margin	Hogs: Semi-variable margin	Hogs: Fixed margin
					(pounds)				
1955	2	41.6	41.6	41.6	41.6	31.5	31.5	31.5	31.5
1956	1	41.5	41.5	41.0	40.3	31.0	31.0	31.0	31.0
	2	42.0	42.0	41.3	41.2	30.4	30.5	30.4	30.3
1957	1	41.3	41.0	40.7	40.5	28.6	28.7	28.5	28.4
	2	42.0	42.5	42.2	41.3	29.0	28.8	28.6	28.4
1958	1	37.5	37.3	36.3	35.9	26.8	26.5	26.3	26.1
	2	39.3	39.0	38.3	37.9	29.5	29.1	29.0	28.9
1959	1	39.0	37.6	37.7	37.6	29.0	29.1	29.2	28.6
	2	40.9	39.4	39.5	39.7	31.5	31.0	31.4	31.7
1960	1	40.8	39.5	40.1	41.0	31.2	30.6	31.1	31.7
	2	42.2	40.9	41.6	42.7	29.8	29.5	29.9	30.5
1961	1	42.0	41.6	42.1	42.5	28.6	28.5	28.7	29.1
	2	44.5	44.2	44.5	44.4	29.2	29.3	29.3	29.0
1962	1	43.0	43.4	43.0	41.7	29.6	29.9	29.8	29.1
	2	44.2	44.6	44.0	42.9	30.3	30.6	30.5	29.9
1963	1	44.3	45.1	44.6	43.0	30.7	31.0	30.9	30.3
	2	46.2	47.0	46.5	45.0	31.5	31.2	31.2	31.1
1964	1	44.5	44.0	44.2	44.2	31.0	31.2	31.2	31.2
	2	48.0	48.0	48.0	48.0	30.7	30.6	30.6	30.6
1965	1	45.2	45.7	45.7	45.1	29.8	29.8	29.8	29.8
	2	44.9	45.5	45.6	44.9	29.7	30.0	30.0	29.5
1966	1	40.7	41.7	41.9	40.8	28.6	29.2	29.3	28.3
	2	43.0	44.2	44.4	43.0	29.6	30.7	30.8	29.4
1967	1	40.9	46.0	46.2	42.4	28.7	30.2	30.4	28.7
	2	43.1	48.6	48.9	45.0	30.9	32.1	32.4	31.1
1968	1	44.8	49.8	50.8	48.2	29.9	31.1	31.5	30.2
	2	47.2	51.7	52.7	50.2	31.8	32.4	32.6	31.9
1969	1	46.7	49.7	50.1	49.0	30.0	30.7	30.8	30.0
	2	48.0	50.9	50.9	50.1	31.2	31.8	31.6	30.7
1970	1	45.3	48.0	47.2	45.4	29.1	29.9	29.7	28.2
	2	46.9	49.8	49.1	46.8	30.8	31.6	31.4	29.8
1971	1	44.9	48.6	48.5	44.2	28.8	29.8	29.7	27.7
	2	47.0	57.0	51.2	46.5	31.3	32.1	32.3	30.9
1972	1	48.2	51.9	52.7	48.7	29.2	30.2	30.5	29.3
	2	50.4	54.3	54.9	51.2	31.8	32.6	33.0	32.5
1973	1	49.9	53.7	54.6	53.2	29.6	30.4	30.8	30.3
	2	51.9	55.6	56.2	55.3	32.1	32.6	32.8	32.3
1974	1	51.1	54.0	53.9	51.5	29.5	30.1	30.2	29.3
	2	52.9	55.9	55.8	52.3	31.9	32.4	32.4	30.8
1975	1	51.8	54.4	53.9	48.0	29.2	29.8	29.8	27.6

Table 16. Estimated wholesale price of beef and pork in cents per pound under alternative margin strategies, Chicago, 1955-1975

		Beef (Choice grade)				Pork			
Year	Half year	Historical structure	Variable margin	Semi-variable margin	Fixed margin	Historical structure	Variable margin	Semi-variable margin	Fixed margin
					(cents)				
1955	2	36.0	36.1	35.1	34.4	36.5	36.9	36.0	35.5
1956	1	34.5	34.7	34.3	34.2	34.9	35.0	34.1	33.4
	2	41.5	37.8	38.4	37.9	42.9	40.7	41.0	41.0
1957	1	37.2	38.1	38.0	37.2	43.1	42.4	42.9	42.9
	2	40.8	38.8	38.4	39.5	45.5	44.5	45.3	36.4
1958	1	46.9	45.6	48.0	49.9	50.3	48.5	50.6	52.7
	2	44.6	45.1	47.0	48.3	43.5	44.7	45.8	46.8
1959	1	46.5	45.7	46.1	46.7	44.5	44.2	44.2	46.3
	2	43.7	45.9	46.3	45.9	38.7	41.8	40.9	39.5
1960	1	44.2	44.4	43.6	40.5	39.4	40.8	39.0	35.3
	2	43.4	46.3	45.7	43.0	46.2	47.0	46.3	43.4
1961	1	42.5	44.4	43.7	41.8	42.8	44.9	43.1	40.9
	2	41.5	43.3	43.0	42.4	45.8	45.8	46.2	46.7
1962	1	43.8	42.3	43.0	45.7	40.0	39.5	39.8	42.0
	2	46.7	43.9	45.2	47.0	42.4	41.0	41.7	43.9
1963	1	41.4	41.2	42.0	43.7	35.4	36.3	36.4	37.7
	2	41.3	42.3	43.0	44.6	39.2	40.3	40.5	40.6
1964	1	41.4	44.6	44.9	43.1	35.6	38.5	38.2	36.1
	2	37.7	42.8	42.9	36.7	39.0	42.4	42.4	37.3
1965	1	39.0	45.1	45.7	41.0	38.7	42.6	42.9	38.2
	2	40.6	48.0	49.0	45.7	43.2	46.1	46.9	44.7
1966	1	48.0	52.6	54.3	53.0	46.2	46.7	47.8	47.9
	2	46.6	51.2	52.6	51.5	46.2	45.7	46.3	47.6
1967	1	49.6	47.9	48.5	51.5	46.5	43.1	42.9	46.4
	2	47.6	46.2	46.3	48.7	42.7	40.7	39.8	41.5
1968	1	42.0	48.7	41.5	40.9	40.0	39.7	37.6	37.7
	2	43.0	43.5	42.0	39.7	38.2	39.6	38.2	35.6
1969	1	44.0	45.8	45.7	41.3	40.4	41.7	41.4	38.5
	2	47.5	46.4	47.2	42.7	41.8	42.2	43.2	41.1
1970	1	49.2	50.1	53.0	51.9	45.7	45.6	47.8	49.0
	2	49.0	49.7	52.3	52.1	43.9	44.3	46.0	47.9
1971	1	49.4	50.2	51.9	56.8	46.8	46.3	47.6	52.6
	2	50.7	49.5	50.5	54.3	44.0	43.8	43.7	46.1
1972	1	50.4	47.1	46.6	48.8	46.1	44.6	43.6	45.0
	2	51.1	46.3	45.9	45.8	41.9	41.2	39.8	37.4
1973	1	47.7	46.1	45.3	40.0	43.9	44.0	42.7	38.3
	2	50.0	45.4	45.7	38.7	40.8	41.3	40.9	35.4
1974	1	50.2	47.4	48.6	47.1	45.4	45.5	46.0	44.5
	2	53.1	47.4	48.6	48.8	42.8	42.7	43.4	44.6
1975	1	52.1	48.6	50.8	57.1	47.3	47.0	48.4	54.1

Table 17. Estimated cattle and hog prices at Chicago in cents per pound under alternative margin strategies, 1955-1975

		Choice grade steers				US No. 3 Hogs			
Year	Half year	Histor-ical struc-ture	Vari-able margin	Semi-vari-able margin	Fixed margin	Histor-ical struc-ture	Vari-able margin	Semi-vari-able margin	Fixed margin
					(cents)				
1955	2	21.5	21.6	20.9	20.4	14.4	14.6	14.1	13.9
1956	1	20.4	20.6	20.3	20.1	13.3	13.4	12.3	12.4
	2	25.2	22.7	23.0	22.7	17.9	16.6	16.8	16.8
1957	1	22.2	22.8	22.7	22.2	17.9	17.5	17.8	17.8
	2	24.7	23.3	23.3	23.8	19.3	18.7	19.2	19.8
1958	1	28.8	28.0	29.6	30.9	22.0	21.0	22.2	23.4
	2	27.2	27.6	28.9	29.8	18.1	18.7	19.4	20.0
1959	1	28.5	27.9	28.2	28.6	18.5	18.3	18.3	19.5
	2	26.5	28.1	28.3	28.1	15.2	16.9	16.4	15.6
1960	1	26.8	26.9	26.4	24.3	15.4	16.2	15.2	13.0
	2	26.3	28.2	27.9	26.0	19.3	19.7	19.4	17.7
1961	1	25.5	26.8	26.4	25.0	17.2	17.8	17.4	16.1
	2	24.8	26.1	25.9	25.4	18.9	18.9	19.1	19.4
1962	1	26.3	25.3	25.8	27.6	15.4	15.1	15.3	16.5
	2	28.3	26.4	27.3	28.5	16.7	16.0	16.4	17.6
1963	1	24.6	24.4	25.0	26.2	12.6	13.1	13.1	13.9
	2	24.6	25.2	25.7	26.8	14.8	15.4	15.5	15.5
1964	1	24.5	26.7	26.9	25.7	12.6	14.2	14.0	12.9
	2	22.0	25.5	25.5	21.3	14.5	16.4	16.5	13.5
1965	1	22.8	27.0	27.4	24.2	14.1	16.4	16.6	13.9
	2	23.9	29.0	29.7	27.4	16.8	18.4	18.9	17.6
1966	1	28.9	32.1	33.3	32.3	18.3	18.7	19.2	19.3
	2	28.0	31.2	32.1	31.3	18.3	18.0	18.4	19.1
1967	1	29.9	28.8	29.2	31.3	18.3	16.4	16.3	18.3
	2	28.6	27.6	27.7	29.4	16.2	15.0	14.5	15.5
1968	1	24.6	25.9	24.3	23.9	14.5	14.3	13.1	13.2
	2	25.3	25.7	24.7	23.1	13.5	14.2	13.5	12.0
1969	1	26.0	27.1	27.2	24.1	14.6	15.3	15.2	13.5
	2	28.4	27.6	28.2	25.1	15.4	15.7	16.2	15.0
1970	1	29.5	30.1	32.1	31.3	17.5	17.4	18.7	19.4
	2	29.4	29.8	31.6	31.5	16.5	16.7	17.7	18.7
1971	1	29.5	30.1	31.2	34.6	18.0	17.7	18.4	21.4
	2	30.4	29.6	30.3	32.9	16.4	16.3	16.2	17.6
1972	1	30.1	27.9	27.5	29.1	17.5	16.6	16.0	16.8
	2	30.6	27.3	27.0	27.0	15.0	14.7	13.9	12.5
1973	1	28.2	27.1	26.5	22.9	16.0	16.1	15.4	12.8
	2	29.8	26.6	26.9	22.0	14.3	14.5	14.3	11.1
1974	1	29.9	28.0	28.8	27.8	16.8	16.8	17.1	16.2
	2	31.9	28.0	28.8	28.9	15.2	15.2	15.6	16.3
1975	1	31.1	28.7	30.2	34.6	17.8	17.5	18.3	21.6

Table 18. Estimated price of good and choice feeder calves at Kansas City in cents per pound under alternative margin strategies, 1955-1975

Year	Half year	Historical structure	Variable margin	Semi-variable margin	Fixed margin
			(cents)		
1955	2	19.6	19.9	18.3	17.3
1956	1	18.7	18.9	17.4	16.4
	2	20.4	17.4	17.6	17.1
1957	1	22.3	19.4	19.8	19.5
	2	25.9	24.6	25.0	25.5
1958	1	30.6	29.8	30.2	30.7
	2	33.8	34.4	37.2	39.5
1959	1	33.4	34.9	37.4	41.1
	2	29.0	30.8	31.2	29.3
1960	1	29.4	30.4	31.0	29.5
	2	26.0	28.2	26.5	27.0
1961	1	27.5	29.4	28.2	27.4
	2	25.7	27.9	27.9	25.2
1962	1	26.5	28.9	29.2	25.7
	2	30.9	27.1	29.0	32.3
1963	1	31.3	27.4	29.2	33.3
	2	23.7	24.5	26.7	28.2
1964	1	22.7	24.0	26.0	27.8
	2	19.4	22.3	23.0	17.8
1965	1	19.3	22.7	22.8	17.8
	2	23.7	33.5	34.7	29.2
1966	1	23.2	30.9	32.0	28.9
	2	34.4	40.0	42.1	41.9
1967	1	36.8	43.5	45.5	45.5
	2	34.9	28.1	27.7	31.3
1968	1	38.3	29.3	28.4	32.2
	2	24.3	26.8	24.7	20.4
1969	1	21.6	22.8	22.4	16.6
	2	26.8	29.6	30.5	23.0
1970	1	26.9	29.2	30.0	25.7
	2	35.9	36.7	40.7	41.7
1971	1	36.9	35.7	42.2	45.4
	2	35.7	34.4	33.6	43.3
1972	1	37.5	34.8	32.2	40.6
	2	33.4	28.8	28.4	25.8
1973	1	31.4	24.6	22.8	21.6
	2	30.6	26.6	27.2	19.6
1974	1	27.4	24.5	25.9	21.5
	2	36.5	32.1	34.3	34.0
1975	1	34.5	29.9	32.6	32.7

Table 19. Estimated number of sows farrowing in millions of head under alternative margin strategies, United States, 1955-1975

Year	Half year	Historical structure	Variable margin	Semi-variable margin	Fixed margin
			(million head)		
1955	2	5.5	5.5	5.5	5.5
1956	1	7.6	7.7	7.6	7.6
	2	5.3	5.2	5.2	5.2
1957	1	7.1	7.0	6.9	6.9
	2	5.0	4.9	4.9	4.8
1958	1	7.4	7.2	7.2	7.2
	2	5.6	5.7	5.8	5.6
1959	1	7.9	7.7	7.9	8.0
	2	6.2	6.1	6.2	6.3
1960	1	6.8	6.8	6.9	7.1
	2	5.7	5.7	5.7	5.7
1961	1	6.8	6.9	6.9	6.9
	2	6.0	6.1	6.1	5.9
1962	1	7.0	7.2	7.1	6.9
	2	6.2	6.3	6.3	6.2
1963	1	7.0	7.1	7.1	7.1
	2	6.2	6.3	6.3	6.3
1964	1	6.6	6.7	6.8	6.8
	2	5.9	5.9	5.9	5.8
1965	1	6.3	6.5	6.5	6.2
	2	5.7	6.0	6.0	5.7
1966	1	6.2	6.8	6.9	6.2
	2	5.9	6.3	6.4	6.0
1967	1	6.7	7.3	7.4	6.8
	2	6.2	6.5	6.6	6.3
1968	1	7.0	7.2	7.3	7.0
	2	6.3	6.5	6.6	6.2
1969	1	6.6	6.9	6.8	6.2
	2	6.1	6.4	6.3	5.8
1970	1	6.4	6.8	6.8	5.9
	2	6.2	6.5	6.5	5.9
1971	1	6.6	7.0	7.2	6.5
	2	6.4	6.7	6.8	6.5
1972	1	6.8	7.2	7.4	7.2
	2	6.5	6.8	6.9	6.7
1973	1	6.9	7.2	7.3	7.0
	2	6.5	6.8	6.8	6.4
1974	1	6.7	7.1	7.0	6.1
	2	6.5	6.8	6.8	6.1
1975	1	6.8	7.1	7.1	6.1

Table 20. Estimated, January 1 inventories of beef cows, steers and bulls in millions of head under alternative margin strategies, United States, 1955-1975

	Beef cows				Steers and bulls			
Year	Historical structure	Variable margin	Semi-variable margin	Fixed margin	Historical structure	Variable margin	Semi-variable margin	Fixed margin
				(million head)				
1956	25.2	25.2	25.1	25.0	11.2	11.2	10.7	10.6
1957	24.5	24.4	24.0	23.8	10.7	10.6	10.4	10.4
1958	24.2	23.6	23.3	23.1	10.8	10.7	10.4	10.2
1959	25.2	24.5	24.2	24.1	11.6	11.0	11.1	11.6
1960	26.1	25.5	25.3	25.4	12.2	11.9	12.0	12.2
1961	27.0	26.5	26.3	26.2	12.6	12.4	12.3	12.0
1962	28.1	27.8	27.5	26.8	12.8	12.6	12.4	12.3
1963	29.5	29.2	28.9	28.1	13.5	13.3	13.1	12.9
1964	31.4	30.6	30.6	30.4	14.5	14.1	14.1	13.8
1965	30.9	31.3	31.3	30.7	14.7	15.0	15.0	14.6
1966	29.9	31.4	31.5	30.2	16.0	16.6	16.6	15.8
1967	30.8	33.6	33.3	32.0	15.7	17.8	18.2	17.0
1968	32.7	35.5	35.5	33.8	17.0	18.4	18.8	17.7
1969	33.7	36.8	36.6	34.5	17.1	19.0	18.8	18.0
1970	33.9	37.8	37.5	34.6	18.0	20.0	19.8	17.7
1971	36.0	40.2	40.0	36.7	18.6	21.3	21.8	19.1
1972	37.8	42.5	42.6	38.6	20.4	23.5	23.3	21.5
1973	39.9	45.2	44.9	40.9	22.0	24.2	24.3	23.1
1974	42.3	47.7	47.3	42.5	22.4	25.7	25.5	21.7
1975	44.8	51.0	50.2	43.7	24.0	27.2	27.0	23.1

Table 21. Estimated retail margins at Chicago in cents per pound, under alternative margin strategies, 1955-1975

		Beef				Pork			
Year	Half year	Historical structure	Variable margin	Semi-variable margin	Fixed margin	Historical structure	Variable margin	Semi-variable margin	Fixed margin
					(cents)				
1955	2	13.9	13.8	14.7	15.2	14.6	14.0	14.8	15.2
1956	1	13.5	13.2	14.5	15.7	13.3	13.3	14.5	15.7
	2	11.4	14.4	15.3	15.7	14.3	15.5	15.8	15.7
1957	1	14.8	14.5	15.2	16.1	14.5	16.1	16.1	16.1
	2	13.6	14.7	15.4	16.1	15.6	16.9	16.6	16.1
1958	1	16.9	17.3	17.1	16.2	14.6	18.5	17.6	16.2
	2	15.8	17.2	17.0	16.2	16.4	17.0	16.7	16.2
1959	1	14.0	17.3	16.8	16.5	17.2	16.8	16.4	16.5
	2	16.3	17.5	16.8	16.5	17.4	15.9	15.8	16.5
1960	1	14.4	16.8	16.3	16.7	14.5	15.5	15.4	16.7
	2	17.5	17.5	16.7	16.7	15.7	17.9	16.8	16.7
1961	1	17.5	16.8	16.3	16.8	16.8	16.7	16.2	16.8
	2	17.4	16.5	16.2	16.8	16.8	17.4	16.8	16.8
1962	1	15.5	16.0	16.2	17.1	16.5	15.0	15.6	17.1
	2	14.9	16.6	16.6	17.1	16.9	15.6	15.9	17.1
1963	1	16.6	15.6	16.0	17.3	17.5	13.8	14.9	17.3
	2	18.0	16.0	16.2	17.3	17.2	15.4	15.7	17.3
1964	1	18.8	17.0	16.5	17.5	18.2	14.7	15.3	17.5
	2	20.1	16.2	16.1	20.8	18.4	16.1	16.0	20.8
1965	1	22.7	17.2	16.7	21.0	18.6	16.1	16.2	21.0
	2	25.4	18.3	17.3	21.0	18.9	17.5	16.9	21.0
1966	1	25.5	20.0	18.3	21.2	19.1	17.7	17.1	21.2
	2	25.6	19.5	18.0	21.2	19.4	17.4	16.8	21.2
1967	1	25.8	18.2	17.2	21.5	19.6	16.4	16.1	21.5
	2	25.9	17.5	16.8	21.5	19.8	15.5	15.6	21.5
1968	1	26.0	16.5	15.9	21.7	20.0	15.1	15.2	21.7
	2	24.2	16.5	16.0	21.7	20.3	15.1	15.3	21.7
1969	1	23.8	17.4	16.7	21.9	20.5	15.9	15.9	21.9
	2	21.5	17.6	17.0	21.9	20.8	16.1	16.2	21.9
1970	1	24.3	19.1	18.1	22.2	21.0	17.3	17.1	22.2
	2	24.3	18.9	18.0	22.2	21.2	16.8	16.7	22.2
1971	1	26.9	19.1	17.9	22.4	21.5	17.6	17.0	22.4
	2	24.5	18.8	17.6	22.4	21.8	16.7	16.3	22.4
1972	1	22.2	17.9	16.8	22.6	22.0	16.9	16.3	22.6
	2	19.8	17.6	16.7	22.6	22.2	15.7	15.6	22.6
1973	1	22.5	17.6	16.6	22.8	22.5	16.7	16.1	22.8
	2	20.1	17.3	16.7	22.8	22.7	15.7	15.8	22.8
1974	1	20.2	18.0	17.3	23.1	23.0	17.3	16.7	23.1
	2	17.9	18.0	17.2	23.1	23.2	16.2	16.2	22.1
1975	1	20.5	18.5	17.6	23.5	23.4	17.9	17.2	23.5

Table 22. Summary of estimated average semi-annual price and output variables prese

Variable	Unit	1955-64 Historical structure	Variable margin	Semi-variabl margin
Commercial cattle slaughter	bil. lbs. (lv. wt.)	12.7	12.6	12.5
Commercial hog slaughter	do.	9.2	9.2	9.2
Iowa commercial cattle slaughter	do.	1.3	1.2	1.2
Iowa commercial hog slaughter	do.	1.7	1.7	1.7
Sows farrowing	mil. hd.	6.4	6.4	6.4
Per capita beef consumption	lbs.	42.0	41.8	41.6
Per capita pork consumption	do.	30.0	29.9	29.9
Wholesale beef price	cents/lb.	42.1	42.3	42.5
Wholesale pork price	do.	41.5	41.8	41.8
Choice grade steer price	do.	25.4	25.5	25.7
U.S. No. 1-3 hog price	do.	16.6	16.8	16.8
Feeder calf price	do.	26.5	26.6	27.1
Beef retailing margin	do.	15.6	15.9	16.1
Pork retailing margin	do.	16.0	15.9	15.9

ples presented under alternative margin strategies, United States, 1955-1975

-64		1964-75			
Semi-variable margin	Fixed margin	Historical structure	Variable margin	Semi-variable margin	Fixed margin
12.5	12.4	15.4	16.7	16.8	15.8
9.2	9.2	10.9	11.1	11.2	10.7
1.2	1.2	2.2	2.4	2.5	2.2
1.7	1.7	2.2	2.3	2.3	2.2
6.4	6.4	6.4	6.7	6.8	6.3
41.6	41.3	46.9	50.0	50.1	47.3
29.9	29.8	30.2	30.9	31.0	30.0
42.5	42.5	47.2	47.5	47.9	47.0
41.8	41.7	43.2	43.5	43.6	43.3
25.7	25.7	28.1	28.2	28.6	28.0
16.8	16.8	16.2	16.3	16.3	16.2
27.1	27.4	30.4	30.3	31.1	29.8
16.1	16.4	23.2	18.0	17.1	22.0
15.9	16.4	20.9	16.5	16.3	22.0

and 2.7 cents. The lower mean value in the case of the semi-variable margin is attributed to the lack of a changing price level in the estimation of the constant portion of the margin. Mean values for the pork retail margin under the historical structure, and the variable, semi-variable, and fixed-margin strategies were 20.9 cents, 16.5 cents, 16.5 cents, and 22.0 cents. The price ranges were 5 cents, 2.8 cents, 2 cents, and 2.7 cents for the same structural ordering.

Results of Alternative Trade and Consumption Strategies

The results of simulations of both the historical and projection periods under limits on net imports of beef and under a policy of consumption control structure are presented in this section. The simulation values of the two types of trade limitation may be compared with each other as well as with those of the historical base structure. The consumption-control simulation should be compared only with the historical base.

Foreign trade limitations of beef

The limitation of four-percent of domestic beef production on net foreign trade in beef became operative in the fall of 1958 in the historical simulation. Both the four-percent restriction and the restriction of imports to the 1958-62 average became operative immediately in the projections and remained operative throughout that period. In the historical period, the four-percent limitation reduced net foreign trade in beef from a total of 7.6-billion pounds to 4.4-billion pounds, a 42-percent decrease. During the 1964 to 1975 period, net foreign trade in beef under the four-percent limit totaled only 8.4-billion pounds, 60-percent less than the 21.1-billion-pound net import under the historical structure. The 1958 to 1962 average import level of just under one million pounds annually allowed 10.7-billion pounds of net beef imports, 50-percent of that under no controls.

Total commercial cattle slaughter during the historical period was only slightly higher under the four-percent limitation, but was five-percent above the historical structure in the projection period. Commercial cattle slaughter under the absolute limit was seven-percent above the base projection in the 1962 to 1975 period. Cattle slaughter in Iowa during the projection period increased from an 11-year total of 48-billion pounds under the base structure to 50.4-billion pounds under the absolute level of imports controls, and to 51.8-billion pounds under the four-percent limit. In terms of market share, Iowa slaughter increased from 11.8 percent of the nation's total in 1965 to 15.5 percent of the national total regardless of the foreign trade limit. The foreign trade limit on beef imports did not have any appreciable effect on the total commercial slaughter of hogs.

Per capita beef consumption under the four-percent foreign trade restriction averaged 0.5 pounds less in the nine-year historical period than the average of the basic structural simulation. In the projection period, per capita beef consumption averaged 0.8 of a pound less under the variable limit and one pound less under the absolute limit. The range of per capita consumption was also one- to one-and-a-half-pounds higher under the foreign trade controls. Average per capita pork consumption was essentially the same under the beef input controls as under no controls; but the range in per capita pork consumption increased slightly under absolute controls during the projection period.

Wholesale beef prices averaged 90-cents per hundredweight higher under the four-percent control in the 1955 to 1964 period but average pork prices were the same under either system. However, the variable limit on beef imports, operative only in the last two-thirds of the period, increased the range in wholesale beef prices from 10.9 cents to 14.4 cents and the rangein wholesale pork prices from 15.4 cents to 17.6 cents.

Wholesale beef prices in the projection period averaged about one-cent per pound higher under either form of control with a two-cent wider range existing only in the case of the absolute limit. As in the historical period, pork prices were more variable under the beef import controls but averaged the same showing that import controls intensified the cyclical amplitude.

Live prices followed wholesale price patterns. Feeder-calf prices averaged one-cent per pound more in all import control simulations and exhibited a slightly wider range of one-cent per pound.

Total sow farrowings in the two periods were essentially the same under controls and no controls, but their range was up to 300,000 head greater under the control assumption.

January 1 inventories of beef cows were estimated to be 1.6-million-head higher in 1964 under the control structure while steer inventories were 0.9-million-head higher. In the 11-year projection period, beef-cow inventories increased 3.0-million head under variable controls and 1.9-million head under absolute controls, while steer numbers increased 2.1- and 1.2-million head, respectively under variable and absolute limitations.

In general, either the variable or absolute limit on net foreign trade in beef increased commercial cattle slaughter, lowered per capita consumption and raised price levels. However, variability in most of the series was increased by the trade controls.

Consumption control

The consumption control with guaranteed domestic prices would turn the United States into a substantial meat exporter, especially of pork. Throughout the past nine years, net exports would have totaled to 2.1-billion pounds of beef and 1.2-billion pounds of pork, instead of 7.6-billion pounds of net beef imports and 0.5-billion pounds of net pork imports. In the next eleven years, we could expect to have a total net import of beef of only 1.2-billion pounds compared with net imports of 21.1-billion pounds under our present market structure. Moreover, net pork imports of a modest 2.4-billion pounds over the next eleven years would change to net pork exports of 16.9-billion pounds. This would be slightly over ten percent of the expected commercial hog slaughter during the projection period.

Commercial cattle slaughter increased nine-billion pounds during the historical period under consumption controls while there was no change in total commercial hog slaughter. However, in the eleven years of the projection period, commercial cattle slaughter under consumption controls totaled 11-percent more than that under the base structure while commercial hog slaughter increased 13 percent under the same conditions. Iowa commercial cattle and hog slaughter increased proportionately under the consumption control programs but the market share remained about the same under the alternative structure.

Per capita consumption of beef and pork averaged about the same as under the existing structure during the 1955-64 period; however, there was no variation under the consumption control compared with a range of 8.7 pounds for beef and 4.7 pounds for pork. In the projection period, per capita beef consumption under controls averaged one pound over the base simulation (a 5.5-pound trend was allowed during the period) while per capita pork consumption averaged 30 pounds under both the base and control simulations.

In the nine-year historical period, wholesale beef prices averaged 42.1 cents per pound with a range of 10.9 cents. Under consumption controls the average beef price fell to 40.6 cents per pound but the range in the 1955 to 1964 period was reduced to 5.4 cents. Wholesale pork prices under consumption control during the historical period averaged slightly higher (42.9 cents versus 41.5 cents) with the range reduced from 15.4 cents to 6.1 cents per pound.

In the eleven-year projection to 1975, wholesale beef price averaged 48 cents per pound, one cent above the average price under the historical model. Variation was reduced from 15.4 cents to four cents per pound. The mean of projected pork prices under the consumption control was 45.8 cents with a variation of only 1.9 cents compared with a mean pork price under the base structure of 43.2 cents per pound with

Table 23. Estimated net foreign trade in beef and pork in millions of pounds, carcass weight, under alternative trade and consumption strategies, United States, 1955-1975

		Beef				Pork	
Year	Half year	Historical structure	4% limit	1958-62 limit	Consumption control	Historical structure	Consumption control
				(million pounds)			
1955	2	161	161	--	-138	-3	-363
1956	1	83	82	--	-42	-13	-275
	2	79	79	--	-234	-13	-143
1957	1	123	123	--	-159	10	15
	2	131	131	--	-411	14	4
1958	1	252	252	--	76	23	180
	2	371	269	--	-222	39	-29
1959	1	348	263	--	271	27	-55
	2	452	279	--	-26	33	-98
1960	1	393	281	--	400	23	-145
	2	450	294	--	91	29	253
1961	1	400	300	--	253	49	236
	2	699	312	--	-75	45	204
1962	1	659	302	--	45	56	3
	2	753	315	--	-278	46	44
1963	1	756	308	--	-373	56	-229
	2	761	327	--	-791	43	-246
1964	1	723	324	--	-502	56	-530
	2	658	345	488	-84	59	-54
1965	1	727	322	488	534	64	26
	2	743	330	488	514	67	-68
1966	1	725	295	488	1,380	81	-42
	2	875	320	488	897	92	-304
1967	1	829	310	488	578	96	-324
	2	955	338	488	231	101	-559
1968	1	902	362	488	485	96	-536
	2	954	383	488	152	93	-740
1969	1	923	382	488	421	93	-694
	2	944	400	488	47	102	-896
1970	1	941	370	488	257	109	-821
	2	994	393	488	-137	122	-1,031
1971	1	962	367	488	148	122	-931
	2	1,091	392	488	-248	133	-1,158
1972	1	1,065	403	488	-56	130	-1,030
	2	1,120	431	488	-482	139	-1,278
1973	1	1,091	437	488	-322	133	-1,122
	2	1,140	462	488	-778	142	-1,391
1974	1	1,124	452	488	-568	138	-1,203
	2	1,184	475	488	-1,066	153	-1,512
1975	1	1,174	465	488	-829	151	-1,295

Table 24. Estimated commercial slaughter of cattle and hogs in billions of pounds, liveweight, under alternative strategies, United States, 1955-1975

		Cattle				Hogs			
Year	Half year	Historical structure	4% FTR limit	1958-62 FTR limit	Cons. control	Historical structure	4% FTR limit	1958-62 FTR limit	Cons. control
					(billion pounds)				
1955	2	12.7	12.7	--	12.7	9.2	9.2	--	9.2
1956	1	12.6	12.6	--	12.5	9.2	9.2	--	9.2
	2	13.0	13.0	--	13.0	8.9	8.9	--	9.0
1957	1	12.5	12.5	--	12.9	8.5	8.5	--	8.7
	2	13.0	13.0	--	13.5	8.6	8.6	--	8.8
1958	1	11.1	11.5	--	12.6	8.1	8.0	--	8.6
	2	11.9	11.9	--	13.3	8.9	8.9	--	9.1
1969	1	11.6	11.6	--	12.4	9.0	9.0	--	9.2
	2	12.3	12.3	--	13.0	9.6	9.6	--	9.3
1960	1	12.3	12.4	--	12.2	9.9	10.0	--	9.5
	2	12.8	12.9	--	12.9	9.0	9.1	--	8.8
1961	1	12.8	13.2	--	12.6	9.0	9.1	--	8.9
	2	13.3	13.7	--	13.4	9.2	9.2	--	9.0
1962	1	12.7	13.2	--	13.1	9.6	9.6	--	9.4
	2	13.3	13.8	--	13.8	9.6	9.6	--	9.4
1963	1	13.1	13.3	--	14.1	10.0	10.0	--	10.0
	2	14.0	14.2	--	14.9	10.0	10.0	--	10.1
1964	1	13.2	14.0	--	14.4	10.2	10.6	--	10.7
	2	15.0	15.0	15.0	15.0	9.9	9.9	9.9	9.8
1965	1	13.8	13.8	13.8	13.9	9.9	9.9	9.9	9.8
	2	14.1	14.1	14.0	14.3	9.9	9.9	9.9	10.1
1966	1	12.3	12.3	12.2	12.8	9.7	9.7	9.6	10.2
	2	13.5	13.5	13.4	14.0	10.0	10.1	10.0	10.8
1967	1	12.3	12.9	12.2	14.7	9.9	10.0	9.9	10.9
	2	13.4	14.3	13.5	15.7	10.6	10.9	10.7	11.4
1968	1	14.0	15.4	14.9	15.3	10.5	10.8	10.7	11.5
	2	15.2	16.4	16.0	16.3	11.1	11.3	11.4	11.9
1969	1	14.9	16.3	16.3	15.9	10.8	10.9	11.0	12.0
	2	15.8	17.1	17.0	17.0	11.1	11.2	11.1	12.4
1970	1	14.5	15.5	15.2	16.7	10.5	10.6	10.4	12.4
	2	15.6	16.6	16.2	17.8	11.1	11.1	11.0	12.9
1971	1	14.5	15.3	14.7	17.4	10.6	10.5	10.4	12.8
	2	15.7	16.5	15.9	18.6	11.5	11.5	11.4	13.3
1972	1	16.2	16.9	16.1	18.3	11.0	10.9	10.9	13.2
	2	17.4	18.3	17.5	19.5	11.9	12.1	12.1	13.8
1973	1	17.1	18.5	18.4	19.4	11.3	11.5	11.5	13.6
	2	18.4	19.7	19.6	20.6	12.2	12.3	12.5	14.2
1974	1	17.9	19.1	19.1	20.4	11.5	11.5	11.7	14.0
	2	19.0	20.2	20.1	21.7	12.3	12.4	12.4	14.6
1975	1	18.4	19.7	19.3	21.4	11.5	11.5	11.5	14.3

Table 25. Estimated commercial cattle and hog slaughter in Iowa in billions of pounds, liveweight, under alternative trade and consumption strategies, 1955-1975

		Cattle[a]				Hogs			
Year	Half year	Historical structure	4% FTR limit	1958-62 FTR limit	Cons. control	Historical structure	4% FTR limit	1958-62 FTR limit	Cons. control
					(billion pounds)				
1955	2	1.69	1.69	--	1.69	1.65	1.65	--	1.65
1956	1					1.52	1.52	--	1.53
	2	2.08	2.08	--	2.07	1.57	1.57	--	1.60
1957	1					1.46	1.46	--	1.50
	2	2.19	2.19	--	2.56	1.55	1.55	--	1.60
1958	1					1.42	1.42	--	1.50
	2	2.21	2.20	--	2.65	1.70	1.70	--	1.70
1959	1					1.62	1.62	--	1.64
	2	2.52	2.54	--	2.70	1.86	1.86	--	1.78
1960	1					1.79	1.80	--	1.73
	2	2.74	2.81	--	2.85	1.71	1.73	--	1.67
1961	1					1.68	1.70	--	1.64
	2	2.94	3.09	--	3.13	1.79	1.80	--	1.75
1962	1					1.80	1.81	--	1.77
	2	2.97	3.15	--	3.27	1.90	1.89	--	1.87
1963	1					1.89	1.90	--	1.90
	2	3.44	3.61	--	3.84	1.95	1.97	--	2.02
1964	1					1.91	2.00	--	2.05
	2	3.06	3.06	3.06	3.06	1.95	1.95	1.95	1.95
1965	1					1.85	1.85	1.85	1.90
	2	3.30	3.32	3.28	3.55	1.96	1.96	1.95	2.05
1966	1					1.86	1.88	1.86	2.00
	2	3.81	3.79	3.84	4.05	2.02	2.06	2.04	2.22
1967	1					1.95	1.99	1.97	2.15
	2	3.55	4.17	3.63	4.37	2.19	2.25	2.23	2.38
1968	1					2.06	2.10	2.11	2.27
	2	4.17	4.54	4.67	4.44	2.30	2.33	2.35	2.52
1969	1					2.09	2.12	2.12	2.39
	2	4.25	4.85	4.78	5.01	2.30	2.31	2.29	2.65
1970	1					2.09	2.08	2.06	2.50
	2	4.52	4.82	4.44	5.32	2.34	2.33	2.30	2.78
1971	1					2.13	2.12	2.11	2.60
	2	4.52	4.84	4.67	5.68	2.45	2.45	2.44	2.90
1972	1					2.22	2.24	2.24	2.70
	2	5.41	5.99	5.68	6.08	2.56	2.60	2.60	3.02
1973	1					2.30	2.31	2.34	2.79
	2	5.78	6.30	6.30	6.55	2.64	2.65	2.69	3.14
1974	1					2.33	2.34	2.36	2.88
	2	5.74	6.16	6.05	6.95	2.68	2.69	2.70	3.25
1975	1					2.37	2.36	2.36	2.97

[a]Regional cattle slaughter is estimated on an annual basis.

Table 26. Estimated per capita consumption of beef and pork in pounds, carcass weight equivalent, under alternative strategies, United States, 1955-1975

		Beef				Hogs			
Year	Half year	Histor-ical struc-ture	4% FTR limit	1958-62 FTR limit	Cons. control	Histor-ical struc-ture	4% FTR limit	1958-62 FTR limit	Cons. control
		(pounds)							
1955	2	41.6	41.6	--	41.5	31.5	31.5	--	30.0
1956	1	41.5	41.5	--	41.5	31.0	31.0	--	30.0
	2	42.0	42.0	--	41.5	30.4	30.4	--	30.0
1957	1	41.3	41.3	--	41.5	28.6	28.6	--	30.0
	2	42.0	42.0	--	41.5	29.0	28.9	--	30.0
1958	1	37.5	37.5	--	41.5	26.8	26.8	--	30.0
	2	39.3	38.7	--	41.5	29.5	29.5	--	30.0
1959	1	39.0	38.6	--	41.5	29.0	29.0	--	30.0
	2	40.9	40.0	--	41.5	31.5	31.5	--	30.0
1960	1	40.8	40.4	--	41.5	31.2	31.3	--	30.0
	2	42.2	41.7	--	41.5	29.8	30.0	--	30.0
1961	1	42.0	42.4	--	41.5	28.6	28.8	--	30.0
	2	44.5	43.5	--	41.5	29.2	29.4	--	30.0
1962	1	43.0	42.3	--	41.5	29.6	29.7	--	30.0
	2	44.2	43.1	--	41.5	30.3	30.3	--	30.0
1963	1	44.3	42.4	--	41.5	30.7	30.7	--	30.0
	2	46.2	44.4	--	41.5	31.5	31.2	--	30.0
1964	1	44.5	44.3	--	41.5	31.0	32.0	--	30.0
	2	48.0	46.3	47.0	45.0	30.7	30.6	30.6	30.0
1965	1	45.2	43.2	43.9	45.5	29.8	29.8	29.8	30.0
	2	44.9	42.8	43.5	45.5	29.7	29.7	29.7	30.0
1966	1	40.7	38.6	39.3	46.0	28.6	28.6	28.5	30.0
	2	43.0	40.3	40.9	46.0	29.6	29.8	29.6	30.0
1967	1	40.9	39.8	39.0	46.5	28.7	29.2	28.9	30.0
	2	43.1	42.2	40.9	46.5	30.9	31.5	31.3	30.0
1968	1	44.8	45.4	44.6	47.0	29.9	30.6	30.4	30.0
	2	47.2	47.6	47.2	47.0	31.8	32.2	32.4	30.0
1969	1	46.7	47.2	47.6	47.5	30.0	30.5	30.7	30.0
	2	48.0	48.5	48.9	47.5	31.2	31.5	31.3	30.0
1970	1	45.3	45.1	45.0	48.0	29.1	29.2	28.9	30.0
	2	46.9	46.3	45.7	48.0	30.8	30.7	30.4	30.0
1971	1	44.9	43.8	43.0	48.5	28.8	28.6	28.3	30.0
	2	47.0	45.4	44.5	48.5	31.3	31.1	31.0	30.0
1972	1	48.2	46.8	45.5	49.0	29.2	29.2	29.1	30.0
	2	50.4	49.4	47.8	49.0	31.8	32.1	32.1	30.0
1973	1	49.9	50.0	49.8	49.5	29.6	29.9	30.0	30.0
	2	51.9	52.0	51.9	49.5	32.1	32.2	32.6	30.0
1974	1	51.1	50.9	50.9	50.0	29.5	29.6	30.0	30.0
	2	52.9	52.4	52.2	50.0	31.9	32.0	32.1	30.0
1975	1	51.8	51.5	50.8	50.5	29.2	29.2	29.2	30.0

Table 27. Estimated wholesale price of beef and pork in cents per pound under alternative trade and consumption strategies, Chicago, 1955-1975

		Beef (Choice grade)				Pork			
Year	Half year	Histor-ical struc-ture	4% FTR limit	1958-62 FTR limit	Cons. control	Histor-ical struc-ture	4% FTR limit	1958-62 FTR limit	Cons. control
					(cents)				
1955	2	36.0	36.0	--	39.4	36.5	36.5	--	38.7
1956	1	34.5	34.5	--	41.0	34.9	34.9	--	40.2
	2	41.5	41.5	--	40.3	42.9	42.9	--	40.6
1957	1	37.2	37.2	--	41.7	43.1	43.1	--	42.3
	2	40.8	40.8	--	40.9	45.5	45.5	--	42.3
1958	1	46.9	46.9	--	42.6	50.3	50.3	--	42.6
	2	44.6	45.8	--	41.9	43.5	44.0	--	42.5
1959	1	46.5	47.4	--	43.3	44.5	44.9	--	43.1
	2	43.7	45.5	--	43.2	38.7	39.3	--	42.9
1960	1	44.2	45.0	--	43.8	39.4	39.4	--	43.2
	2	43.4	44.5	--	43.8	46.2	46.1	--	43.8
1961	1	42.5	40.5	--	44.3	42.8	41.3	--	44.3
	2	41.5	43.4	--	44.0	45.8	46.0	--	44.3
1962	1	43.8	45.1	--	44.8	40.0	40.3	--	44.8
	2	46.7	48.9	--	43.9	42.4	43.3	--	44.8
1963	1	41.4	45.3	--	44.2	35.4	37.0	--	44.4
	2	41.3	45.0	--	42.9	39.2	40.4	--	44.4
1964	1	41.4	41.3	--	44.4	35.6	32.7	--	43.8
	2	37.7	38.3	36.6	45.7	39.0	39.2	38.6	45.7
1965	1	39.0	40.3	38.7	46.4	38.7	39.2	38.5	46.5
	2	40.6	44.9	43.4	46.4	43.2	45.0	44.6	46.9
1966	1	48.0	52.3	50.8	47.0	46.2	47.8	47.6	46.8
	2	46.6	52.0	50.8	47.0	46.2	47.7	47.8	45.7
1967	1	49.6	51.5	53.1	47.5	46.5	46.0	47.5	46.0
	2	47.6	49.1	52.0	47.5	42.7	41.4	43.3	45.2
1968	1	42.0	44.4	43.0	48.0	40.0	38.7	38.7	45.8
	2	43.0	45.0	42.7	48.0	38.2	37.6	36.3	45.0
1969	1	44.0	42.7	43.7	48.5	40.4	38.5	38.2	45.7
	2	47.5	46.3	45.6	48.5	41.8	40.7	40.9	45.0
1970	1	49.2	49.4	47.0	49.0	45.7	45.4	45.2	45.7
	2	49.0	50.2	51.7	48.6	43.9	44.8	46.2	45.0
1971	1	49.4	51.7	53.5	49.5	46.8	48.3	50.0	45.8
	2	50.7	54.0	53.0	48.8	44.0	45.7	45.7	45.1
1972	1	50.4	49.1	53.0	49.8	46.1	45.7	47.4	46.0
	2	51.1	50.2	53.5	48.8	41.9	40.8	41.9	45.3
1973	1	47.7	50.2	47.7	49.7	43.9	44.1	42.6	46.2
	2	50.0	48.7	48.8	48.6	40.8	39.9	38.8	45.4
1974	1	50.2	50.6	50.4	49.6	45.4	45.2	44.0	46.4
	2	53.1	51.1	50.4	48.6	42.8	41.8	41.1	45.5
1975	1	52.1	51.7	54.0	49.7	47.3	47.2	47.9	46.8

Table 28. Estimated cattle and hog price at Chicago in cents per pound under alternative trade and consumption strategies, 1955-1975

		Choice grade steers				U.S. No. 1-3 hogs			
Year	Half year	Histor-ical struc-ture	4% FTR limit	1958-62 FTR limit	Cons. control	Histor-ical struc-ture	4% FTR limit	1958-62 FTR limit	Cons. control
					(cents)				
1955	2	21.5	21.5	--	23.8	14.4	14.4	--	15.7
1956	1	20.4	20.4	--	24.9	13.3	13.3	--	16.4
	2	25.2	25.2	--	24.4	17.9	17.9	--	16.6
1957	1	22.2	22.2	--	25.3	17.9	17.9	--	17.5
	2	24.7	24.7	--	24.7	19.3	19.3	--	17.5
1958	1	28.8	28.8	--	25.9	22.0	22.0	--	17.6
	2	27.2	28.0	--	25.4	18.1	18.3	--	17.5
1959	1	28.5	29.1	--	26.3	18.5	18.7	--	17.7
	2	26.5	27.8	--	26.2	15.2	15.5	--	17.6
1960	1	26.8	27.4	--	26.5	15.4	15.4	--	17.5
	2	26.3	27.0	--	26.5	19.3	19.2	--	17.9
1961	1	25.5	24.1	--	26.7	17.2	16.3	--	18.0
	2	24.8	26.1	--	26.6	18.9	19.0	--	18.0
1962	1	26.3	27.2	--	27.0	15.4	15.5	--	18.2
	2	28.3	29.9	--	26.4	16.7	17.3	--	18.2
1963	1	24.6	27.3	--	26.5	12.6	13.5	--	17.8
	2	24.6	27.0	--	25.6	14.8	15.4	--	17.7
1964	1	24.5	24.5	--	26.6	12.6	10.9	--	17.3
	2	22.0	22.3	21.2	27.5	14.5	14.6	14.2	18.3
1965	1	22.8	23.7	22.6	27.9	14.1	14.5	14.1	18.6
	2	23.9	26.8	25.9	27.9	16.8	17.8	17.6	18.9
1966	1	28.9	31.9	30.9	28.2	18.3	19.3	19.2	18.7
	2	28.0	31.7	30.9	28.2	18.3	19.2	19.2	18.0
1967	1	29.9	31.3	32.4	28.5	18.3	18.1	18.9	18.1
	2	28.6	29.6	31.6	28.5	16.2	15.4	16.5	17.6
1968	1	24.6	26.3	25.4	28.8	14.5	13.8	13.8	17.8
	2	25.3	26.7	25.1	28.8	13.5	13.1	12.4	17.4
1969	1	26.0	25.1	25.7	29.0	14.6	13.5	13.3	17.6
	2	28.4	27.6	27.1	29.0	15.4	14.8	14.9	17.2
1970	1	29.5	29.6	27.9	29.3	17.5	17.3	17.2	17.5
	2	29.4	30.1	31.2	29.1	16.5	17.0	17.8	17.1
1971	1	29.5	31.1	32.3	29.6	18.0	18.9	19.8	17.4
	2	30.4	32.7	32.0	29.1	16.4	17.4	17.4	17.0
1972	1	30.1	29.3	31.9	29.8	17.5	17.2	18.2	17.4
	2	30.6	30.0	32.3	29.0	15.0	14.4	15.0	17.0
1973	1	28.2	30.0	28.2	29.6	16.0	16.1	15.3	17.4
	2	29.8	28.9	28.9	28.9	14.3	13.7	13.0	16.9
1974	1	29.9	30.2	30.0	29.5	16.8	16.6	15.9	17.4
	2	31.9	30.5	30.0	28.7	15.2	14.7	14.3	16.8
1975	1	31.1	30.8	32.5	29.5	17.8	17.6	18.0	17.4

Table 29. Estimated price of good and choice feeder cattle at Kansas City, in cents per pound, under alternative trade and consumption strategies, 1955-1975

Year	Half year	Historical structure	4% FTR limit	1958-62 FTR limit	Consumption control
			(cents)		
1955	2	19.6	19.6	-	24.6
1956	1	18.7	18.7	-	23.6
	2	20.4	20.4	-	23.0
1957	1	22.3	22.3	-	23.2
	2	25.9	25.9	-	27.0
1958	1	30.6	30.6	-	30.6
	2	33.8	34.8	-	28.7
1959	1	33.4	34.4	-	29.4
	2	29.0	31.2	-	26.9
1960	1	29.4	31.2	-	26.8
	2	26.0	27.1	-	27.4
1961	1	27.5	28.2	-	28.1
	2	25.7	24.9	-	28.9
1962	1	26.5	25.4	-	29.6
	2	30.9	33.3	-	29.0
1963	1	31.3	33.6	-	28.4
	2	23.7	28.5	-	26.5
1964	1	22.7	26.6	-	25.0
	2	19.4	20.0	17.7	25.4
1965	1	19.3	19.8	17.7	25.2
	2	23.7	28.1	26.0	32.9
1966	1	23.2	27.4	25.8	29.8
	2	34.4	41.4	40.2	32.4
1967	1	36.8	44.8	42.1	33.1
	2	34.9	32.0	39.9	31.6
1968	1	38.3	33.0	42.3	32.4
	2	24.3	28.1	22.7	31.1
1969	1	21.6	23.8	18.2	29.1
	2	26.8	26.7	23.7	31.9
1970	1	26.9	27.1	26.9	30.5
	2	35.9	36.4	38.0	33.2
1971	1	36.9	37.8	38.4	32.4
	2	35.7	39.8	39.9	33.0
1972	1	37.5	39.7	40.7	30.4
	2	33.4	33.2	36.4	32.5
1973	1	31.4	31.0	33.6	29.2
	2	30.6	30.2	31.8	32.7
1974	1	27.4	27.2	28.7	29.7
	2	36.5	35.0	33.6	32.8
1975	1	34.5	32.0	31.3	29.6

Table 30. Estimated number of sows farrowing, in millions of head, under alternative trade and consumption strategies, United States, 1955-1975

Year	Half year	Historical structure	4% FTR limit	1958-62 FTR limit	Consumption control
			(million head)		
1955	2	5.5	5.5	-	5.6
1956	1	7.6	7.6	-	7.8
	2	5.3	5.3	-	5.4
1957	1	7.1	7.1	-	7.4
	2	5.0	5.0	-	5.3
1958	1	7.4	7.4	-	7.5
	2	5.6	5.6	-	5.7
1959	1	7.9	7.9	-	7.5
	2	6.2	6.2	-	6.0
1960	1	6.8	6.9	-	6.6
	2	5.7	5.7	-	5.5
1961	1	6.8	6.9	-	6.6
	2	6.0	6.0	-	5.9
1962	1	7.0	7.0	-	6.9
	2	6.2	6.2	-	6.2
1963	1	7.0	7.1	-	7.3
	2	6.2	6.5	-	6.6
1964	1	6.6	6.8	-	7.6
	2	5.9	5.9	5.8	6.0
1965	1	6.3	6.3	6.3	6.7
	2	5.7	5.8	5.7	6.2
1966	1	6.2	6.4	6.3	7.2
	2	5.9	6.1	6.0	6.6
1967	1	6.7	7.0	6.9	7.7
	2	6.2	6.4	6.4	7.0
1968	1	7.0	7.2	7.3	8.1
	2	6.3	6.4	6.4	7.3
1969	1	6.6	6.7	6.6	8.4
	2	6.1	6.1	6.0	7.6
1970	1	6.4	6.3	6.2	8.7
	2	6.2	6.1	6.0	7.8
1971	1	6.6	6.6	6.5	9.0
	2	6.4	6.4	6.4	8.1
1972	1	6.8	7.0	7.0	9.2
	2	6.5	6.6	6.7	8.3
1973	1	6.9	7.0	7.2	9.5
	2	6.5	6.6	6.6	8.5
1974	1	6.7	6.7	6.8	9.7
	2	6.5	6.5	6.5	8.7
1975	1	6.8	6.7	6.7	9.9

Table 31. Estimated January 1 inventories of beef cows and steers and bulls, in millions of head, under alternative trade and consumption strategies, United States, 1955-1975

	Beef cows				Steers and bulls			
Year	Histor-ical struc-ture	4% FTR limit	1958-62 FTR limit	Cons. control	Histor-ical struc-ture	4% FTR limit	1958-62 FTR limit	Cons. control
				(million head)				
1956	25.2	25.2	-	25.5	11.2	11.2	-	11.1
1957	24.5	24.5	-	25.5	10.7	10.7	-	11.6
1958	24.2	24.2	-	25.8	10.8	10.8	-	11.7
1959	25.2	25.3	-	27.0	11.6	11.6	-	12.2
1960	26.1	26.5	-	27.4	12.2	12.4	-	12.9
1961	27.0	27.7	-	28.4	12.6	12.9	-	13.5
1962	28.1	28.9	-	30.0	12.8	13.2	-	13.9
1963	29.5	30.5	-	32.0	13.5	14.1	-	14.8
1964	31.4	33.0	-	34.2	14.5	15.4	-	16.0
1965	30.9	31.0	30.7	31.6	14.7	14.7	14.6	15.1
1966	29.9	30.5	29.8	31.9	16.0	15.9	15.9	16.8
1967	30.8	32.3	31.5	33.7	15.7	17.1	16.0	17.5
1968	32.7	34.2	33.1	35.7	17.0	17.9	17.9	18.1
1969	33.7	35.0	34.8	37.3	17.1	18.5	18.3	19.6
1970	33.9	36.0	34.6	39.3	18.0	19.1	18.0	20.9
1971	36.0	38.0	36.8	41.8	18.6	19.7	18.9	22.0
1972	37.8	40.0	38.7	44.5	20.4	22.3	21.3	23.8
1973	39.9	42.7	41.1	47.0	22.0	23.9	23.2	25.7
1974	42.3	45.2	44.4	49.9	22.4	24.2	23.5	27.5
1975	44.8	47.8	46.7	53.0	24.0	26.1	25.2	29.5

Table 32. Summary of estimated average semi-annual price and output variables pr(
States, 1955-1975

Variable	Unit	1955-64 Historical structure	1955-64 4% FTR limit
Commercial cattle slaughter	bil. lbs. (lv. wt.)	12.7	12.9
Commercial hog slaughter	do.	9.2	9.3
Iowa commercial cattle slaughter	do.	1.3	1.3
Iowa commercial hog slaughter	do.	1.7	1.7
Sows farrowing	mil. hd.	6.4	6.4
Net foreign trade in beef	mil. lbs. (carcass wt.)	0.4	0.2
Net foreign trade in pork	do.	0.03	---
Wholesale beef price	cents/lb.	42.1	43.0
Wholesale pork price	do.	41.5	41.5
Choice grade steer price	do.	25.4	25.8
U.S. No. 1-3 hog price	do.	16.6	16.6
Feeder calf price	do.	26.5	27.5
Per capita beef consumption	lbs.	42.0	41.5
Per capita pork consumption	do.	30.0	30.0

iables presented under alternative trade and consumption strategies, United

1955-64		1964-75			
4% FTR limit	Consumption control	Historical structure	4% FTR limit	1958-62 FTR limit	Consumption control
12.9	13.2	15.4	16.3	16.6	17.1
9.3	9.3	10.9	10.9	10.9	12.3
1.3	1.4	2.2	2.4	2.3	2.5
1.7	1.7	2.2	2.2	2.2	2.5
6.4	6.5	6.4	6.5	6.4	8.0
0.2	-0.1	1.0	0.4	0.5	0.05
---	-0.06	0.1	---	---	-0.8
43.0	40.6	47.2	48.3	48.2	48.2
41.5	42.9	43.2	43.2	43.3	45.8
25.8	25.9	28.1	28.9	28.9	28.4
16.6	17.5	16.2	16.1	16.2	17.6
27.5	27.0	30.4	31.5	31.6	31.4
41.5	41.5	46.9	46.1	45.9	47.8
30.0	30.0	30.2	30.3	30.3	30.0

a variation of 9.1 cents.

Live-cattle and hog prices followed wholesale prices. In the projection period, the variation in Choice grade steer price was cut from 9.9 cents to 2.3 cents per pound while the variation in hog price was cut from 4.8 to 2.1 cents per pound.

Feeder-calf prices averaged 50-cents to one-dollar per hundredweight higher under the consumption-control assumptions than under the historical structure. The feeder price was somewhat more variable than wholesale or slaughter price; nevertheless, variation in feeder-calf prices was cut from 19 cents per pound in the 1975 projection period to eight cents per pound.

The total number of sows farrowing in the 1964 to 1975 period increased 25 percent under the consumption control assumption. In the historical period, beef-cow and steer numbers on January 1 increased nine and 11 percent, respectively, over January 1, 1964 levels of the existing structural estimates. In addition, there was no cyclical downturn during the period. Similarly, beef-cow inventories rose to 53-million head in 1975, 18 percent above the estimate under the historical structure. Steer inventories also increased to 20.5-million head in 1975, 23 percent above the estimate under the base simulation.

Results of Alternative Producer and Processor Strategies

The two strategies of producer withholding action and contracting with the packer for 33 percent of the livestock could be accomplished under existing legislation. The widening of the packer margin would require some modification of anti-trust laws of the Packer and Stockyards Act. (The 1964 to 1975 projections were not made for the producer and processor strategies.)

Producer withholding action

The initial situation, including the immediate short-run effects, was outlined in the previous chapter. The long-run effects, given the initial short-run effect on wholesale and live price, were traced from July 1, 1955 to June 30, 1964.

Total commercial slaughter of both cattle and hogs was about the same as that of the historical period. However, the time path is quite different. Commercial cattle slaughter was 1.2-billion pounds lower as a result of the holding action in 1957 but exceeded 1958 to 1959 slaughter by 1.4-billion pounds. Thus commercial cattle slaughter during the 1955 to 1960 period was held at about the same level, except for seasonal variation. Cattle slaughter then increased sharply in the early 1960's exceeding the slaughter of 1963 and early 1964 that was predicted in the historical simulation.

Commercial hog slaughter maintained the same cycle, but the amplitude was somewhat accentuated. This increased cyclical amplitude was particularly evident in the 1960's.

The commentary of the previous two paragraphs could be extended to include per capita consumption and wholesale beef and pork prices. Per capita consumption of both beef and pork increased substantially during the last year and a half of the simulation period with a resulting drop in wholesale prices. Live-animal prices followed wholesale prices closely.

The amplitude of feeder-calf price was increased considerably by the withholding action. Feeder prices fell sharply in 1959, showed a substantial recovery in 1961 and 1962, and fell again in 1963. The range in feeder prices increased from 15 cents to 19 cents in the nine-year period.

The time path of the January 1 cattle inventories was altered considerably. Cow inventories increased sharply in 1959 but remained almost stationary in 1960 and 1961. The increase during the next three years was much more rapid as they reached the 1964 level of the existing structure. Steer inventories on January 1 were equal or greater than those predicted for the existing structure, throughout the nine-year period.

The general effect on the time paths of the output and price variables in the long run was a leveling out of inventory and slaughter until 1960, followed by a sharp rise. Prices in general showed more cyclical amplitude as a result of the holding action.

Packer margin increase

The 25-cent increase in the packer margin showed practically no change over the entire system in the first two or three years of its operation, with the exception of slightly lower live-animal prices. The increase in packer margins restricted inventories and the resulting slaughter and per capita consumption enough to raise wholesale prices slightly during the last few years of the simulation. Neither the period nor the amplitude of the price or output cycles were affected appreciably.

Producer contracts

The simulation of producer contracts over the nine-year period on one-third of the stock at an average of one dollar above the central market price resulted in time paths that were nearly the mirror image of the increase in the packer margin. In this case live prices were slightly higher during the first three years, equal, and finally slightly lower than prices under the existing structure. After three years, livestock inventories began to increase gradually, slaughter increased slightly, per capita consumption increased slightly, and as a result, prices were slightly lower at the end of the period.

The effects of this group of structural changes on net foreign trade were not presented in the accompanying tables. Net foreign trade was not affected by the latter two alternative structural changes. Net beef imports under the conditions imposed by the holding action increased moderately in 1958 and fell below existing levels in the last two years of the simulation.

Table 33. Estimated commercial cattle and hog slaughter in billions of pounds, liveweight, under alternative producer and processor market strategies, United States, 1955-1964

		Cattle				Hogs			
Year	Half year	Historical structure	Holding action	Packer margin	Producer contract	Historical structure	Holding action	Packer margin	Producer contract
		(billion pounds)							
1955	2	12.7	12.7	12.7	12.7	9.2	9.3	9.2	9.2
1956	1	12.6	12.5	12.5	12.6	9.2	9.0	9.2	9.2
	2	13.0	13.0	13.0	13.0	8.9	8.6	8.9	8.9
1957	1	12.5	11.8	12.5	12.6	8.5	8.0	8.4	8.5
	2	13.0	12.5	13.0	13.0	8.6	8.4	8.5	8.7
1958	1	11.1	11.6	11.0	11.3	8.1	8.0	8.0	8.1
	2	11.9	12.4	11.8	12.1	8.9	9.2	8.9	9.0
1959	1	11.6	12.4	11.5	11.7	9.0	9.3	9.0	9.1
	2	12.3	13.0	12.2	12.4	9.6	9.7	9.6	9.7
1960	1	12.3	12.2	12.3	12.3	9.9	9.9	9.9	10.0
	2	12.8	12.8	12.8	12.9	9.0	8.8	9.0	9.0
1961	1	12.8	11.9	12.8	12.8	9.0	8.7	9.0	9.0
	2	13.3	12.6	13.3	13.4	9.2	9.0	9.1	9.2
1962	1	12.7	12.5	12.6	12.8	9.6	9.6	9.5	9.6
	2	13.3	13.2	13.2	13.5	9.6	9.9	9.6	9.7
1963	1	13.1	14.1	13.0	13.2	10.0	10.4	10.1	10.1
	2	14.0	14.9	13.9	14.1	10.0	10.2	10.0	10.0
1964	1	13.2	14.0	13.3	13.4	10.2	10.6	10.3	10.3

Table 34. Estimated per capita consumption of beef and pork in pounds, carcass weight equivalent, under alternative producer and processor market strategies, United States, 1955-1964

		Beef				Pork			
Year	Half year	Historical structure	Holding action	Packer margin	Producer contract	Historical structure	Holding action	Packer margin	Producer contract
		(pounds)							
1955	2	41.6	40.7	41.6	41.6	31.5	31.6	31.5	31.5
1956	1	41.5	41.4	41.5	41.5	31.0	30.6	31.0	31.0
	2	42.0	41.8	42.0	42.0	30.4	29.4	30.4	30.5
1957	1	41.3	39.2	41.2	41.4	28.6	27.4	28.6	28.8
	2	42.0	41.0	41.9	42.1	29.0	28.3	28.8	29.1
1958	1	37.5	38.9	37.1	37.8	26.8	26.6	26.6	27.1
	2	39.3	40.7	39.0	39.7	29.5	30.1	29.3	29.7
1959	1	39.0	41.0	38.8	39.3	29.0	29.8	28.9	29.3
	2	40.9	42.8	40.7	41.1	31.5	31.8	31.4	31.6
1960	1	40.8	40.7	40.9	40.9	31.2	31.2	31.2	31.3
	2	42.2	41.7	42.2	42.3	29.8	29.1	29.8	29.8
1961	1	42.0	39.5	42.0	42.0	28.6	27.7	28.5	28.7
	2	44.5	42.4	44.5	44.6	29.2	28.8	29.1	29.3
1962	1	43.0	42.4	42.7	43.3	29.6	29.6	29.4	29.8
	2	44.2	44.4	43.9	44.6	30.3	31.1	30.1	30.5
1963	1	44.3	46.9	43.9	44.5	30.7	31.7	30.5	30.9
	2	46.2	48.2	45.8	46.4	31.5	31.8	31.1	31.2
1964	1	44.5	46.4	44.6	44.7	31.0	32.0	31.0	31.1

Table 35. Estimated wholesale beef and pork price in cents per pound under alternative producer, processor market strategies, Chicago, 1955-1964

		Beef (Choice grade)				Pork			
Year	Half year	Historical structure	Holding action	Packer margin	Producer contract	Historical structure	Holding action	Packer margin	Producer contract
		(cents)							
1955	2	36.0	37.9	36.0	36.0	36.5	37.0	36.5	36.5
1956	1	34.5	34.8	34.6	34.5	34.9	36.3	34.8	34.8
	2	41.5	42.3	41.6	41.4	42.9	46.5	43.0	42.8
1957	1	37.2	42.2	37.4	37.0	43.1	49.0	43.4	42.7
	2	40.8	43.0	41.1	40.5	45.5	48.2	46.0	44.7
1958	1	46.9	44.0	47.7	45.9	50.3	49.7	51.1	49.0
	2	44.6	41.3	45.3	43.7	43.5	40.2	44.2	42.4
1959	1	46.5	42.0	47.0	45.7	44.5	40.2	45.1	43.4
	2	43.7	39.7	44.0	43.2	38.7	36.1	39.0	38.2
1960	1	44.2	45.4	44.1	44.0	39.4	40.0	39.5	39.0
	2	43.4	45.0	43.3	43.2	46.2	49.0	46.2	46.0
1961	1	42.5	47.9	42.5	41.4	42.8	47.6	43.0	42.0
	2	41.5	46.0	41.7	41.3	45.8	49.0	46.2	45.3
1962	1	43.8	44.9	45.5	42.9	40.0	40.5	41.2	39.1
	2	46.7	44.8	47.4	45.7	42.4	39.3	43.2	41.4
1963	1	41.4	35.5	42.3	40.9	35.4	29.9	36.2	34.5
	2	41.3	35.8	42.0	40.9	39.2	35.0	39.6	38.7
1964	1	41.4	37.0	41.0	40.8	35.6	30.9	35.4	35.0

Table 36. Estimated cattle and hog price at Chicago, in cents per pound, under alternative producer and processor market strategies, 1955-1964

		Choice grade steers				U.S. No.1-3 hogs			
Year	Half year	Historical structure	Holding action	Packer margin	Producer contract	Historical structure	Holding action	Packer margin	Producer contract
					(cents)				
1955	2	21.5	22.8	21.2	21.8	14.4	14.7	14.2	14.7
1956	1	20.4	20.6	20.2	20.6	13.3	14.1	13.0	13.7
	2	25.2	25.8	25.0	25.4	17.9	20.0	17.8	18.2
1957	1	22.2	25.6	22.1	22.3	17.9	21.3	17.9	18.1
	2	24.7	26.2	24.6	24.7	19.3	20.8	19.4	19.2
1958	1	28.8	26.8	29.1	28.5	22.0	21.6	22.2	21.7
	2	27.2	25.0	27.4	26.9	18.1	16.2	18.2	17.7
1959	1	28.5	25.3	28.6	28.3	18.5	16.1	18.6	18.3
	2	26.5	23.8	26.5	26.5	15.2	13.7	15.0	15.1
1960	1	26.8	27.6	26.5	27.0	15.4	15.8	15.2	15.6
	2	26.3	27.3	26.0	26.4	19.3	20.9	19.0	19.5
1961	1	25.5	29.2	25.3	25.1	17.2	19.9	17.0	17.2
	2	24.8	27.9	24.7	25.0	18.9	20.7	18.9	18.9
1962	1	26.3	27.1	27.3	26.0	15.4	15.7	15.9	15.3
	2	28.3	27.0	28.5	28.0	16.7	15.0	17.0	16.5
1963	1	24.6	20.5	25.0	24.5	12.6	9.4	12.8	12.5
	2	24.6	20.8	24.8	24.5	14.8	12.3	14.7	14.7
1964	1	24.5	21.5	24.0	24.4	12.6	9.9	12.2	12.6

Table 37. Estimated price of good and choice feeder calves at Kansas City, in cents per pound, under alternating producer and processor market strategies, 1955-1964

Year	Half year	Historical structure	Holding action	Packer margin	Producer contract
			(cents)		
1955	2	19.6	22.4	19.1	20.2
1956	1	18.7	21.4	18.2	19.3
	2	20.4	21.3	19.9	20.8
1957	1	22.3	22.1	22.0	22.6
	2	25.9	29.8	26.0	25.9
1958	1	30.6	34.2	30.7	30.5
	2	33.8	29.4	34.3	33.0
1959	1	33.4	30.3	34.0	32.6
	2	29.0	22.0	29.2	28.9
1960	1	29.4	22.3	29.4	28.9
	2	26.0	29.0	25.3	26.7
1961	1	27.5	30.7	26.8	28.1
	2	25.7	34.0	25.6	25.8
1962	1	26.5	34.7	26.6	26.6
	2	30.9	28.9	32.1	30.0
1963	1	31.3	28.2	32.6	30.3
	2	23.7	16.0	23.9	23.8
1964	1	22.7	15.7	22.8	22.8

Table 38. Estimated number of sows farrowing, in million of head, under alternative producer and processor market strategies, United States, 1955-1964

Year	Half year	Historical structure	Holding action	Packer margin	Producer contract
			(million head)		
1955	2	5.5	5.4	5.5	5.5
1956	1	7.6	7.2	7.6	7.7
	2	5.3	5.0	5.2	5.3
1957	1	7.1	6.9	7.0	7.2
	2	5.0	5.0	5.0	5.1
1958	1	7.4	7.7	7.3	7.5
	2	5.6	5.8	5.6	5.7
1959	1	7.9	8.0	7.9	8.0
	2	6.2	6.1	6.2	6.2
1960	1	6.8	6.5	6.8	6.8
	2	5.7	5.5	5.7	5.7
1961	1	6.8	6.7	6.8	6.9
	2	6.0	6.1	6.0	6.1
1962	1	7.0	7.4	7.0	7.1
	2	6.2	6.4	6.2	6.3
1963	1	7.0	7.2	7.0	7.1
	2	6.2	6.4	6.2	6.3
1964	1	6.6	6.2	6.6	6.6

Table 39. Estimated January 1 inventories of beef cows, steers and bulls in millions of head under alternative producer and processor market strategies, United States, 1955-1964

	Beef cows				Steers and bulls			
Year	Historical structure	Holding action	Packer margin	Producer contract	Historical structure	Holding action	Packer margin	Producer contract
				(million head)				
1956	25.2	25.4	25.2	25.2	11.2	11.0	11.2	11.2
1957	24.5	24.5	24.4	24.6	10.7	11.1	10.6	10.7
1958	24.2	24.7	24.0	24.5	10.8	11.3	10.7	10.9
1959	25.2	26.1	25.0	25.5	11.6	11.7	11.5	11.7
1960	26.1	26.1	26.0	26.4	12.2	12.2	12.2	12.4
1961	27.0	26.5	26.9	27.3	12.6	12.6	12.5	12.8
1962	28.1	28.6	27.8	28.5	12.8	13.0	12.6	13.0
1963	29.5	30.5	29.2	29.9	13.5	14.1	13.4	13.8
1964	31.4	31.7	31.3	31.8	14.5	14.8	14.4	14.7

Table 40. Summary of estimated average semi-annual price and output variables presented under alternative producer and processor market strategy, United States, 1955-1964

		1955-64			
Variable	Unit	Historical structure	Holding action	Packer margin	Producer contract
Commercial cattle slaughter	bil.lbs. (lv.wt.)	12.7	12.8	12.6	12.8
Commercial hog slaughter	do.	9.2	9.2	9.2	9.2
Sows farrowing	mil.hd.	6.4	6.3	6.4	6.5
Per capita beef consumption	lbs.	42.0	42.7	41.9	42.2
Per capita pork consumption	do.	30.0	30.0	30.0	30.0
Wholesale beef price	cents/lb.	42.1	41.6	42.5	41.6
Wholesale pork price	do.	41.5	41.4	41.9	40.9
Choice grade steer price	do.	25.4	23.5	25.4	25.3
U.S. No. 1-3 hog price	do.	16.6	16.6	16.6	16.6
Feeder calf price	do.	26.5	25.1	26.6	26.5

CHAPTER X: EVALUATION OF ALTERNATIVE MARKET STRUCTURE MODELS

The empirical results presented in Chapter IX may be evaluated in light of the norms of price and output stabilization, reduction of marketing margins, and optimization of foreign trade. The norms of effective competitive, equitable returns to investment and consumer sovereignty will be used to evaluate the structural model according to the alternative market strategies. Finally, comparisons of the effects of the alternative models on the distribution of commercial slaughter in Iowa will be summarized.

Marketing Margin Models

During the historical period, the level of pork output was the same, regardless of the margin strategy. However, all of the alternative margin strategies restricted beef output only slightly compared with output of the historical base simulation. This restriction in beef output was the result of sharp reduction in cattle inventories during the downturn of the cycle early in the period. Cattle numbers did not regain this earlier loss in subsequent years.

The greater range in commercial hog slaughter, per capita pork consumption, and sows farrowing indicate a slight increase in the amplitude of the output cycle in hogs as a result of the fixed-margin strategy.

The relatively greater restriction of commercial cattle slaughter, consumption and year-end inventories under the fixed margin during the historical period does not necessarily denote reduction in the amplitude of the output cycle since the range of these variables over the period is about the same. During the eleven-year projection period, the increase in the amplitude of the beef and pork output cycles associated with the fixed margin is supported by the increased range in the predicted values, in spite of the lower production levels.

Turning to the price series generated by the simulation of the alternative margin structure, cyclical amplitude increases from the variable to semi-variable to fixed margins in both the historical and projection periods. The range in wholesale prices under the fixed margin is four-to five-cents above that of the variable margin during the historical period and twice that of the variable margin in the projection period. The variation in live prices and feeder prices is identical. In the simulation of the past nine years, 1955 to 1964, the fixed-margin strategy emphasizes the possibility that the cattle cycle may have turned down in late 1960 and 1961. This possibility is suggested by the other two margin strategies as well as the simulation of the historical structure. The simulation of the closed system supports the hypothesis of a transition to a four-to five-year cattle cycle.

The presence of extreme price and output variation was condemned in Chapter II. Using the criterion presented on page 12 of Chapter II concerning the acceptable limits of live animal prices as an operational norm, we find that in the case of the historical period, Choice grade steer prices fell below \$24.00 three times, and did not exceed \$30.00. Steer prices under the alternative margin strategies fell below \$24.00 as follows: variable-margin strategy five times, semi-variable-margin strategy four times, and fixed-margin strategy five times. A Choice grade steer price in excess of $30.00 was obtained once under the fixed margin assumption.

In the case of hog prices, the price level under the existing structure during the 1955-64 period fell below $13.00 twice and exceeded $19.00 three times. During the historical period, the price level exceeded $19.00 twice under the variable-margin strategy, and five times under both the semi-variable-and-fixed margin strategies. Hog prices for the historical period fell below $13.00 three times under the fixed-margin strategy and once under the semi-variable-margin strategy, but did not fall below this point under the variable-margin strategy.

In the projections to 1975, steer prices fell below $24.00 five times and exceeded $30.00 four times under the fixed-margin assumption. The unacceptably low prices were not estimated under the variable and semi-variable-margin strategies during the projection period, but exceeded $30.00 one and three times, respectively. Hog prices also exceeded the $13.00 to $19.00 range in the 1975 projections more often under the fixed-margin strategy. Hog price exceeded $19.00 four times and fell below $13.00 six times under the fixed-margin assumption. Prices under the variable margin were between the limiting values while they dropped below $13.00 twice in the case of the semi-variable margin and exceeded $19.00 once under the semi-variable-margin assumption.

The fixed margin increases cyclical amplitude, especially price amplitude. In so far as prices are flexible, the increased output variability under the fixed margin intensifies the price cycle. A fixed margin also tends to restrict output. The semi-variable margin tends to perform the same; however, if the fixed portion is kept low, the variable portion leads to behavior more closely approximating that of the completely variable margin. This is the case in the projection series where the fixed component was not allowed to increase with the price level.

The average wholesale-to-retail margin (see Table 21) is lower under the variable-margin strategy than the semi-variable and fixed-margin strategy, unless the semi-variable margin has a relatively small fixed component. The producer, therefore, is viewed as preferring a variable-margin strategy if he wishes to realize a greater share of the consumer dollar. On the other hand, the consumer is interested in obtaining a given per capita consumption for as low a price as possible. When retail prices (wholesale price plus the retail margin) are adjusted to a common per capita consumption, this norm may be applied to the prices generated by the simulation of alternative margin strategies. The deviation in retail prices from the historical simulated price for given per capita consumptions over time are shown in Figures 15 and 16.

The fixed margin yields a lower average retail price for a given per capita consumption while the variable margin yields the highest average retail price for any given consumption level. This is particularly true in the case of beef prices in the projection period. The lower retail price under the fixed margin might be expected in this case as prices are rising rapidly during the projection period.

Net foreign trade was slightly higher under the semi-variable than variable-margin strategy and lower under the fixed margin; but the difference is not appreciable. Therefore, the margin strategy employed affected domestic prices and output with little effect on net foreign trade.

Figure 15. Estimated deviations in retail beef prices at Chicago simulated under alternative margin strategies from retail beef price at Chicago simulated under the existing market structure

Legend

__________ Variable margin
_ _ _ _ _ Semi-variable margin
.... Fixed margin

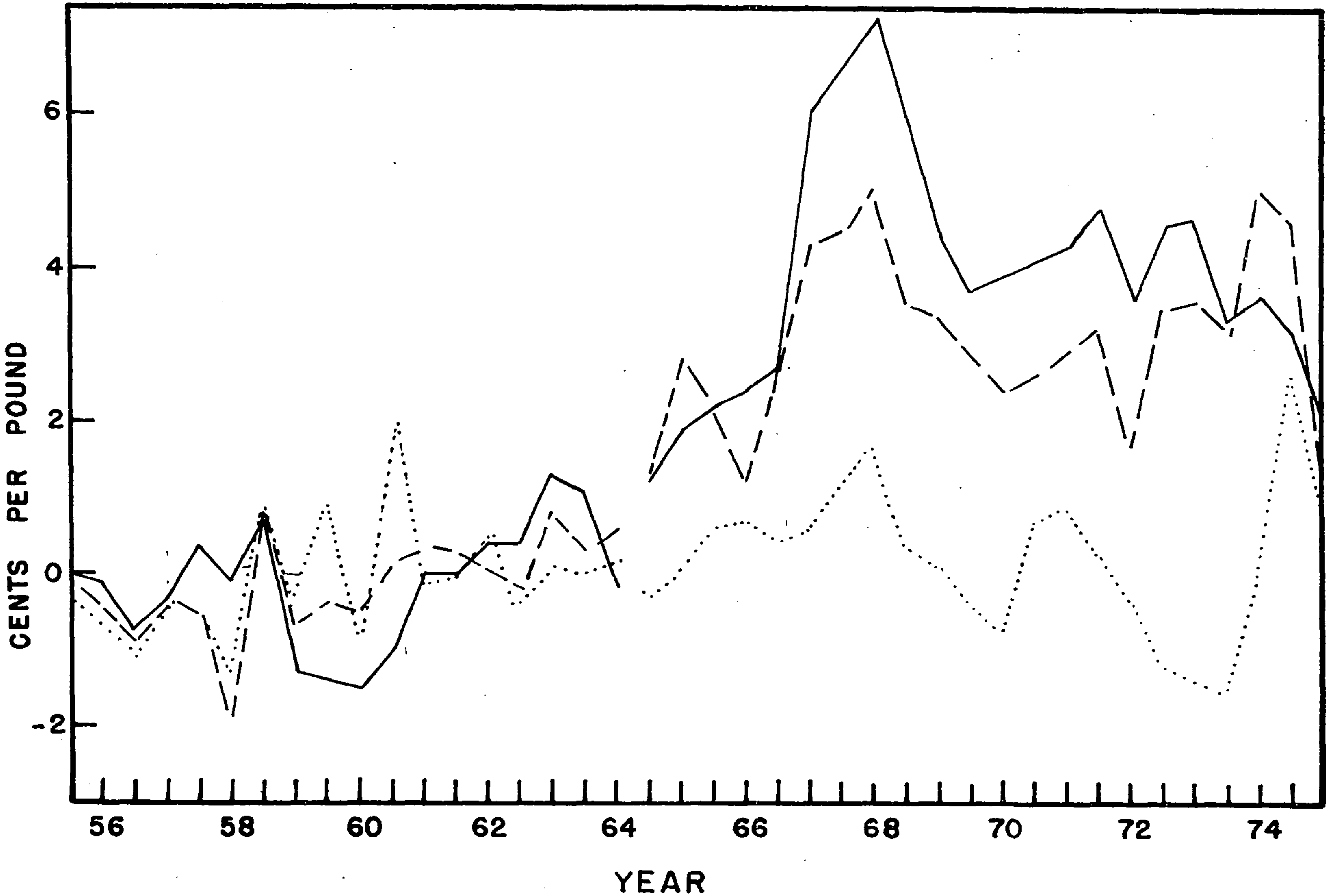
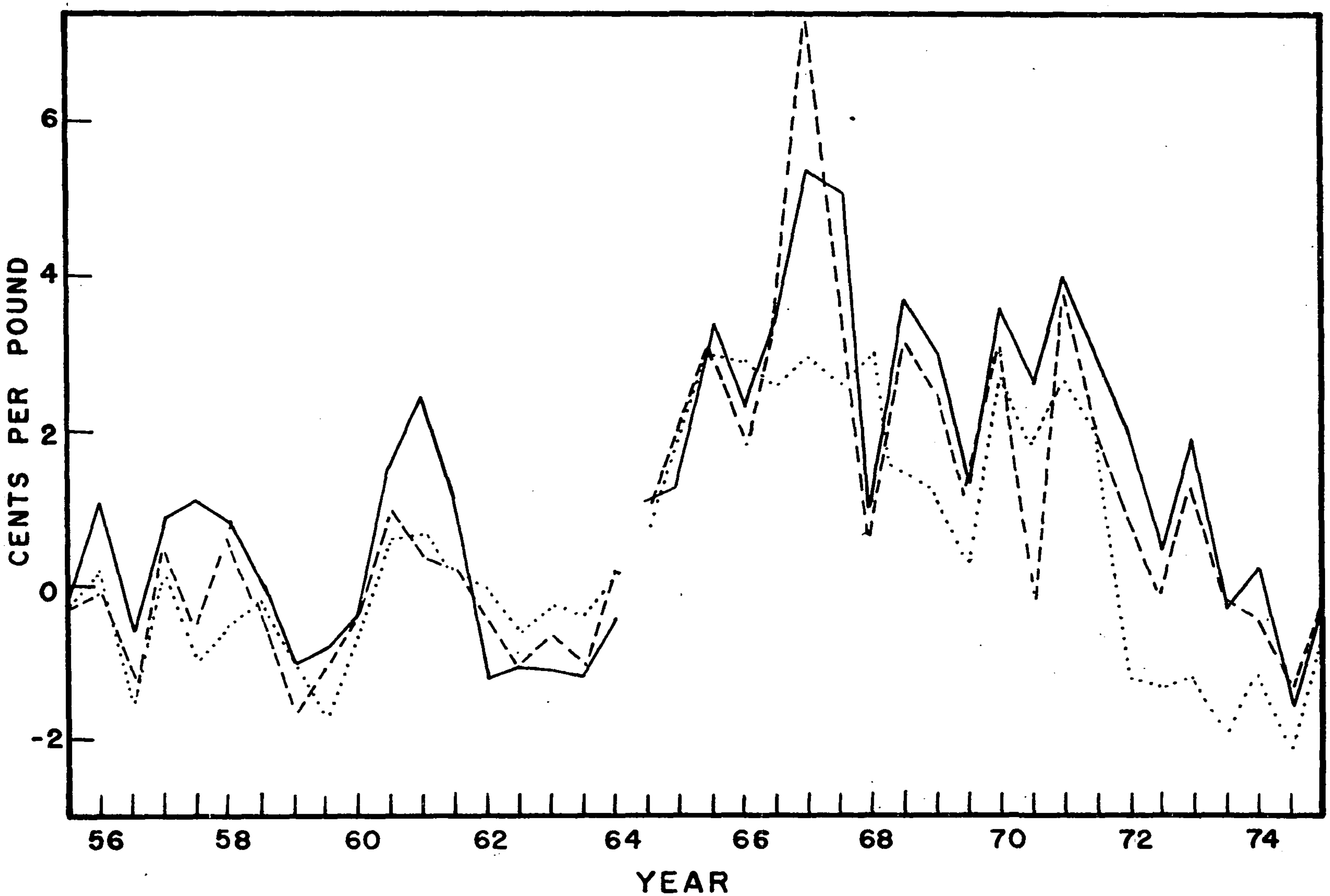


Figure 15. Estimated deviations in retail beef prices at Chicago simulated under alternative margin strategies from retail beef price at Chicago simulated under the existing market structure

Figure 16. Estimated deviations in retail pork prices at Chicago simulated under alternative margin strategies from retail beef price at Chicago simulated under the existing market structure

Legend:

__________ Variable margin
_ _ _ _ _ Semi-variable margin
.... Fixed margin


CENTS PER POUND
6
4
2
0
-2
56
58
60
62
64
66
68
70
72
74
YEAR

The fulfillment (or lack of fulfillment) of the consumer sovereignty norm is implied in the market structure assumptions giving rise to particular margin strategies. The knowledge of quality and protection from fraud aspects of this norm could be implemented under any of the three alternative margin assumptions. However, the reflection of consumer desires to the producer, as specified in Chapter II, may be assessed as follows: In the 1955 to 1964 period, the intersection of the derived demand curves under the fixed-and variable-margin strategies occurred at a wholesale price of 43 cents (60-cent retail price) in the case of both beef and pork. During the 1964 to 1975 period, the intersection of the derived demand curves occurred at a wholesale price of 58 cents per pound (80-cent retail price).

The maintenance of competition under alternative margin strategies depends on the form of the structure from which the postulated margin strategy is derived. If the fixed margin is postulated as the strategy of a small number of large firms, competition would be deemed to have been reduced unless the "counterveiling power" thesis is employed. However, if the fixed margin is postulated as the strategy of a fragmented retailing industry, then competition would be maintained.

Similarly, a fixed-margin strategy could include a return on investment desired by the industry. However, the same could be true of a variable margin provided that the quantity to be handled for the year could be estimated with reasonable accuracy in advance.

Total commercial hog slaughter in Iowa during both the historical and projection periods was not constrained much under the fixed margin.

Commercial cattle slaughter was constrained more than hog slaughter by the fixed margin. However, in terms of market share, there was little difference in Iowa's market share under the three market strategies.

The variable margin performed better, with reference to the accepted norms, than the fixed margin in terms of cyclical stability, lower average margin, level of output and price transmission. Average wholesale prices and average live prices were about the same during the past nine years and also during the projection period. The fixed margin did provide the consumer with a given amount of meat at a lower price in almost all instances during the projection period. However, this advantage of fixed margins must be qualified by the level and trend in the retail price.

Foreign Trade Limitation Models

Domestic beef production would increase under both forms of trade limitation. The simulation runs for the period to 1975 revealed increases that might be slightly greater under the absolute limit. The percentage of animals to be slaughtered in Iowa is not affected by the trade limitations, and per capita consumption of beef fell from one-half to one pound in spite of increased domestic beef production. Pork consumption was unaffected by the limitation of beef imports.

Average wholesale, and retail, beef prices would be one-to-two-cents per pound higher under trade limitation; however, the amplitude of the beef price cycle would be increased substantially, and some of this increased amplitude would be carried over into pork prices even though average pork prices were about the same as in the historical simulation.

The 1958-62 average import limitation in the projection period was not as restrictive as the variable limitation, but a greater cyclical amplitude was evident in it than in the variable trade-limitation model. In the projections to 1975, steer prices fell below $24.00 three times under the four-percent limit but not once under the absolute limit.

The wholesale-to-retail margin was the same as in the historical base simulations by assumption. The retail price for a given per capita consumption was not restricted to equal that of the historical period. However, there was essentially no difference in this respect between either of the limitation models and the base simulation.

The return to investment in meat packing and live animal production could be improved, provided other costs of production and processing did not increase. Average wholesale prices were one-dollar higher over both simulation periods, and live animal prices were fifty-cents to one-dollar higher. Feeder-calf prices averaged one-dollar higher under trade limitations.

In summary, trade limitations increase cyclical amplitude, raise producer and consumer prices, and reduce domestic consumption. Consumer sovereignty is violated to some extent, but returns to domestic investment in the livestock-meat economy could be improved if costs are held in check.

Consumption Control Model

Control of per capita consumption with a guaranteed domestic price for beef and pork virtually eliminated the price and output cycles in cattle and hogs. Some cyclical variation persisted in the feeder-cattle market. The price of both dressed beef and pork and live-animal prices averaged slightly above that of the historical base in both the historical and projection periods despite substantial exports at world prices. In the 1955-64 simulations, wholesale beef prices averaged one dollar more than that of the existing structure while pork prices averaged two dollars higher than that of the existing structure. Slaughter-animal prices and feeder-calf prices were about fifty cents to one dollar above those predicted under the historical simulation. January 1 inventories of cattle and hogs increased sharply under the guaranteed domestic prices.

Under the assumed fixed wholesale-to-retail margin accompanying the fixed wholesale price, the producer and processor share of the consumer dollar would vary with the amount of exports needed to hold consumption down to the regulated level. During the historical period, the retail beef price would have averaged one-cent per pound higher for a given per capita consumption, and the retail pork price would have averaged two-cents per pound higher for a given per capita consumption.

The consumption control program leads to a net exporter position for the United States in pork during both the historical and projection periods. Imports of beef were necessary to maintain consumption during the projection period, but total imports were only a fraction of those predicted under the current structure.

Producer Holding Action

In the long run, the lower average prices of the first half of 1955 tended to reduce the amplitude of the cattle price and output cycles during the remainder of the 1950's and then increase the amplitude in the 1960's. The amplitude of the hog price and output cycle increased immediately. After the holding action, steer prices fell below $24.00 six times compared with three times under the existing structure in the 1955-64 period. Hog prices after the holding action fell below $13.00 the same number of times as under the existing structure, but exceeded $19.00 seven times compared with three under the existing 1955-64 structure. Therefore, the holding action accentuated the amplitude of the cycle but did not increase long-run price levels.

The immediate effects of the holding action lowered prices during the period the holding action took place which would be regarded as unsuccessful by those initiating the action. In the long run, total production was about the same and prices averaged slightly lower. In addition, the net effect was an increase in the amplitude of the cycle. It appears that neither consumers nor producers benefited from either the short- or long-run effects of the thirty-day withholding action.

Packer Margin Increase

The increase of 25 cents per hundredweight in the packer margin was introduced merely to show the effects of a return on investment equal to that of other members of the food and kindred products industry. Wholesale prices averaged slightly higher and live-animal prices averaged about the same as during the historical period. Neither the amplitude nor period of the cycles were affected. Live-animal prices were slightly lower during the earlier years, but regained these losses in latter years as output declined moderately as a result of the lower prices in earlier years.

Producer Contract

Contracting one-third of the livestock at an average of one dollar above the central market price did not alter the period or amplitude of the cycle. Over the nine-year period, 1955 to 1964, domestic output increased slightly with a corresponding reduction in wholesale and live animal prices. There was no appreciable change in net foreign trade.

Since only one-third of the animals were under contract, market forces were assumed to operate in price determination. Also, the form of the contract (a variable mark-up over the central market price) did not result in fixed live prices. If packer savings in procurement and plant operation equals the higher price, returns on investment to the packer would not be reduced whereas producer returns could increase.

The contract allows variation in the reduction of the margin, thus the ability of the consumer to guide production decisions would not be affected. Since price and output changes were small, retail prices were not adjusted for per capita consumption.

CHAPTER XI: SUMMARY AND CONCLUSIONS

The widening disparity in firm size and market position of businesses operating in the livestock-meat economy is rooted in several policy issues. Recognition of these policy issues is vital in developing a framework for evaluating research results in a normative sense.

The policy norms must be quantified in one of two ways; namely through the underlying assumptions that call for adjustments in parameters of the model, or through the normative evaluation of the results of the investigation. For example, the marketing margin norm was used to evaluate the wholesale-to-retail margins of alternative market strategies generated over time. On the other hand, in the producer contract model, the marketing margin norm was quantified by use of the assumption that contracting one-third of the cattle and hogs produced would affect the relationship between wholesale price and the live-to-wholesale margin.

The six norms developed in Chapter II do not preclude the development of other norms for evaluation of market performance in the livestock-meat economy. However, to be operational, each norm must be translated into numerical form for use in the computer models. Stabilization of price and output cycles, reduction of marketing margins, and maximization of foreign trade were introduced as norms which would be used to evaluate the results of the computer models. The norms of consumer sovereignty, equitable return on investment, and maintenance of competition were introduced into the model through the assumptions.

The contribution to the methodology of building computer models is contained in the first objective of this study -- to construct and test a simulation model of the livestock-meat economy depicting the dynamic interaction of livestock inventories, meat production and prices. A single economic structure was established for the pork sector while two variations in economic structure were established for the beef sector. The preparation of a well defined economic structure was a pre-requisite to the building of the computer models. The economic structure specifies not only behavioral relations needed, but also the form of the relationships.

The alternative organization of the beef sector shows that the economic structure need not be unique. Indeed, the computer model lends itself to the development of alternative economic structures suggested by early simulations of the model. However, any structural model developed should be logical; it should provide, also, an accurate description of the economic and technical relationships that describe the organization of the industry.

In the models presented in Chapter III, the biologic lag of the production process led to the construction of lag relationships that represented a recursive causal ordering which could be easily simulated by use of a computer. The logic of the model was to establish the components of the consumption identity, estimate the wholesale price, and relate the wholesale price to live-animal price. Live-animal prices, in turn, would affect the build-up or reduction of inventories of breeding stock, which, subsequently, determine slaughter -- the major component of consumption.

Initially, all of the behavioral relationships were established by least-squares regression. After an early series of computer simulations, certain deficiencies in the model were noted and alternative behavioral relationships were constructed. These alternative relationships often involved coefficient adjustments at discontinuous points when the explanatory variable took on large or small values. Another type of alternative relationship involved establishment of coefficients on the basis of average values, computation of the residual of predicted minus reported values, and estimation of the residual as a function of selected explanatory variables by means of least squares. Derivation of the behavioral relationship by this method offered a means of by-passing the multicollinearity problem and also allowed the introduction of some relations not linear in the explanatory variable. The introduction of limiting values also restricted variables from taking negative or quite small values. The introduction of these alternative behavioral relationships gave a better reproduction of the endogenous variables of the economic structure over the historical period -- 1955 to 1964.

After making projections for the exogenous variables, the model simulated market performance in terms of prices and outputs over the 1964 to 1975 period. Several modifications were needed, however, in the projection period. When values of variables such as beef-cow inventories exceeded the range over which their estimating equations were developed, certain items formerly included at their average value in the constant term had to be introduced as variables. For example, in the case of the beef-cow inventory equation, death losses and non-fed heifer slaughter had been included in the constant term. In the projections, death loss and non-fed heifer slaughter was introduced as a variable. Also, trend terms required modification as their continued use at original values led to less than plausible results. The coefficients of the trend variables were either reduced or allowed to decline to zero by 1975. The series of projections was accepted as a basis for comparison of alternative models when the projected values were not only plausible, but also were in agreement with earlier projections for 1975.

Alternative market strategies were developed under assumptions of different forms of market organization. These alternative market strategies depicted different wholesale-to-retail margin relations, different live-to-wholesale margin relations, restrictions on foreign trade, and consumption control. These changes in market conduct were then introduced into the computer model as changes in coefficients, limiting values, or changes in initial conditions. The alternative models were then re-run over both the historical and projection periods to simulate the prices and outputs of these market strategies.

The market performance of the hypothesized market strategies was then evaluated in light of the legal-economic norms developed early in the study and summarized at the beginning of this chapter.

Briefly, the prices and outputs under the variable-margin strategy met more of the specifications of the norms developed than those of the fixed-margin strategy. Under the variable margins, price and output did not show as much extreme fluctuation, margins were somewhat lower, while foreign trade was about the same under all margin strategies.

Limitations of foreign trade under either a variable or absolute form of trade restriction increased price and output variability, raised producer and consumer prices, and lowered per capita consumption. The four-percent limit was more restrictive than the 1958-62 average limit during the projection period.

The consumption-control model led to a considerable reduction in price and output variation, raised prices to producers, and resulted in a substantial increase in pork exports. However, the increase in pork supplies on the world market could create problems for other exporting nations if the additional supply was large enough to depress world prices appreciably.

The postulated increase in the packer margin lowered primary market prices slightly, but did not give any major changes over the period simulated. Conversely, the producer contract model yielded slightly higher primary market prices but did not change the time paths of average levels of other variables to any appreciable extent.

The evaluation of the market performance of the variable, semi-variable, and fixed-margin strategies at the wholesale-to-retail level suggests that either the variable margin or a semi-variable margin with a small fixed component is desirable from both the producer and consumer standpoint. While the variable-margin strategy is viewed as that of a retailing industry having a fragmented structure, it is also acknowledged that a retailing industry composed of a fewer number of large firms might find this type of margin strategy more feasible in large-scale pricing operations.

Limitations of net foreign trade in beef over a long period of time was found to be undesirable for the consumer. Since controls raised simulated producer prices over the long run, as well as in the short run, selective use of foreign trade regulation for several years could maintain producer equity while inter-industry adjustments were being effected.

Maintenance of a target rate of consumption in the United States likely would make a program of such magnitude difficult and expensive to administer. However, simulation of prices and outputs under this model does serve to illustrate that price and output cycles can be reduced appreciably through the primary market mechanism using consumption management without direct supply controls.

Finally, the long-run market performance of the producer holding action is conditional on the short-run assumptions. If these short-run assumptions were changed so as to change the six-month average prices which made up part of the initial conditions, the simulated long-run prices and outputs would be different. However, this model does illustrate the nature of the possible long-run effects associated with a short-term holding action.

No conclusions are warranted by the simulated results of the packer margin of producer contract models. The simulated prices and outputs are so close to those of the prices and outputs simulated under the existing structure that one is unable to tell if the postulated changes in the coefficients had no effect on the system or whether the postulated change was too small to affect the economic structure.

A computer model such as this one of the livestock-meat economy may be used to simulate the market performance in terms of prices and outputs of many changes in market organization as they affect specified parameters and variables. The objectives of this study were to develop such a model and test several alternative market strategies that seemed to be of current interest. The computer model itself can no doubt be improved upon. Re-estimation of behavioral relations estimated by least squares would be desirable after revisions of data based on the next agricultural census are available. This would allow a larger number of observations free of the influence of the Korean War and World War II. Although the norms were translated into numerical values, much work needs to be done not only in developing the norms, but also in quantifying them for use in the computer. Simulation of the proposed market strategies at several levels would also provide useful information regarding the incidence of changes in a strategy (such as a margin strategy) on the consumer, producer, or marketing firms.

The lag nature of the model makes it amenable for use in public forecasting. However, two important additions (or modifications) would be needed: First, appropriate producer reactions to the forecasts would need to be incorporated into the model; second, subroutines encompassing a much shorter period of time (possibly one week) should be added to the model. These weekly subroutines would allow a reaction to prices and outputs within the six-month period to modify the aggregate price and output of the period.

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APPENDIX A

The Computer Program of the Livestock-Meat Economy

```
C     RECURSIVE MODEL OF PRICE AND OUTPUT DETERMINATION IN BEEF AND PORK
      DIMENSION H21(20),H22(20),H23(20),H24(20),H26(20),P2FC(20),P2L(20)
     1,P21FC(20),P22FC(20),CS21(20),BP21(20),FTR21(20),PWB22(20),ES21(20
     2),FIC22(20),ES22(20),CS22(20),H32(20),P3L(20),SF31(20),QPH21(20),S
     3F32(20),CS31(20),P32L(20),PP31(20),FTR31(20),PWB32(20),ES31(20),ES
     432(20),PWB21(20),QPH31(20),PWB31(20),P21L(20),P31L(20),FIC21(20),
     5CS32(20),PP32(20),QPH32(20),BP22(20),FTR22(20),QPH22(20),FTR32(20)
     6,P2LFS(20),H13(20),AWFS2(20),AWFS1(20),          FIBCN(20),D2H23(
     720),D2SFC(20)
      DIMENSION CS2RA(20),CS2RB(20),CS2RC(20),CS2RN(20),CS2RX(20),
     1CS31A(20),CS31B(20),CS31C(20),CS31N(20),CS31X(20),CS32A(20),
     2CS32B(20),CS32C(20),CS32N(20),CS32X(20)
      DIMENSION RM21(20),RM22(20),                    CPI(20),P22L(20),
     1  RM31(20),RM32(20),OM1(20),T2(20),HCP1(20),AMC21(20),P6(20),HF6(2
     20),T1(20),P62(20),AMC31(20),YPH1(20),P61(20),T3(20),HCP2(20),
     3AMC22(20),AMC32(20),YPH2(20),T4(20),RANGE(20),OM2(20),WK1(20),WK2(
     420),AMRGE(20),WK3(20),WK4(20)
      DO 52 J=1,3
   52 READ INPUT TAPE 1,53,H21(J),H22(J),H23(J),H24(J),H26(J),H32(J),SF3
  5211(J),P2FC(J),P21FC(J),P22FC(J),P21L(J),PWB21(J),P31L(J),PWB31(J),
  522CS21(J),CS22(J),H13(J),FIC21(J),PP31(J),PP32(J),ES21(J),ES31(J),
     3ES32(J),D2H23(J),P22L(J),P2LFS(J),AWFS1(J)
   53 FORMAT(5X,7F5.0,7F5.2,/5X,10F5.0,2F4.2,1F4.0)
      DO 54 J=1,13
   54 READ INPUT TAPE 1,55, T1(J),T2(J),T3(J),T4(J),OM1(J),OM2(J),HCP1(J
  541),HCP2(J),HF6(J),P6(J),P61(J),P62(J),AMC21(J),AMC22(J),AMC31(J),AM
  542C32(J),YPH1(J),YPH2(J),RANGE(J),RM21(J),RM22(J),RM31(J),RM32(J),WK
     31(J),WK2(J),AMRGE(J),                 CPI(J),H13(J),WK3(J),WK4(J)
   55 FORMAT(5X,4F2.0,2F4.1,2F6.3,1F4.0,3F3.2,4F3.0,2F4.0,1F2.0,/5X,4F4
     1.2,2F1.0,1F2.0,8X,1F4.3,1F5.0,2F1.0)
      DO 199 I=4,K
  101 CS32(I)=99.20+0.776365*SF31(I-1)-16.067859*P31L(I-1)+861.43331*P61
 1011(I-1)+238.59594*T1(I-1)
  102 PP32(I)=256.18+0.525844*CS32(I)+9.576242*T3(I)
  103 FTR32(I)=2.320585*PWB31(I-1)+3.927658*T3(I)-156.66
```

Figure 17. Computer program of the beef and pork sectors for simulation of the existing market structure 1955-64

```
 104 ES32(I)=68.0+0.6245*ES32(I-1)+0.102*PP32(I)-0.102*PP32(I-1)
 105 QPH32(I)=ES31(I-1)/HCP2(I)+PP32(I)/HCP2(I)+FTR32(I)/HCP2(I)-AMC32
 1051(I)/HCP2(I)-ES32(I)/HCP2(I)
1061 AWFS2(I)=885.0+5.3*(P21L(I-1)/P61(I-1))+3.05*T3(I)+0.017*H24(I-1)
    1-0.017*H24(I-2)
1062 CS22(I)=0.1125*H13(I-1)+0.077*H23(I-1)+.50*H24(I-1)+236.5*P2LFS(I-
    13)-1.0*H13(I)+1.0*H13(I-1)-0.84*((.50*H24(I-1))/(.1125*H13(I-1)+.0
    277*H23(I-1))*AWFS2(I))-2645.0+180.0*WK1(I-1)
 108 BP22(I)=103.0+0.501085*CS22(I)+31.5*T3(I)
     IF(PWB21(I-1)-38.0) 107,109,109
 107 FTR22(I)=6.0*PWB21(I-1)-0.1*FIC21(I-1)+16.45*T3(I)-142.0+250.0*WK4
    1(I)
     GO TO 220
 109 FTR22(I)=8.660288*PWB21(I-1)-0.098796*FIC21(I-1)+16.447167*T3(I)
    1-141.66+250.0*WK4(I)
 220 CONTINUE
 110 ES22(I)=ES21(I-1)+0.048287*CS22(I)-0.096574*CS21(I-1)+0.048287*CS2
 11012(I-1)
     IF(ES22(I)-100.0) 21,22,22
  21 ES22(I)=100.0
  22 CONTINUE
 111 QPH22(I)=ES21(I-1)/HCP2(I)+BP22(I)/HCP2(I)+FTR22(I)/HCP2(I)-AMC22(
 1111I)/HCP2(I)-ES22(I)/HCP2(I)
 124 FIC22(I)=4874.72+0.905034*FIC21(I-1)-53.098081*RANGE(I)
     IF ((FIC22(I)/CS22(I))-0.25) 222,222,223
 223 PWB22(I)=124.57-2.046689*QPH22(I)-0.53893*QPH32(I)-1.1914*RM22(I)
    1-0.094911*RM32(I)+0.010561*YPH2(I)+0.977203*T3(I)
     GO TO 225
 222 IF((FIC22(I)/CS22(I))-0.16)224,112,112
 112 PWB22(I)=123.57-2.046689*QPH22(I)-0.53893*QPH32(I)-1.1914*RM22(I)
    1-0.094911*RM32(I)+0.010561*YPH2(I)+0.977203*T3(I)
     GO TO 225
 224 PWB22(I)=122.57-2.046689*QPH22(I)-0.53893*QPH32(I)-1.1914*RM22(I)
    1-0.094911*RM32(I)+0.010561*YPH2(I)+0.977203*T3(I)
 225 CONTINUE
 113 P22L(I)=0.689685*PWB22(I)-0.014464*OM2(I)-1.50
```

Figure 17 (Continued)

```
114 P2L(I)=0.5*P21L(I-1)+0.5*P22L(I)
    IF ((P22L(I)-P22L(I-1))+1.25) 92,92,93
 92 PM=1.615*P22L(I)-0.615*P22FC(I-1)
    P22FC(I)=1.5*P22L(I)+0.4*PM+0.2*RANGE(I)-37.00
    GO TO 94
 93 PM=1.615*P21L(I-1)-0.615*P21FC(I-2)
    P22FC(I)=1.25*P22L(I)+0.5*PM+0.2*RANGE(I)-33.50
    GO TO 94
 94  CONTINUE
1160P2FC(I)=0.5*P21FC(I-1)+0.5*P22FC(I)
118 PWB32(I)=49.44-3.121849*QPH32(I)-0.549789*RM32(I)+0.061176*YPH2(I)
   1-1.751476*T3(I)+0.407261*PWB22(I)
119 P32L(I)=0.574914*PWB32(I)-0.028405*OM2(I)-2.97
120 P3L(I)=0.5*P31L(I-1)+0.5*P32L(I)
    IF ((P31L(I-1)/P21L(I-1))-0.50) 241,241,242
241 SF32(I)=0.725*SF31(I-1)+210.0*T1(I)+82.0*P3L(I)/P6(I)-3000.0
    GO TO 245
242 IF((P31L(I-1)/P21L(I-1))-0.75) 243,244,244
243 SF32(I)=0.725*SF31(I-1)+210.0*T1(I)+82.0*P3L(I)/P6(I)-3200.0
    GO TO 245
244 SF32(I)=0.725*SF31(I-1)+210.0*T1(I)+82.0*P3L(I)/P6(I)-3400.0
245 CONTINUE
    IF(SF32(I)-SF31(I-1))231,231,232
231 GO TO 233
232 SF32(I)=SF31(I-1)
233 CONTINUE
129 FIBCN(I)=5786.0+0.084*H23(I-1)-126.0*P2FC(I)-210.0*T1(I)+300.0*
   1WK3(I)
130 H23(I)=H23(I-1)+H22(I-1)-3197.0-1.036*FIBCN(I)-1103.0*WK2(I)
    IF(P2L(I)-23.00) 246,247,247
246 H22(I)=0.336*H21(I-1)+135.0*P2L(I)-3418.0
    GO TO 250
247 IF(P2L(I)-28.50) 248,248,249
248 H22(I)=0.336076*H21(I-1)+142.0*P2L(I)-3418.0
    GO TO 250
249 H22(I)=0.336*H21(I-1)+135.0*P2L(I)-3418.0
```

Figure 17 (Continued)

```
      IF(P2FC(I)-22.0)25,26,26
  25  H21(I)=1.07703*H23(I-1)+155.0*P2FC(I)-11990.0
      IF(P2FC(I)-P2FC(I-1))234,235,235
 234  H24(I)=0.706147*H21(I-1)+070.0*P2FC(I)-4017.0
      GO TO 219
 235  H24(I)=0.706147*H21(I-1)+095.0*P2FC(I)-4017.0
      GO TO 219
  26  IF(P2FC(I)-35.0) 217,217,218
 217  H21(I)=1.07703*H23(I-1)+166.25*P2FC(I)-11990.0
      H24(I)=0.706147*H21(I-1)+81.26*P2FC(I)-4017.0
      GO TO 219
 218  H21(I)=1.07703*H23(I-1)+155.0*P2FC(I)-11990.0
      H24(I)=0.706147*H21(I-1)+95.0*P2FC(I)-4017.0
 219  CONTINUE
      IF(P2FC(I)-24.5)236,237,237
 236  H26(I)=0.573518*H21(I-1)+65.0*P2FC(I)-6132.0
      GO TO 240
 237  IF(P2FC(I)-35.0)238,238,239
 238  H26(I)=0.573518*H21(I-1)+70.96*P2FC(I)-6132.0
      GO TO 240
 239  H26(I)=0.573518*H21(I-1)+60.0*P2FC(I)-6132.0
 240  CONTINUE
 132  CS2RA(I)=0.01125*H13(I-1)+0.0056*H23(I-1)+0.11025*H24(I-1)
     1-0.49*H13(I-1)+0.49*H13(I)+57.4*P2LFS(I-3)+1.957* ((1.05*H24(I-1)/
     2(.225*H13(I-1)+.14*H23(I-1))*((AWFS1(I-1)+AWFS2(I))/2.0)))-3993.0
 133  CS2RB(I)=0.00225*H13(I-1)+0.0098*H23(I-1)+0.042*H24(I-1)
     1+0.05*H13(I-1)-0.05*H13(I)+11.75*P2LFS(I-3)+0.347*((1.05*H24(I-1)/
     2(.225*H13(I-1)+.14*H23(I-1))*((AWFS1(I-1)+AWFS2(I))/2.0)))-612.0
 134  CS2RC(I)=0.01125*H13(I-1)+0.0084*H23(I-1)+0.10395*H24(I-1)
     1-0.12*H13(I-1)+0.12*H13(I)+58.0*P2LFS(I-3)-0.19*((1.05*H24(I-1)/
     2(.225*H13(I-1)+.14*H23(I-1))*((AWFS1(I-1)+AWFS2(I))/2.0)))-413.0
 135  CS2RN(I)=0.099*H13(I-1)+0.0392*H23(I-1)+0.4746*H24(I-1)
     1-.46*H13(I-1)+.46*H13(I)+140.6*P2LFS(I-3)-1.686*((1.05*H24(I-1)/
     2(.225*H13(I-1)+.14*H23(I-1))*((AWFS1(I-1)+AWFS2(I))/2.0)))+1668.0
 136  CS2RX(I)=0.10125*H13(I-1)+0.077*H23(I-1)+0.3192*H24(I-1)
     1-.41*H13(I-1)+.41*H13(I)+203.45*P2LFS(I-3)-2.95*((1.05*H24(I-1)/
```

Figure 17 (Continued)

```
   2(.225*H13(I-1)+.14*H23(I-1))*((AWFS1(I-1)+AWFS2(I))/2.0)))-816.0
137 CS32A(I)=0.194105*SF31(I-1)+3.573880*P31L(I-1)-39.353170*P61(I-1)+
137170.591631*T1(I-1)-470.0
138 CS32B(I)=1.32+0.008009*SF31(I-1)-0.521086*P31L(I-1)+19.696910*P61(
1381I-1)-0.808976*T1(I-1)
139 CS32C(I)=26.28+0.016662*SF31(I-1)-0.467850*P31L(I-1)+58.732350*P61
1391(I-1)-0.15489*T1(I-1)
140 CS32N(I)=77.58+0.454725*SF31(I-1)-5.332370*P31L(I-1)+306.801909*P6
14011(I-1)+85.73696*T1(I-1)
141 CS32X(I)=463.56+0.102864*SF31(I-1)-13.320433*P31L(I-1)+515.55531*P
141161(I-1)+83.23122*T1(I-1)
143 P21FC(I)=1.1*P22FC(I)-0.004*H26(I)+0.004*H26(I-1)+0.25*AMRGE(I)
   1-19.55
144 D2H23(I)=H23(I)-2.0*H23(I-1)+H23(I-2)
145 D2SFC(I)=P21FC(I)-2.0*P21FC(I-1)+P21FC(I-2)
146 AWFS1(I)=885.0+5.3* P22L(I)/P62(I)+3.05*T2(I)+.017*H24(I)-.017*H24
   1(I-1)
147 CS21(I)=.1125*H13(I)+.063*H23(I)+.55*H24(I)+295.9*P2LFS(I-2)-0.86*
   1H13(I+1)+0.86*H13(I)-1.51*((.55*H24(I))/(.1125*H13(I)+.063*H23(I))
   2*AWFS1(I))-3460.0+170.0*WK1(I)
148 FIC21(I)=2257.0-0.308*D2H23(I)+21.84*D2SFC(I)-250.0*WK2(I)
149 BP21(I)=103.0+0.501085*CS21(I)+31.5*T2(I)
    IF(PWB22(I)-35.0) 153,150,150
153 FTR21(I)=6.0*PWB22(I)-0.1*FIC22(I)+16.45*T2(I)-142.0+250.0*WK4(I)
    GO TO 221
150 FTR21(I)=8.660288*PWB22(I)-0.098796*FIC22(I)+16.447167*T2(I)-141.6
15016  +250.0*WK4(I)
221 CONTINUE
151 ES21(I)=ES22(I)+0.048287*CS21(I)-0.096574*CS22(I)+0.048287*CS21(I-
15111)
    IF(ES21(I)-100.0) 23,24,24
 23 ES21(I)=100.0
 24 CONTINUE
152 QPH21(I)=ES22(I)/HCP1(I)+BP21(I)/HCP1(I)+FTR21(I)/HCP1(I)-AMC21(I)
1521/HCP1(I)-ES21(I)/HCP1(I)
    IF((P3L(I)/P6(I))-11.0) 86,87,87
```

Figure 17 (Continued)

```
 86 H32(I)=H32(I-1)-3360.0+240.0*P3L(I)/P6(I)-2.68*HF6(I)+2.68*HF6(I-1
   1)
    GO TO 90
 87 IF((P3L(I)/P6(I))-20.0) 88,88,89
 88 H32(I)=H32(I-1)-3359.97+252.87222*P3L(I)/P6(I)-2.680441*HF6(I)+2.6
   180441*HF6(I-1)
    GO TO 90
 89 H32(I)=H32(I-1)-3360.0+240.0*P3L(I)/P6(I)-2.68*HF6(I)+2.68*HF6(I-1
   1)
 90 CONTINUE
154 SF31(I)=0.920649*H32(I)-165.02
1550CS31(I)=283.67+1.333653*SF32(I)-57.574950*P32L(I)+1198.2264*P62(I)
1551+72.874152*T1(I)
156 PP31(I)=256.18+0.525844*CS31(I)+9.576242*T2(I)
157 FTR31(I)=2.320585*PWB32(I)+3.927658*T2(I)-156.66
158 ES31(I)=134.0+0.4769*ES31(I-1)+0.11524*PP31(I)-0.11524*PP31(I-1)
159 QPH31(I)=ES32(I)/HCP1(I)+PP31(I)/HCP1(I)+FTR31(I)/HCP1(I)-AMC31(I)
1591/HCP1(I)-ES31(I)/HCP1(I)
    IF((FIC21(I)/CS21(I))-0.25)226,226,227
227 PWB21(I)=121.73-2.046689*QPH21(I)-0.53893*QPH31(I)-1.1914*RM21(I)
   1-0.094911*RM31(I)+0.010561*YPH1(I)+0.977203*T2(I)
    GO TO 229
226 IF((FIC21(I)/CS21(I))-0.16)228,160,160
160 PWB21(I)=120.73-2.046689*QPH21(I)-0.53893*QPH31(I)-1.1914*RM21(I)
   1-0.094911*RM31(I)+0.010561*YPH1(I)+0.977203*T2(I)
    GO TO 229
228 PWB21(I)=119.73-2.046689*QPH21(I)-0.53893*QPH31(I)-1.1914*RM21(I)
   1-0.094911*RM31(I)+0.010561*YPH1(I)+0.977203*T2(I)
229 CONTINUE
161 PWB31(I)=45.95-3.121849*QPH31(I)-0.549789*RM31(I)+0.061176*YPH1(I)
   1-1.751476*T2(I)+0.407261*PWB21(I)
162 P21L(I)=0.689685*PWB21(I)-0.014464*OM1(I)-1.50
163 P31L(I)=0.574914*PWB31(I)-0.028405*OM1(I)-2.97
164 P2LFS(I)=0.5*P22L(I)+0.5*P21L(I)
174 CS31A(I)=0.272059*SF32(I)+2.908778*P32L(I)+164.1186*P62(I)+32.5281
174182*T1(I)-524.80
```

Figure 17 (Continued)

```
175 CS31B(I)=36.19+0.011845*SF32(I)-2.08331*P32L(I)+27.256021*P62(I)-2
1751.689035*T1(I)
176 CS31C(I)=152.14+0.017409*SF32(I)-6.000647*P32L(I)+92.45823*P62(I)-
17614.000943*T1(I)
177 CS31N(I)=174.84+0.72887*SF32(I)-23.245561*P32L(I)+514.84948*P62(I)
1771+4.777153*T1(I)
178 CS31X(I)=445.30+0.300307*SF32(I)-29.15421*P32L(I)+399.5441*P62(I)+
178142.258795*T1(I)
199 CONTINUE
    WRITE OUTPUT TAPE 2,200
200 FORMAT(1H1,44H  RICHARD CROM  LIVESTOCK MEAT ECONOMY MODEL//)
    WRITE OUTPUT TAPE 2,201
201 FORMAT(1H0,5X,109H  CS32    PP32    FTR32    ES32 QPH32           CS22
   1    BP22  FTR22    ES22 QPH22 PWB22  P22L    P2L  P22FC   P2FC      )
    DO 203 I=1,20
203 WRITE OUTPUT TAPE 2,204,CS32(I),PP32(I),FTR32(I),ES32(I),QPH32(I),
   1        CS22(I),BP22(I),FTR22(I),ES22(I),QPH22(I),PWB22(I),P22L(I)
   2,P2L(I),P22FC(I),P2FC(I)
204 FORMAT(1H0,5X,4F7.0,1F6.2,1F12.0,3F7.0,6F6.2)
    WRITE OUTPUT TAPE 2,205
205 FORMAT(1H1,5X,90H PWB32  P32L   P3L  D2SFC   SF32   FIBCN  D2H223
   1H13          FIC22  AWFS2  AWFS1  P2LFS                    )
    DO 206 I=1,20
206 WRITE OUTPUT TAPE 2,207,PWB32(I),P32L(I),P3L(I),D2SFC(I),SF32(I),
   1FIBCN(I),D2H23(I),H13(I),          FIC22(I),AWFS2(I),AWFS1(I),P2LFS
   2(I)
207 FORMAT(1H0,5X,4F6.2,4F7.0,7X,3F7.0,1F6.2)
    WRITE OUTPUT TAPE 2,208
208 FORMAT(1H1,5X,107H    H21    H22    H23    H24    H26  P21FC   CS21
   1    BP21  FTR21    ES21  QPH21    H32    SF31    CS31    PP31       )
    DO 209 I=1,20
209 WRITE OUTPUT TAPE 2,210,H21(I),H22(I),H23(I),H24(I),H26(I),P21FC(I
   1),CS21(I),BP21(I),FTR21(I),ES21(I),QPH21(I),H32(I),SF31(I),CS31(I)
   2,PP31(I)
210 FORMAT(1H0,5X,5F7.0,1F7.2,4F7.0,1F7.2,4F7.0)
    WRITE OUTPUT TAPE 2,211
```

Figure 17 (Continued)

```
211 FORMAT(1H1,5X,85H  FTR31    ES31 QPH31   PWB21   PWB31   P21L   P31L
   1FIC21    RM21    RM22    RM31    RM32                           )
    DO 212 I=1,20
212 WRITE OUTPUT TAPE 2,213,FTR31(I),ES31(I),QPH31(I),PWB21(I),PWB31(I
   1),P21L(I),P31L(I),FIC21(I),RM21(I),RM22(I),RM31(I),RM32(I)
213 FORMAT(1H0,5X,2F7.0,5F6.2,1F7.0,4F7.2)
    WRITE OUTPUT TAPE 2,214
214 FORMAT(1H1,5X,105HCS2RA  CS2RB  CS2RC  CS2RN  CS2RX  CS31A  CS31B
   1 CS31C  CS31N  CS31X  CS32A  CS32B  CS32C  CS32N  CS32X    )
    DO 215 I=1,20
215 WRITE OUTPUT TAPE 2,216,CS2RA(I),CS2RB(I),CS2RC(I),CS2RN(I),CS2RX
   1(I),CS31A(I),CS31B(I),CS31C(I),CS31N(I),CS31X(I),CS32A(I),CS32B
   2(I),CS32C(I),CS32N(I),CS32X(I)
216 FORMAT(1H0,5X,15F7.0)
    STOP
    END
```

Figure 17 (Continued)

APPENDIX B

Short-term Results of 30 Day Withholding Action January, 1955

A. Assumptions

1) All cattle and hogs held an average of 45 days.
2) Cattle gain 1 1/2 lbs. per day and hogs 1 lb. per day during the holding period.
3) Civilian population is 161,203,000.
4) All January 1 stocks of beef and pork are consumed in January with April 1 stocks being replenished in February.
5) No change in imports or exports.

B. Table 41. Per capita supply changes

	Reported			Withholding action		
	Comm. sl.	Meat prod.	Per cap. supply	Comm. sl.	Meat prod.	Per cap. supply
	(mil. lbs.)		(lbs.)	(mil. lbs.)		(lbs.)
January						
Cattle	1,975	1,042	7.20	494	260	2.82
Hogs	1,646	939	7.27	401	235	4.24
Feb.-March						
Cattle	3,672	2,008	12.45	3,672[a] 1,481[b] 105[c]	2,875	17.21
Hogs	2,931	1,676	10.40	2,931[a] 1,235[b] 230[c]	2,514	14.35
April-June						
Cattle	586	3,232	20.00	5,861	3,232	20.00
Hogs	3,743	2,118	12.05	3,743	2,118	12.05
Total						
Cattle	11,508	6,313	39.65	11,613	6,375	40.04
Hogs	8,320	4,733	29.82	8,550	4,867	30.64

[a]Normal slaughter.
[b]Slaughter from animals withheld.
[c]Weight gain from animals withheld.

C. Price estimates

The per capita consumption was converted to a six-month equivalent.

	Beef	Pork
January	17.0	25.5
Feb.-Mar.	51.6	43.0
April-June	40.0	24.0

Under the assumption that the demand curve is not linear outside the range of the observed data, the coefficients associated with per capita beef and pork consumption was adjusted for high and low per capita consumption. The coefficient of per capita beef consumption was increased 25 percent in January and the coefficients associated with both per capita beef and per capita pork consumptions were cut 25 percent in the Feb.-March period.

Table 42. Short-term price estimates

Period	Beef		Pork
		(dol./cwt.)	
January	65.00		63.00
Feb.-March	20.43		21.47
April-June	39.00		43.00
Six-month average[a]	32.65		25.50

[a]Weighted by consumption.

D. Six-month average live price estimates

Choice-grade steers - $19.20

U.S. No. 1 - 3 hogs - $13.96

APPENDIX C

Foreign Prices used in Consumption Control Strategy

Table 43. Net prices realized from sales in Liverpool market

July-June year	Beef	Pork
	(dol./cwt.)	
1955[a]	20.40	24.55
1956[a]	14.80	22.50
1957[a]	16.40	22.00
1958[a]	17.85	19.25
1959[a]	20.25	20.10
1960[a]	20.75	21.00
1961[a]	18.80	20.50
1962[a]	20.00	21.70
1963[a]	18.25	19.70
1964[b]	18.87	20.60
1965[b]	19.18	20.60
1966[b]	19.50	20.60
1967[b]	19.82	20.60
1968[b]	20.15	20.60
1969[b]	20.48	20.60
1970[b]	20.82	20.60
1971[b]	21.16	20.60
1972[b]	21.50	20.60
1973[b]	21.85	20.60
1974[b]	22.21	20.60

[a]1955-64 period (Liverpool price minus a 6¢ per pound ocean freight rate plus a 20 percent tariff.

[b]1964-75 period (Liverpool prices are those estimated by the British marketing board for 1975 and interpolated. A 6¢ ocean freight rate and 20 percent tariff are subtracted to obtain the net price.