Simulation of Farm Bargaining Board Policies In the Western Late Potato System

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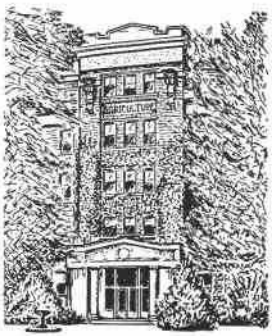

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ABSTRACT

Farm bargaining boards have been proposed as a policy alternative designed to increase bargaining power of farmers. The concern over farmer bargaining power arises from the changing institutional structure in the marketing system. Vertical and horizontal coordination, often involving production under contracts, may result in a bargaining advantage accruing to the relatively more powerful processing and distributing firms with whom individual producers deal.

This bulletin reports research designed to evaluate farm bargaining boards as a means of increasing farmer bargaining power. To evaluate the effects of establishing a bargaining board, computer-generated results obtained from establishing a hypothetical board in the western late potato system were analyzed. The analysis was based on a simulation model of the western late potato system, incorporating the production and marketing sectors and their interactions. Alternative bargaining board policies were assumed to be established in the system, the board was assumed to control appropriate variables at different levels compatible with the policy being tested, and results were generated by the interacting relationships in the simulation model.

The conclusion is reached that bargaining boards may offer a policy tool leading to price and income results more favorable to producers than those obtained under the system operating without interference. This conclusion is applicable to industries having characteristics conducive to gains from a bargaining board operating under the institutional and legal framework assumed in this study. Alternative operating frameworks for bargaining boards were not evaluated, nor were bargaining boards compared with other policy tools.

Key words: farm bargaining boards, farmer bargaining power, marketing system, western late potato system, simulation model.

I. INTRODUCTION

Farm bargaining boards have been proposed as a policy alternative designed to increase bargaining power of farmers. The concern over farmer bargaining power arises from the changing institutional structure in the marketing system. Vertical and horizontal coordination, often involving production under contracts, may result in a bargaining advantage accruing to the relatively more powerful processing and

distributing firms with whom individual producers deal (NCFM, 1966, p. 110; Cochrane, 1968, p. 157; Freeman, 1967, p. 5; Breimyer, 1965, p. 117).

Legislation was proposed in the National Agricultural Bargaining Act of 1968 to create a bargaining system based on bargaining boards (U. S. Congress, Senate, 1968). A bargaining board was defined as a producer-elected marketing committee established to negotiate with processors and other buyers for minimum price and nonprice terms of trade. The marketing committee could establish marketing allotments, with or without production limitations, necessary to coordinate quantities supplied with those demanded at negotiated prices. All producers would share the costs of operating the marketing board, and all producers and purchasers would be bound by the negotiated terms.

This bulletin reports research designed to evaluate farm bargaining boards as a means of increasing farmer bargaining power. The operation of a board was assumed to be patterned after that outlined in the proposed legislation cited above. To evaluate the effects of establishing a bargaining board, computer-generated results obtained from establishing a hypothetical board in the western late potato system were analyzed. The analysis was based on a simulation model of the western late potato system, incorporating the production and marketing sectors and their interactions. Alternative bargaining board policies were assumed to be established in the system, the board was assumed to control appropriate variables at different levels compatible with the policy being tested, and results were generated by the interacting relationships in the simulation model.

II. A FARM BARGAINING BOARD IN A COMMODITY SYSTEM

Choice of the Western Late Potato System

Analysis of the effectiveness of a bargaining board requires evaluation of results from alternative sources of bargaining gains. Supply control is the source thought to offer the greatest potential. Several factors, characteristics favorable to supply control among them, contributed to the choice of the western late potato system as the basis for analysis: (1) price fluctuations due to relative inelasticity of demand for potatoes and variation in yearly production; (2) different final market forms for late potatoes used as food—fresh, frozen, dehydrated, and chips; (3) a production area which is relatively well defined with similar production response and market demand conditions faced by the entire group of producers included; (4) importance of the crop in terms of farm income and share of the total U. S. market represented by the bargaining board area; and (5) widespread experience with market order programs.

For this analysis, the western late potato crop bargaining unit was defined as the western states included in the USDA Crop Reporting Board's estimates of potato production. The Crop Reporting Board's late summer production was included with the dominant fall production for each of these states in determining late potato production. The storage and use patterns of these two seasonal potato crops are similar. In addition, harvesting takes place over a continuous period and the production of several states is split between the late summer and fall categories.

Total U. S. potato production can be separated into three crops, based on harvest time—the early crop, including the Crop Reporting Board's winter and early spring potatoes; the intermediate crop, including late spring and early summer potatoes; and the late crop, including late summer and fall potatoes. The late crop accounts for over 80 percent of total potato production in the U. S., and the western states produce about 45 to 50 percent of the total late crop.

The potato marketing season may be categorized into three groupings corresponding to the seasonal production categories. During the early season, December through April, and the intermediate period, May through August, the marketing period corresponds to the harvest period. Potatoes are also marketed directly during the late crop harvest period from mid-August through November. However, much of the late crop is stored and marketed during the early and intermediate production periods. Winter and early spring crops provide about 10 percent of total potato consumption during the early period, in which late crop potatoes from storage are the principal market influence. Intermediate period consumption during the May through June period is provided by slightly more than half late spring potatoes, with the remainder coming from storage stocks of the late crop; during the July through mid-August period, intermediate consumption is provided by the early summer crop (Hee, 1967, p. 5). The late crop marketing season thus extends from mid-August through June, although the June carlot shipments from Idaho are only about 20 to 25 percent of the shipments in May (USDA, FSMNS, 1963-1967).

A large portion of the western late potato crop is processed into starch and food products. About 50 percent of Idaho's production has gone into processed products each year since 1964. About one third of the total potatoes processed in the U. S. are processed in Idaho (including those Idaho potatoes processed in Malheur County, Oregon). Potatoes grown and processed in Malheur County, Oregon, and Washington's rapidly expanding processing industry also contribute to the U. S. total of processed products.

The processing industry is a dominant influence in the market for the western late potato crop. The processor influences the potato

market even more than reflected in the quantities processed. Much of the processing potato crop is raised on contracts with the processors, who take all the potatoes but sell some of them on the fresh market.

Economic Model of the Western Late Potato System

Analyses of economic relationships within the potato production-marketing system have been conducted by Hee (1958, 1967), Simmons (1962), and Zusman (1962) among others.[1] The relationships derived in those studies could be used to develop a model designed to evaluate alternative bargaining board actions. However, the tremendous shift during the 1960's from fresh to processed utilization of the potato crop and the accompanying shift in location of potato production indicate a necessity to update those analyses. Further, each of those studies dealt with parts of the system or relationships needed, rather than with the complete production-marketing system.

Production and marketing decisions in the western late potato system are affected by interacting marketing and production variables. Therefore, analysis of a bargaining board in the system needs to be based on a model representing the entire system and including relationships between the production and marketing sectors, as well as relationships within the sectors. The relationships are best estimated from a comparable set of data to assure internal consistency in the model.

Production Sector

Late crop production decisions usually are made in the winter and early spring months, planting takes place in the spring, and the crop is harvested in the late summer and fall. Production decisions are based on expectations regarding the market price at harvest time and during the following storage months. Price expectations are based primarily on prices received for quantities produced in previous seasons, but are tempered by consumption trends, processed product inventories, and exogenous variables that may affect the market. Western producers also must consider the competing production in other late crop areas and in the early and intermediate crop areas for the following season.

Marketing Sector

Distribution of potato production into various utilization categories occurs in the marketing sector of the system. Major portions of the crop are used for food, but feed, seed, and industrial uses also com-

[1] See Walter J. Armbruster, Simulation of farm bargaining board policies in the western late potato system, unpublished Ph.D. dissertation, Oregon State University, 1971, pp. 50-58, for a more detailed review of their findings.

pete for potatoes. The allocation into various uses, including allocation between fresh and processed food use, is dependent on a number of interacting factors and determines prices at different levels in the system. Processors and handlers may be assumed to make allocation decisions based on their knowledge of current prices, price expectations, inventory levels, and quantities which can be sold at prices allowing individual processors and handlers some profit margin.

Interrelationships Between the Sectors

Numerous interrelationships exist between the production and marketing sectors. The relationship between prices received for potatoes marketed and production in succeeding periods is one of the more obvious connections between the sectors. Other direct relationships also exist between the sectors: actual quantities produced affect quantities going into different uses; processing and marketing costs connect the farm level price of the production sector and the final product price of the marketing sector; and contract prices are a direct result of interaction between processors and growers.

The Complete System

The sectors of the system, and interactions between them, form the complete late potato crop system. A schematic model of the system is presented in Figure 1. The supply and demand factors discussed in the preceding sections are the components of this diagram. Decision points are indicated by the diamond-shaped boxes, and the factors influencing these decisions are indicated by lines connecting the decision points to appropriate elements of the system. This diagram helps identify relationships which must be quantified in a model designed to evaluate policy alternatives for a bargaining board in the western late potato system.

The production sector relationships are shown in the upper portion of the diagram. The transition to the marketing sector is through farm sales by growers to processors and handlers. The lower portion of the diagram includes the interacting elements of the marketing sector. Interrelationships between the sectors are partially represented by marketing charges relating final product prices to farm prices which affect production in the following periods.

In the western late potato system, a large portion of the interaction between the production and marketing sectors is consummated prior to planting by growers contracting production for sale to processors at a predetermined base price. Processors use contracts to assure themselves of potatoes better suited to their quantity and quality needs for processing. Farmers are guaranteed a market for the portion of their production contracted. These processor contracts generally specify a base price for field-run potatoes pegged on the quality of delivered

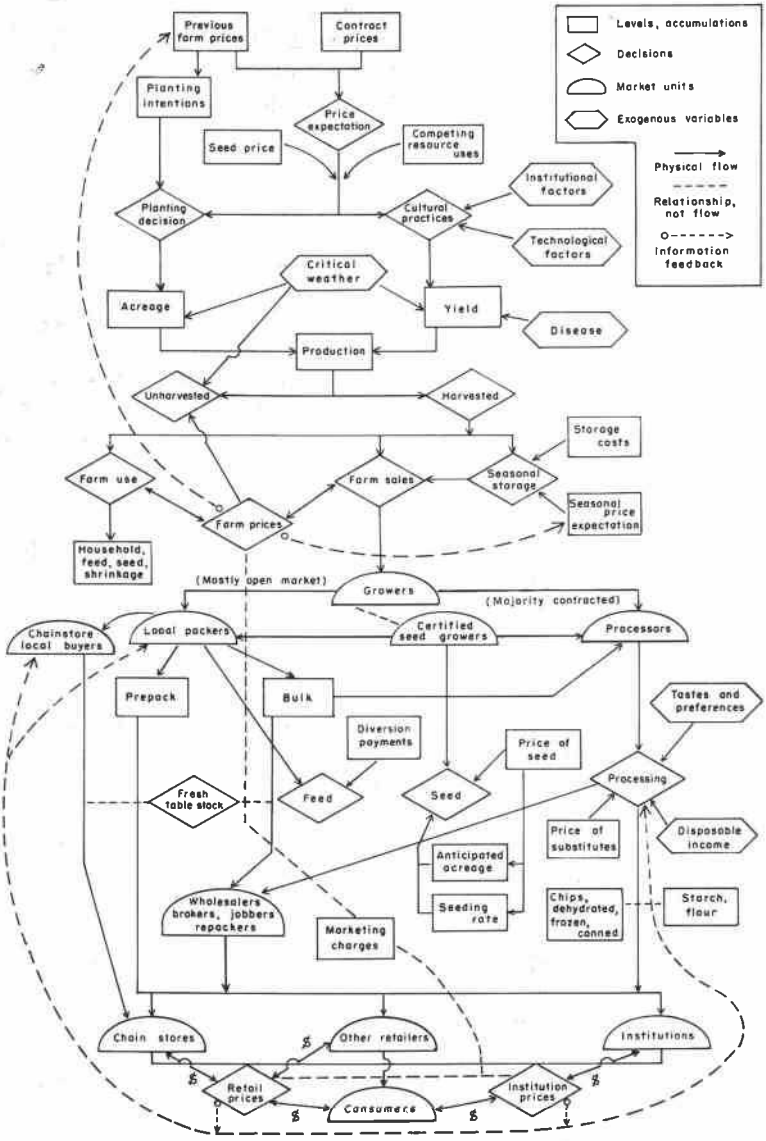

Figure 1. Late crop potato system model.

potatoes. For example, the base price may require 50 percent U. S. No. 1's with one-cent price adjustments for each percent variation in the portion grading U. S. No. 1. Contract terms, which vary annually, also vary among processors for a given year.

Geographic separation of processors usually limits the individual producer to one or a few firms with which to contract for his production. The alternative to contracting requires the producer to grow potatoes for the open market and accept the price risk assumed by the processor under a contract. Many farmers prefer to contract enough acreage to cover variable production costs for their entire acreage and gamble on the market price for their remaining acreage.

Operation of a Bargaining Board in the Western Late Potato System

The preceding description of the economic interrelationships within the U. S. potato system provides the basis for testing bargaining board actions which might benefit producers. This research assumed that a bargaining board would negotiate price and other terms of trade with processors and first handlers in the western late potato area. Terms negotiated would be expected to be more favorable to producers than if producers individually negotiated with the relatively powerful economic units to which they sell their potatoes.

It is assumed that negotiations would take place prior to planting time. The board could thus obtain some bargaining power by discouraging producers from planting until satisfactory terms were agreed upon and could use production quotas to help achieve desired prices; bargaining at harvest time would only permit maximization based on actual production. The necessity to maintain some minimum flow of final products into established market channels would encourage processors to complete contracts before planting deadlines to assure availability of sufficient potatoes for processing. However, necessity of planting by a certain date and inelasticity of demand in the fresh market would also put pressure on producers to settle on contract terms.

The general objective of negotiating for better terms of trade from the producers' viewpoint must be separated into meaningful components in order to analyze the effects of a bargaining board. Although there are several possible sources of bargaining gains, the source which offers the greatest potential of increasing producers' income is control of supply. This research analyzed bargaining gains obtainable in conjunction with supply control. Such control may involve regulating the total quantity of potatoes sold and/or altering the allocation of potatoes between uses having different elasticities of demand. Allocation may be between fresh and processed food uses, among processed products, and between food and nonfood uses. This restriction

and allocation of supply may be necessary to sustain higher prices through bargaining, since negotiations cannot be isolated from the influence of demand as reflected in the price-quantity sales combinations which the market will accept. Finally, fresh sales could be regulated between marketing seasons if economic conditions warranted this action.

Shifting potatoes from one use into another having more elastic demand may result in greater income to marketing firms. The portion of the resulting gain passed on to producers will depend upon the stability of costs and margins in the short run and, over a longer period of time, on the economic power of producers relative to processors.

Assumed Bargaining Board Actions

In actual operations, a board would need to set goals which were meaningful and reasonable in terms of effects on total production, prices, incomes, and/or allocation of physical quantities. These goals would then form the basis for the preplanting negotiations.

The board is assumed to negotiate and establish three items for the western late potato system:

1. A base price for all field-run potatoes sold. The average price actually received by producers from processors would be dependent upon the proportions of potatoes processed and sold fresh by processors, and upon location differentials.
2. A marketing margin for fresh market sales designed to return to producers the final market price minus the negotiated margin. The margin could be flexible to allow profit increases to handlers at various levels as the final market price increases.
3. Quantity sold on the fresh market annually and/or seasonally.

Actions required of the bargaining board to make such negotiations effective are assumed to include:

1. Controlling production at a level permitting regulation of fresh sales to meet goals under expected market conditions. This control is assumed to be established in terms of total production, taking account of expected yields, and implemented through negotiable production quotas with the quota for each year expressed in terms of the base period's quota.
2. Controlling fresh market sales on an annual and/or seasonal basis at a level consistent with negotiated prices. The control is assumed to be exercised via negotiable marketing certificates issued to handlers, the quantity marketable with each certificate being specified annually prior to harvest, when production has been estimated accurately. Adjustments in the specified quantities may be necessary when competing early crop production is determined.

The use of production quotas and marketing quotas in combination is expected to avoid some of the problems of using either alone. Production quotas are assumed to be more effective in controlling supply than are acreage allotments. Experience with several commodities indicates that acreage allotments do not guarantee reduced production because increases in use of variable inputs can increase yields relatively more than the reduction in acreage. Acreage allotments prevent transfer of production to more efficient producing areas, but negotiable production quotas will allow the market mechanism to determine resource allocation in potato production. Negotiable production quotas also could facilitate entry of new producers or expansion of efficient operators while maintaining a ceiling on total production. Even though marketing quotas are used, production quotas adjusted annually for expected yields are also necessary to avoid repercussions from destruction, waste, and nonfood use of large quantities of potatoes.

Marketing quotas covering only fresh market sales neglect the large portion of the potato crop used in processed products. However, the combination of processor awareness of quantities of potato products which can be sold profitably and regulation of fresh market sales would limit total food use of potatoes. Negotiable marketing certificates will allow the market to make interfirm allocation of fresh market sales and provide a convenient means of market entry and exit for firms, while the bargaining board controls only the total volume of fresh sales.

Alternative Policies for a Bargaining Board

Given the assumptions regarding operation of a bargaining board in the western late potato system, analysis of results of operating a bargaining board were undertaken for the following goals which were assumed as plausible alternatives:

1. Increased stability of prices received by producers
2. Increased average level of prices or income received
3. Annual increases in price or income received
4. Increased or stabilized quantity on the market or through processing facilities to achieve more efficient operation
5. Increased or stabilized per capita consumption
6. Annual increases in western acreage

Those sources of gain which represent efficiency increases or reduction of processor profits may be implicitly represented in these operational goals in the form of higher prices to producers without proportional increases in consumer prices. These operational goals are assumed to represent all the potential gains from operation of the bargaining board.

III. SIMULATION MODEL FOR EVALUATING BARGAINING BOARD POLICIES

Simulation Analysis in Economic Systems

To evaluate the impact of alternative bargaining board policies, an operational model is needed. Development of such a model requires quantification of the demand and supply relationships incorporating interactions between production, processing, and marketing decisions affecting farmers, marketing firms, and consumers. A simulation model of the system may be used to evaluate bargaining board policies in a complex, dynamic environment. The model's behavior over time can be generated on a computer, parameters changed, and results compared with those based on other parameter values to determine the effects on the endogenous variables being studied. Thus, alternative decisions can be evaluated in a short period without actually implementing them and observing the results in the real system.

Building a simulation model requires development of mathematical equations representing the functional relationships, consisting of identities and operating characteristics, between components of the economic system. According to Naylor (1966, p. 12), operating characteristics are hypotheses which express interrelationships between variables of the system and usually take the form of mathematical equations. The parameters of operating characteristics can be derived only on the basis of statistical inference. Thus, the accuracy of a simulation depends to a great extent on the accuracy of these estimates of the system's parameters. The possibility of using partial relationships derived by others must be rejected if the model is to contain a consistent set of relationships estimated from comparable data.

Elements of the Potato Simulation Model

Given data limitations for the potato system and the policies to be tested, a simulation model was constructed. The logic of the simulation model was derived from the model of the late crop potato system presented in Figure 1 and the assumed actions of a bargaining board established in the system. A recursive, stochastic model was developed to represent the system and permit evaluation of as many of the specific bargaining board policies as possible. The model does not simulate the operating mechanism of the board; it assumes terms are negotiated and necessary enforcing actions are taken by the board, and then analyzes the effects of these actions on the potato system. The simulation model is composed of three time-related sections corresponding to the seasonal aspects of the potato system. Each section of the model contains several interrelated modules, as illustrated in the schematic representation of the model (Figure 2).

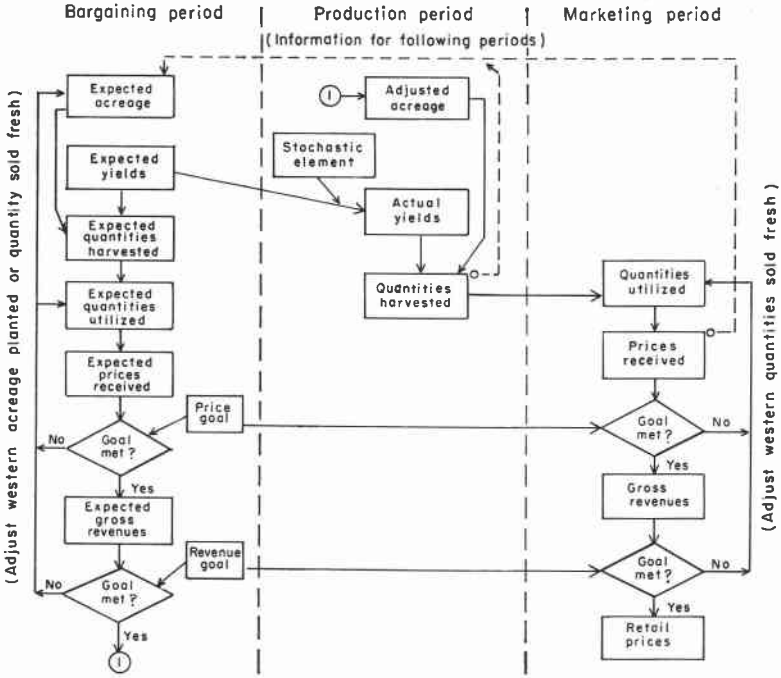

Figure 2. Simulation model for evaluating bargaining board policies.

Under the assumed bargaining board, contract terms are negotiated for the entire western late potato system and appropriate actions are taken by the board to coordinate supply and demand variables to facilitate bargaining. The bargaining board is assumed to negotiate price and quantity terms prior to planting time. The information available to the board at that time furnishes the basis for these negotiations. The same information is used by growers and marketing firms to make preplanting decisions in the absence of a bargaining board. The board must predict these expected production decisions and the corresponding quantities marketed. If the predicted results do not meet various goals established by the board, the board must initiate necessary production and marketing quotas for western late producers to facilitate achieving these goals. The expected results of these predicted and adjusted variables provide the basis upon which final terms are negotiated and necessary facilitative actions are taken by the bargaining board.

The bargaining section of the simulation model is designed to determine the average price and production-marketing terms negotiated in this preplanting bargaining by the board. In this section of the

computer program of the simulation model, expected values of all the endogenous production and marketed quantity variables are estimated, using equations based on exogenous and lagged endogenous variables. The resulting values of the endogenous variables are compared to the goals specified for that year. If these goals are not met, the computer program adjusts the western acreage or the quantity marketed fresh from the West, and again compares the resulting endogenous variables with the goal. This process is continued for the given year until the resulting values meet the assumed goals. The model predictions are the expected results from the specific terms negotiated by the board. The western production and fresh market quantities calculated by the computer program are those which the board would need to specify to achieve its predetermined goals for that year.

In the production period section of the simulation model, actual production in the system is estimated for the crop year. At this point the expected acreage from the bargaining section, including bargaining board adjustments in western acreage, is assumed to be harvested acreage. Stochastic elements are generated by the computer program and combined with the predicted yields of the bargaining period to determine actual yields for the year. This procedure allows for deviations from expected yields due to weather, disease, and other unpredictable influences affecting yields during the growing season. The harvested acreage is combined with actual yield to determine the year's actual production of each crop. Thus, the simulation model takes account of factors beyond the control of the board, just as variables beyond the control of the growers affect actual production in the system.

The marketing period section of the model deals with disposition of harvested production. The board is assumed to adjust fresh sales of western late potatoes to obtain desired goals based on actual production and demand conditions. Certain restrictions are built into the model to represent realistic conditions in the system. Variations between expected and actual yields for some years make adjustments in fresh market sales to meet predetermined goals inconsistent with these restrictions, and the goals are thus unobtainable.

After having estimated the endogenous variables for all segments of the simulation model for a given year, time is updated by one year and the process is repeated. The model is dynamic in the sense that the resulting values of the endogenous variables are input variables from which to calculate the endogenous variables in the following period. The simulated actions taken by a board in one time period thus affect the results obtainable in subsequent time periods, as would be expected in the actual system. The changing stochastic elements incorporated in the yield estimates prevent the system from following smooth trends precisely and add to the realism of the model.

Description of the Potato Simulation Model

The specific relationships used in each segment of the simulation model (Figure 2) are discussed in this section. The underlying economic logic of the various relationships is discussed under headings which correspond to the seasonal periods and segments illustrated in Figure 2. The economic relationships were hypothesized on the basis of factors indicated in the economic model (Figure 1). The nature of the system makes possible the theoretical determination of endogenous variables based on exogenous, lagged endogenous, and current predetermined endogenous variables. Such recursive equations are appropriately estimated by ordinary least squares methods. Stepwise regression analysis and standard statistical techniques were used to estimate the parameters and test the hypothesized economic relationships.[2] Those hypothesized variables passing the statistical tests were retained in the final equations (see Appendix B) incorporated into the simulation model used to predict effects of different actions in the system.[3]

Bargaining Period

The bargaining period section of the computer simulation program generates expected values of the endogenous production and marketing variables, using equations based on exogenous and lagged endogenous variables. This information is available to the board during the preplanting bargaining period and provides the basis for expectations upon which the board must carry out its bargaining.

The expected acreages are derived from prices received in previous years. Expected yields then are derived from trend equations and combined with expected acreage to derive expected production. Utilization of this expected production is determined from trend data. Expected prices received and gross revenues then are calculated from the utilization and production predictions. If a goal has been specified, the appropriate resulting endogenous variables are tested against the goal. Necessary adjustments are made in western acreage or quantity marketed fresh, representing production and marketing quotas available for use by the bargaining board, to help meet the predetermined goals. If adjustments are necessary, the affected endogenous variables are recalculated and again compared with the goal. This process is repeated until the goal for the year is met on the basis of expected values of the variables. The final acreage values are assumed to be the actual harvested acreage used in the production section of the model. It is assumed that the bargaining board takes action to control western production in line with the calculated values.

[2] See Walter J. Armbruster, *ibid.*, pp. 72-78, for further discussion of statistical considerations.

[3] The Fortran program of the model is available from the authors.

Expected acreage. Expected acreages harvested are calculated for the western late, eastern late, early, and intermediate crops. It was hypothesized that planted acreage for each crop was influenced by lagged prices of that crop, lagged prices and production of competing potato crops, alternative production possibilities, and trends in other interacting factors. Harvested acreages are used to allow for the acreage unharvested due to economic conditions, quality, and weather factors.

The resulting regression estimates are used to calculate the expected acreages (Appendix B, Equations 1-4). For western and eastern late potatoes, lagged price of the same crop and the change between weighted average prices for competing late potatoes lagged one and two years were statistically significant explanatory variables. Time was important as an explanatory variable representing influences, such as increases in irrigated acreage, not explicitly included in the equations due to lack of data. An index of prices received for crops which could be grown in place of potatoes failed to come into the equations at significant levels. Variables representing production of the late crop were not important in estimating early and intermediate acreage responses. For early crop acreage, the significant variables were the previous year's acreage and average price received. Intermediate crop acreage was dependent on time and lagged prices for the intermediate crop.

Since satisfactory results were not obtained in attempts to estimate acreage in the central late crop area, the quantity harvested was estimated directly. It is assumed that the predictive equations used here, and the intentions to plant published by the U. S. Department of Agriculture, give adequate information to accurately determine acreages at bargaining time.

Expected yields. Although a number of interwoven influences affect yields, relating yields to time gave the most reasonable results in terms of reproducing the behavior of the system. The resulting equations are used to estimate yields for each crop (Appendix B, Equations 5-9).

Because yield for the early crop was not significantly related to time, the mean yield of early crop potatoes over the estimation period is used as expected yield. Quantity produced, rather than yield, is estimated as a function of time for the central late crop, since a satisfactory estimate of acreage was not obtained. A squared term for time, included to allow for a declining rate of increase in yields, entered some of the equations at a significant level with negative coefficients. However, use of such equations in the simulation model leads to untenable results because the squared term becomes dominant after a period of time, leading to decreasing yields.

Expected quantities harvested. Expected quantities harvested take account of adjustments for production unharvested due to economic conditions, quality, and weather factors. This creates consistency between quantities available for use from the production sector and utilization projections from the marketing sector of the system. Expected quantities harvested are calculated by multiplying expected acreage by expected yields. The exception is the quantity of central late potatoes harvested, which is estimated directly as a function of time. Total quantity harvested is derived by summing the harvested quantities of the individual crops.

Expected quantities utilized. Ideally, demand relations for the different food uses should be estimated at the wholesale level, since wholesale prices and costs influence interproduct allocation of potatoes. Marketing and processing costs could then be used to evaluate the effect of a change in production or allocation of the western crop on the total marketing system. Adequate data are not available to estimate demand relations at the wholesale level for all individual food uses of potatoes. Nor are sufficient data available on marketing and processing costs to make inferences to other market levels from the wholesale level.

The best data available are on a farm-level basis. Data on utilization of raw potatoes by major categories are available for the total U. S. on a yearly basis. It was assumed that relating average prices received by farmers to utilization data would provide a sound basis for the necessary analysis, even though the relationships could not be considered demand relationships. Actions of the western late potato marketing board could be analyzed for effects on utilization and, in turn, on prices received in various production units.

It is assumed that per capita consumption of potatoes is largely dependent on factors exogenous to the potato production-marketing system such as processing technology, per capita income, and expenditures for food away from home. Processing technology may be influenced in the longer run by potato prices, but trend data reflect the influence of prices on processing. Quantities actually processed and marketed are determined by processors' and marketing firms' knowledge of the amounts which can be sold at prices they deem reasonable. Perusal of per capita consumption data for the past decade suggests that such assumptions are justifiable. The decline in total food use of potatoes per capita has been halted, and the pattern has shifted to one of nearly steady or slightly increasing utilization. During this time, fresh consumption has continued to decline, and increased consumption of processed products has offset the decrease in fresh consumption.

Consumption of processed potato products per capita would be expected to increase at an increasing rate in early years of availability

as quality improves and price decreases, but to increase at a decreasing rate in later years as consumption approaches the saturation point. The logistic function is a symmetrical mathematical function which exhibits such a pattern (Appendix B, Equation 10). The logistic function was found to give a reasonable fit to per capita data for potatoes used for frozen products and potato chips.

For dehydrated potatoes, the small number of observations and the jumps in utilization due to development of satisfactory dehydration technologies make it impossible to fit any type of curve to the data. However, utilization of dehydrated potatoes per capita has increased rapidly in recent years and might be in the lower portion of the logistic curve. If consumption of each of the processed forms of potatoes is assumed to follow the logistic pattern, then total consumption of processed forms also follows the logistic form. A logistic fit was obtained for total processed potato utilization per capita. Dehydrated utilization then was obtained by deducting chip and frozen potato utilization from this total. The resulting value of the upper asymptote for per capita utilization of potatoes for dehydrated products was 31.39 pounds annually, nearly identical to the value for frozen products. This result may be due to the dominance of frozen utilization in the data used to derive total processed utilization. However, it seems reasonable to expect rather similar results for frozen and dehydrated potatoes, since both are used to a large extent in restaurants and institutions as substitutes for fresh potatoes.

Fresh utilization is obtained by deducting total processed from total food utilization. Total food utilization may be assumed to be constant at 110 pounds per capita annually or to be increasing slightly. The derived lower asymptote for fresh utilization, based on 110 pounds per capita total food utilization, is 21.34 pounds.

The per capita utilizations are calculated and multiplied by population to determine total quantities utilized in the various food forms. Then the quantity utilized for other purposes is obtained by deducting food use from total quantities available. This approach assumes that trends in per capita consumption will not change significantly in the near future. The population projection is based on time (Appendix B, Equation 11). Utilization is on a crop year basis, encompassing the production from the late crop and the following early and intermediate crops which are marketed in conjunction with the stored quantities of the late crop.

Expected prices received. The quantities utilized are employed to estimate prices received for each of the late crops. Prices were hypothesized to be related to utilization in forms most important to each area. Prices are related to total harvested quantity through the quantity of other uses, which is a residual category consisting of shrinkage or

loss and potatoes used for canning, starch and flour, feed, and seed. The resulting regression equations are used to calculate the expected prices received (Appendix B, Equations 12-18).

Quantities for other uses and fresh use of potatoes are the most important variables in explaining late crop prices. These are variables which the western bargaining board can affect in manipulating production or fresh sales to meet specified goals. The relative size of the western late crop assures important influence on total potato crop utilization in fresh and other uses. The quantity of potatoes used for frozen products is included in the price equation for western potatoes and the quantity dehydrated is included in the equation for eastern potatoes, since these are felt to be important economic influences. Though not entering the equations at significant levels, these utilization variables contributed to increasing the R^2 value and reducing the standard deviation of the estimated prices. Prices for the early and intermediate crops are calculated on the basis of per capita production of those crops and per capita quantities of late potatoes in storage at the appropriate time.

The computer program calculates the price for western late potatoes and then, if there is no price goal indicated, proceeds to calculate prices for the other crops. If a price goal has been set, necessary adjustments are made and the western price is recalculated as many times as necessary to achieve the price goal. The adjustments also affect prices in the other areas; hence, those prices cannot be determined until the western price goal has been achieved and the adjustments completed.

The adjustments take the form of changing acreage in the West to get harvested production into the range that will allow further necessary adjustments to be made by controlling sales of fresh potatoes from the West. If the calculated price is below the price goal, acreage or quantity allocated to fresh sales is decreased to raise the price. The opposite adjustments are made to lower the price, assuming that it is desirable not to exceed the goal and thereby encourage competitive production. If the calculated price is two percent or more away from the price goal, acreage is adjusted. The adjusted acreage is the basis upon which the bargaining board would specify production quotas to attain the desired quantity. When the price is less than two percent from the goal, quantity sold fresh is adjusted. The goal is assumed to be met when the price is within one percent of the price goal. Prices for the other crops are then calculated.

Harvested production for the West, total production, and quantity of potatoes for other uses all must be recalculated when western acreage is adjusted. If the quantity marketed fresh is adjusted, a change results in total quantity used for food and for other uses, but total processing

is assumed unaffected; hence, the total per capita consumption is adjusted. A restriction imposed on the process of adjustment is that quantity for other uses cannot decline below 14 percent of total harvested production. This minimum was established based on 1956-1968 data for use of potatoes as seed and the amounts taken by shrinkage and loss. The possibility of reducing the amount of shrinkage and loss could be evaluated to determine the value or cost of the loss. If the assumed goal is unable to be met because of this restriction, the adjustment is carried as far as possible towards the goal, and price predictions are based on those adjusted quantities.

The calculated price received is not the price which would be established by a bargaining board. The average price received is dependent upon the allocation of the actual production into different uses. The board would need to establish a contract base price and marketing margin for fresh sales, based on information obtained from growers, processors, and shippers, which would achieve the specified average price received. The price equations in the model implicitly assume the same marketing and processing margins as in the past, although a board may be expected to alter these margins to some degree.

Expected gross revenues. Expected gross revenues are determined by multiplying expected prices by expected quantities harvested. This gross revenue is the value of harvested production which is higher than actual sales value. Sales value would be smaller than the calculated gross revenue by the imputed value of shrinkage and loss, and the value of feed, seed, and household use on farms where grown. The gross revenue for western late potatoes is calculated after the western price has been determined. The other gross revenues are then calculated, unless a gross revenue goal has been established.

If a revenue goal has been established, adjustments are made in a manner similar to those for price adjustments. The gross revenue goal adjustment mechanism in the computer program manipulates western quantity produced or sold fresh to affect price received. But adjusting acreage one direction to move price received the opposite direction may result in failure to change gross revenue in the desired direction after a certain point. The limit for gross revenue change depends upon price flexibilities which are implicit in the coefficients of the western price equation. It is therefore necessary to provide for stopping the adjustment process if the absolute rate of change becomes very small, indicating a limit has been approached on gross revenue under the particular supply and demand conditions for that year. An increment of .2 percent of the previous level of gross revenue was established as a minimum change to indicate progress toward the gross revenue goal. If the goal is unable to be met, adjustment is carried out as far as possible towards the goal and the western gross

revenue calculated is the limit under the given conditions. Prices and gross revenues for the other areas can then be calculated on the basis of the adjusted quantities.

Production Period

The actual production realized in the system during the crop year may differ from the expected production upon which bargaining was based. The difference is caused by actual yields deviating from expected yields, due to uncontrollable influences. In this section of the computer program, the actual acreage is assumed to be the same as the final acreage values used in the bargaining section. Actual yields are generated by the computer program and used to calculate the actual production in the system for the year.

Adjusted acreage. The block for adjusted acreage is included in Figure 2 to indicate the transition from the bargaining to the production and marketing segments of the model. The acreages of this block are the actual acreages harvested in each area, and are the same as calculated under expected acreages in the bargaining period, including the adjusted western acreage. There are no additional calculations involved in the simulation program at this point.

Actual yields. Actual yields are determined by combining a stochastic element with the expected yields projected in the bargaining period. The stochastic element is included to account for the random effects of weather and other factors which are likely to cause yields to deviate from expected yields. A normal distribution is assumed for these deviations. The stochastic element to be added to or subtracted from the expected yield for each area is derived by generating a standard normal variate and multiplying it by the appropriate standard deviation of yield obtained from the estimating equations (Appendix B, Equations 5-9). The procedure is applied to quantity in the case of central late potatoes. The same sequence of standard normal deviates is used in each run of the model to reduce residual variation between average responses for alternative policies and thus improve the forecast ability of the model.

Quantities harvested. Quantities harvested are obtained by multiplying adjusted acreages by yields for each crop. The stochastic effect of weather is thus accounted for in determining results in the potato system beyond the bargaining period. The actual harvested quantities usually will differ from the expected quantities, and this difference will be reflected in utilization, prices received, and gross revenues.

Marketing Period

The actual values of the marketing sector variables may also differ from their expected levels upon which bargaining was based. These differences arise because actual harvested production deviates from

expected production. In this section of the computer program, the actual quantities harvested are used to calculate actual values of the marketing variables for the crop year. The general calculation sequence is the same as employed in the bargaining section.

Quantities utilized. It was hypothesized that quantities utilized would be affected to some degree by the quantities of potatoes actually harvested. The assumption is maintained that quantities actually processed and marketed are determined by processors' and marketing firms' knowledge of the amounts which they individually can sell at acceptable prices. Quantities utilized, estimated on the basis of per capita consumption trends in the bargaining period, would be expected to change to the extent necessitated by harvested production. The hypothesized regression equations treated the dependent variables for potato utilization in food forms as a function of the previous year's utilization, the change between the previous and current year's quantity harvested of relevant potato crops, and total expenditures for food away from home, except in the equation for chips. The resulting regression relationships (Appendix B, Equations 20-23) are used to determine quantities utilized.

When the model was run for an extended period, quantities utilized, estimated on the basis of these equations, deviated from the bargaining period projections based on the logistic curves. Hence, a restriction was included in the model to require that actual quantities utilized be within 10 percent of the expected utilizations for fresh, dehydrated, and frozen products. These limits were imposed to allow reasonable fluctuation while acknowledging the necessity of maintaining established market shares. The restrictions led to more tenable results from the model.

The per capita expenditure for food away from home was found to be satisfactorily projected by using the logistic function to determine annual increases in per capita expenditure (Appendix B, Equation 19). The per capita expenditure thus projected is mutiplied by population to determine total annual expenditure.

Prices received. Based on the actual quantities utilized, the average price received for western late potatoes is calculated. Any adjustments necessary to meet an established price goal are then made in the quantity marketed fresh, since production has already been determined and the board can only adjust sales allocation at this point. Adjustment limits are established by the requirements that the actual quantity of potatoes marketed fresh must be at least 90 percent of the expected quantity from the bargaining period, and the actual quantity going into other uses must be at least 14 percent of actual harvested production. The adjustments are carried out until the goal is met, or a restriction prevents further adjustment, and the final price for western potatoes

is determined. The adjustment mechanism is similar to that used in the bargaining period. Prices received for the other crops, based on adjusted or unadjusted quantities as appropriate, are then calculated.

Gross revenues. Gross revenues are derived from quantities harvested and actual prices received for each of the crops. If a goal is established for gross revenue in the western late area, adjustments are carried out subject to the restrictions discussed above regarding attempts to achieve price goals. The provision to stop adjustment when the absolute change in gross revenue is less than .2 percent of the previous gross revenue level is included in the program, as it was in the case of expected gross revenue adjustments.

Retail prices. Some measure of the effect on final product prices is required to permit evaluation of the relative effects of various bargaining board actions on consumers. Data are available over a period of time long enough to permit analysis for retail prices of frozen french fries and fresh potatoes, but not for dehydrated products or potato chips. Several factors indicate that retail prices for fresh potatoes and frozen french fries can be estimated using a single-equation technique. These factors include trends in consumption of potatoes, accompanied by fluctuation in prices for fresh potatoes and potato products, and the assumption that individual processors and marketing firms determine quantities marketable at suitable prices.

It was hypothesized that retail prices for fresh potatoes are influenced by per capita utilization of fresh potatoes, total per capita use of potatoes for processed products, time, and the average price received by farmers for all potato crops. The variable for per capita consumption of fresh potatoes was not significant in the estimated relationship (Appendix B, Equation 24). The retail price of frozen french fries was hypothesized to be influenced by per capita utilization of potatoes for frozen products and for fresh use, expenditures for meals away from home, time, and price of western late potatoes. Only per capita fresh utilization and western price received proved significant (Appendix B, Equation 25). These equations are used to estimate retail prices of fresh potatoes and frozen products.

Using retail prices for frozen potato products is not completely satisfactory, since over half of the frozen products are sold for institutional use. But the available information on institutional sales is for f.o.b. prices, so it is impossible to derive a consistent weighted average price for retail and institutional sales. If the retail price is assumed to reflect general market conditions for frozen products, then the estimated price provides a useful measure. These calculated retail prices should be interpreted as indicating relative effects on consumer welfare from different bargaining board actions rather than as absolute results expected from specific actions.

Information Generated by the Potato Simulation Model

The actual values of the variables generated in the production and marketing periods are the relevant ones for evaluating actions of a western bargaining board. Variables chosen for analysis are those which give information of interest to the three parties concerned in bargaining: producers are interested in quantities produced and prices received; processors and handlers are most concerned with quantities utilized, retail prices, and prices received by farmers; consumers are affected by retail prices and quantities going into different uses.

Although values for these variables are calculated and printed for each year of model operation, statistics which summarize the large amounts of data generated are needed to facilitate evaluation of different actions. The level of each variable is indicated by its mean over the simulated time period, and the coefficient of variation indicates variability about this mean. The endogenous variables for which these summary statistics are generated are listed in Table 1. The mean of these variables will be presented for selected model runs as a basis for analysis of the bargaining board policies tested.

Verification of the Potato Simulation Model

The model was verified before its use to simulate and evaluate alternative bargaining board actions. Inferences cannot be made about the accuracy of regression relationships projected beyond the range of the data from which they are estimated. The equations of the model were estimated from data generated by components of a system hypothesized to interact in a manner similar to that assumed in the simulation model. However, it is important to test the model's dynamic nature over a period of simulated years by determining the degree of agreement between model and actual system results.

One measure of model validity is the ability to duplicate behavior characteristics of the system under study—stability, growth, and time relationships among changing variables. Two different methods have been used to test the model's ability to reproduce behavioral characteristics of the potato system. First, the model was run for a period of time over which data are available for comparing actual and simulated results. Secondly, the model was run for an extended period of time to provide a basis for judging reasonableness of growth, stability, and time relationships among the changing endogenous variables of the model.

Historical Comparison

Model results were generated for an 11-year period representing the 1958-1968 crop years and were compared to observed data from that period. The 1958 crop year was the first for which model results

Table 1. Output Variables from Potato Simulation Model

Symbol	Variable	Units
AWL	Harvested acreage of western late potatoes	Thousand acres
AQWL	Harvested quantity of western late potatoes	Thousand cwt.
APWL	Season average price received for western late potatoes	Dollars per cwt.
AGRWL	Value of western late potatoes harvested	Thousand dollars
AQFR	Quantity of potatoes utilized for fresh food	Thousand cwt.
AQFF	Quantity of potatoes utilized for frozen food products	Thousand cwt.
AQD	Quantity of potatoes utilized for dehydrated food products	Thousand cwt.
AQC	Quantity of potatoes utilized for potato chips	Thousand cwt.
AQO	Quantity of potatoes utilized for other than food	Thousand cwt.
APFR	Annual average retail price of fresh potatoes	Cents per pound
APFF	Annual average retail price of frozen french fries	Cents per pound
AQEL	Harvested quantity of eastern late potatoes	Thousand cwt.
APEL	Season average price received for eastern late potatoes	Dollars per cwt.
AQCL	Harvested quantity of central late potatoes	Thousand cwt.
APCL	Season average price received for central late potatoes	Dollars per cwt.
AQE	Harvested quantity of early potatoes	Thousand cwt.
APE	Season average price received for early potatoes	Dollars per cwt.
AQI	Harvested quantity of intermediate potatoes	Thousand cwt.
API	Season average price received for intermediate potatoes	Dollars per cwt.
RAQWL	Ratio of western late to total harvested quantities	
RAGRWL	Ratio of western late to total value of potatoes harvested	
WAPWL	Weighted average price received for western late potatoes	Dollars per cwt.

could be generated, since 1956 values were the earliest available for certain variables lagged two years in the model. Using results from the actual system to start the simulation model assumes that if a bargaining board were established in the potato system, it would start operations given the condition of the system at that time. Further, observed values of the variables provide the information available to decision makers in the system.

Results comparable to the actual operating system were obtained by generating the endogenous variables based on the relationships discussed previously. The mean values of the variables for the simulated

run, and those observed for the actual system for the 1958-1968 crop years, are presented in Table 2. No bargaining board goals were set in generating these results, since no bargaining board existed during that period. In this approach, stochastic elements used to estimate actual crop yields would be expected to have some influence in causing model results to differ from those of the actual system. Hence, the model was also run substituting historic yields for the stochastic yields generated for each year in the production section of the model. For the central late crop, historic quantity was substituted for the stochastic quantity. In accord with expectations, the means of simulated values, based on historic yields, were at least as accurate as simulated values using stochastic yields in predicting the observed values of the actual system. But the improvement in the estimates using historic rather than stochastic yields was generally small, relative to the observed actual system values. Hence, the conclusion was drawn that the stochastic yield generation was not unduly affecting the model's ability to duplicate the actual system.

The relative difference between the means of the simulated results and those of the actual system indicate that the model duplicates the behavior characteristics of the system reasonably well. Of the 10 quantity-harvested and price-received variables, only the simulated mean price received for intermediate crop potatoes deviates more

Table 2. Comparison of Simulated and Observed Results, 1958-1968

	Mean value		Percent change: Observed to simulated	Coefficient of variation	
	Observed	Simulated		Observed	Simulated
AWL	452.10	452.81	.2	11.2	10.3
AQWL	102,490.00	103,167.27	.7	18.0	16.5
APWL	1.85	1.92	3.8	30.8	17.7
AQFR	145,348.00	145,625.31	.2	7.8	7.1
AQFF	25,177.00	22,168.28	-12.0	51.3	49.0
AQD	13,092.00	12,404.50	- 5.3	46.2	45.1
AQC	26,447.00	27,349.29	3.4	22.1	18.5
AQO	66,034.00	64,402.93	- 2.5	19.8	10.2
APFR	7.13	6.84	- 4.1	13.2	5.9
APFF	30.90	31.64	2.4	10.4	10.4
AQEL	73,161.00	70,368.03	- 3.8	3.7	5.0
APEL	2.02	2.10	4.0	34.2	16.3
AQCL	55,023.00	54,154.27	- 1.6	7.6	7.6
APCL	1.89	1.97	4.2	34.4	15.9
AQE	8,441.00	8,392.53	- .6	12.7	11.4
APE	3.18	3.23	1.6	24.2	12.8
AQI	36,706.00	35,868.21	- 2.3	9.0	6.8
API	2.68	2.94	9.7	32.8	22.0
RAQWL	.37	.38	2.7	0.4	7.5
WAPWL	1.83	1.92	4.9		

than 5 percent from its value in the actual system. Other variables which approach or exceed 5 percent deviation between simulated and observed values are weighted price for western late potatoes and quantities utilized for frozen and dehydrated products. Thus, the growth of the variables generated by the model is fairly representative of that for the actual system over the period for which comparative data exists.

An indication of the relative stability of the simulated and actual systems is given by the coefficient of variation (the standard deviation expressed as a percent of the mean) of the variables over the 11-year period. Coefficients of variation which are nearly the same for a variable in the simulated and actual system indicate that stability characteristics of the system are duplicated by the model. The simulation model gives estimates for the variables which are generally slightly more stable than those of the actual system, as indicated by smaller coefficients of variation in Table 2. The greatest increases in stability of model-generated variables over those of the actual system involve average prices received by farmers for each of the crops and the retail price of fresh potatoes. Further analysis would be needed to determine the cause of this greater stability of simulated results and the changes needed in the model to better duplicate the variability of these observed prices. One possible explanation is that price inelasticity of demand, at the farm level generally and at the retail level for fresh potatoes, causes these observed prices to fluctuate widely with relatively small changes in the quantities influencing them. Hence, differences in stability between observed and simulated quantities are magnified in determining price estimates and the spread in stability increases.

Model estimates of yearly levels of the endogenous variables were less accurate than were their means over the 11-year period. The absolute level of the variables calculated each year should not be considered as precise estimates of actual levels. However, the intended use of the model is for evaluating relative results of different bargaining board policies over a period of years. The means and standard deviations of the variables over a period of years should provide reliable measures of the effects of alternative actions.

Extended Projection

Another test of the model was conducted by generating results for a 40-year period starting with 1958 under three different conditions: no goal specified, a gross revenue goal increasing 6 percent annually, and a price goal increasing 3 percent annually. These tests, made to assure that untenable results were not obtained when the model was run for an extended period, served as a basis for model revision

incorporating restrictions on actual quantities marketed fresh and those marketed for other uses. The criterion of judgment must be apparent reasonableness of the estimates, since there is no way of knowing what levels to expect for most of the variables. The model used here was judged to give reasonable results over the extended run in addition to acceptably duplicating growth and stability of the system.

IV. ANALYSES OF BARGAINING BOARD POLICIES

Method of Analysis

Given the ability of the model to generate reasonable results over the 11-year period tested against actual data, a decision was required on the length of time to be simulated beyond that period. Testing policies of a bargaining board required projecting operation of a board in the system. The approach used assumed that a board was established starting in 1968. Operation of the system was simulated only to 1980, since all projections assumed the general trends and relationships observed in the past continued basically unchanged over the projection period.

Since no comparable historical data existed for the 1968-1980 period without a bargaining board, a standard for comparison of results simulated under assumed bargaining board alternatives was provided by a base run for 1968-1980. The base run represented projection of the present system into the future and consisted of values of the endogenous variables generated by the model when it was run with no goals or other interference. Although the base run did not precisely duplicate the results expected from the actual system over that period, the previous comparison of simulated and actual results for 1958-1968 indicated that the base run values were reasonable estimates of the actual system values. The impact of each alternative was evaluated by comparing simulated values of endogenous variables for that alternative with the corresponding base run values.

Bargaining Board Alternatives Tested

Most of the bargaining board operating goals previously specified were tested by simulating results under different levels of the assumed goals. A goal of increased price stability was tested, using a range of prices which included the average price received for the western late crop in the base run. Different levels of price stability were tested by setting the price goal at constant levels over the entire period. The model mechanism then forced adjustments in other variables, so that the average price received for the western late crop was very close to the specified price level.

A goal of increasing prices was tested by using various rates of increase in the price goal, with the initial price goal for all runs equal to the price received in the first year of the base run. Results of this test led to use of a 5 percent annual rate of increase for testing the goal of increased average level of prices received. A range in levels of initial price goal was chosen to include the price received in the first year of the base run. Increasing the various initial price goals by 5 percent annually resulted in different average levels of price received for western late potatoes over the period.

To test a goal of increasing gross revenue, a number of increase rates for gross revenue were used. The initial gross revenue goal for all runs was set equal to the gross revenue obtained for the first year in the base run. Tests of a policy to increase western acreage by various amounts each year were conducted using a range of rates of increase which seemed reasonable, starting with acreage in the first year for all runs equal to that for the first year of the base run. The goal of increased per capita consumption of potatoes for food was tested by using different values at which total per capita consumption was fixed. Another test of this goal was conducted in which per capita consumption of potatoes for food was increased one pound annually from the initial level of 110 pounds annually. Per capita food consumption of 110 pounds annually was assumed in all the years for the base run and for all other policy tests.

No test was specifically conducted to test a policy of stabilizing quantity on the market or through processing facilities to achieve more efficient operation. Quantities utilized under the various other alternatives tested were examined as a means of evaluating the results. If two alternatives gave nearly the same results for most variables, the coefficient of variation for quantities utilized could be used to choose the alternative resulting in the greater stability of quantity processed or marketed fresh. Further analysis of this policy would require development of data on operating costs related to volumes handled.

Results of Tests

The results of the tests of various policy alternatives are presented by tabulating the average values of the variables over the 13-year period for several levels of the alternatives tested and for the base run (Tables 3-8). The percentage change from the base values to the values of the level chosen for comparison are presented as the last column in each of the tables. The percentage change is given for variables most important to western late potato producers and showing the greatest changes. The alternative chosen for comparison with the base is generally the one resulting in the highest average level of gross revenue for western late potatoes. Of the additional runs made, only enough are

Table 3. Results of Price Stability Policy (average values for 1968-1980)

	Base	Level at which price received is stabilized				Percent change: Base to $3.10
		$3.00	$3.10	$3.20	$3.30	
AWL	624.80	607.15	589.12	568.37	549.27	- 5.7
AQWL	156,648.00	152,662.02	148,139.66	142,946.31	138,164.03	- 5.4
APWL	3.18	3.01	3.12	3.21	3.32	- 1.9
AGRWL	506,903.79	459,628.43	461,813.37	459,493.27	458,681.62	- 8.9
AQFR	88,492.55	100,027.04	99,086.42	99,361.60	98,722.45	12.0
AQFF	65,037.22	63,961.63	63,691.40	63,394.22	63,101.41	
AQD	44,408.70	44,416.99	44,416.99	44,416.99	44,416.99	
AQC	40,260.00	40,260.00	40,260.00	40,260.00	40,260.00	
AQO	92,474.69	78,341.32	75,992.42	71,781.89	68,905.15	-17.8
APFR	8.99	8.83	8.88	8.92	8.97	- 1.2
APFF	18.42	20.33	20.25	20.39	20.36	9.9
AQEL	70,227.20	69,875.26	70,397.66	70,881.04	71,406.68	
APEL	2.63	2.47	2.59	2.70	2.82	
AQCL	65,700.22	65,700.22	65,700.23	65,700.22	65,700.22	
APCL	2.69	2.80	2.90	3.02	3.12	
AQE	7,945.04	8,098.51	8,176.86	8,265.87	8,346.97	
APE	2.88	2.94	3.01	3.10	3.17	
AQI	30,152.69	30,670.97	31,032.83	31,421.26	31,788.09	
API	3.52	3.58	3.65	3.73	3.80	
RAQWL	.47	.46	.45	.44	.43	
RAGRWL	.50	.48	.47	.46	.45	
WAPWL	3.24	3.01	3.12	3.21	3.32	-3.7

presented to give an indication of the variation in results under alternative levels of the policy variable being tested.

The average annual gross revenue for western potatoes over the simulated period generally reached a maximum at one level of the policy. This result occurred because the range of adjustment in quantity produced included the point of unitary elasticity of demand at the farm level. At lesser quantities, decreases in production resulted in less than proportional increases in price, and at greater quantities decreases in production increased price more than proportionally. The maximum average gross revenue under bargaining board policies never attained the level achieved in the base run, at least partly because greater amounts of resources were used annually for potato production in the base run. The bargaining board was assumed to limit resource use through production quotas to achieve the goals specified.

Using the average level of gross revenue as a criterion for choosing the best alternative assumes that the aggregate welfare of western late potato producers increases with higher levels of gross revenue. Since more resources may be committed to attain the higher gross revenue, net revenue may provide a better basis for determining the welfare of producers under different alternatives. However, information on production costs and their variation under different levels of production are unavailable. Because this information was unavailable, the return on resources committed to achieve a given gross revenue was evaluated by assuming that a larger quantity produced indicated use of greater amounts of resources. Then the weighted average price received (the gross return per hundredweight of potatoes produced) was used as a criterion of evaluation.

The weighted average price received generally increased as prices were raised under more restrictive production limits imposed by a bargaining board. If some economies of size in potato production were lost under production restriction, then the cost increase per hundredweight, relative to the revenue increase, would need to be evaluated. No best alternative level of a policy could be chosen on the sole basis of a weighted average price received which continued to increase as western production was further restricted. This measure should be used in conjunction with average gross revenue and the other variables to evaluate alternatives.

Price Stability Policy

The results of a policy to increase price stability are shown in Table 3. The largest average gross revenue for any level of price stability tested occurred when the goal was set at $3.10 per hundredweight. Western late potato producers fared better under the present

system than under a bargaining board which attempted to stabilize the annual average price received at $3.10 per hundredweight. Under this goal, average gross revenue for the western system was down nearly 9 percent and the average revenue per hundredweight was down nearly 4 percent from the base run.

Processors used less than 3 percent fewer potatoes for frozen products, but the retail price for frozen products was 10 percent higher under this price stability policy than in the base run. Greater fresh sales from smaller total quantities available probably led to higher prices paid by processors for potatoes for freezing; this was reflected in the smaller quantity processed and the higher average price passed on to retail sales. The consumer gained from availability of more fresh potatoes at a slightly lower average price than in the base run. This greater quantity marketed fresh could be expected to benefit firms selling or handling fresh market potatoes. The lower average price paid producers for potatoes also would benefit processors and handlers. Generally it appears that a policy of a bargaining board to stabilize price at $3.10 per hundredweight may benefit the other parties concerned at the expense of the producers.

But stabilizing the price received at $3.30 per hundredweight may be desirable for producers. Total gross revenue was 9.5 percent below that for the base run, but only down slightly from the $3.10 price stability level. The weighted average price per hundredweight was about 2.5 percent above the base, compared to a weighted average price which was 3.7 percent below the base under the $3.10 price level. There were still substantially more fresh potatoes marketed at approximately the same price as the base, although consumers did not fare quite as well as at the $3.10 level. The price of frozen products was slightly higher at retail and the quantity of potatoes utilized for frozen products slightly less than for the $3.10 level. Processors and handlers did not fare as well as under the $3.10 level, since slightly smaller quantities were handled, but prices paid farmers were increased by more than retail prices increased. Hence, under price stability at the $3.30 level, producers fared better on the basis of revenue per hundredweight produced, while fresh handlers and consumers of fresh potatoes were better off than in the base. The consumers of frozen products had smaller quantities available at higher retail prices. Prices paid to farmers by processors (indicated by the average price received by farmers) increased less than the retail price for frozen products, compared to the base. One source of increased average price received by farmers under restricted production conditions established by a bargaining board was reduced utilization of potatoes for lower-valued nonfood uses. This source was apparently important under most of the policies tested, as can be seen in Tables 3-8.

Under either level of price stability, producers of other potato crops gained over the base run conditions. They produced the same or greater quantities and sold them at a higher average price, implying greater total and per hundredweight revenue.

Policy to Increase Price at Various Rates

The results of a policy to increase season average price received by western late potato producers at different rates are presented in Table 4. A 5 percent rate of annual increase gave the largest average gross revenue over the period, but the mean value for the western producers was 7 percent less than under the base conditions. However, the 5 percent annual increase in price resulted in a slightly higher average price per hundredweight produced than for the base run. Consumers had an average of 11 percent more fresh potatoes over the period. The greater quantity marketed fresh resulted from attempts to increase the average price received for western late potatoes to meet the goal for each year. But the average retail price over the period was also about 1 percent above that in the base run. An apparent contradiction of the accepted demand curve for fresh potatoes exists in the higher retail price for a larger quantity marketed fresh. However, the price and quantity variables listed in Table 4 are average values over the period, and the quantity and price movements within a given year are still consistent with expectations.

Under this policy of increasing the season average price received by farmers, consumers paid a 10 percent higher average price for nearly the same quantity of frozen products as in the base run. Since the retail price of frozen products increased substantially more than the farm price received, processors of frozen products fared better, given a board with such a policy. Fresh handlers paid an average price to farmers which was increased by a greater proportion than the retail price. The larger additional quantity handled may benefit or hurt handlers, depending upon their cost structure. If fixed costs were such that the additional quantities resulted in lower unit costs, the increased quantities could be favorable to handlers. Again, producers in other areas would gain under a price increase goal, compared to the base conditions.

Price Level Increase Policy

A goal of increasing the average level of price received by western producers gave the results shown in Table 5. Based on the results from the previous test of increasing price at various rates, the 5 percent rate of increase was used in this test. Varying the initial price level led to different average price levels over the period. The highest average gross revenue for the system was attained with a price initially set at $2.36 per hundredweight. This was the same price as the initial

Table 4. Results of Policies to Increase Price at Various Rates (average values for 1968-1980)

	Base	Percent annual increase in price goal				Percent change: Base to 5
		3	4	5	6	
AWL	624.80	641.04	608.91	573.89	535.82	– 8.1
AQWL	156,648.00	160,665.54	152,464.93	143,549.41	133,786.75	– 8.4
APWL	3.18	2.84	3.04	3.24	3.48	1.9
AGRWL	506,903.79	464,341.77	470,296.76	471,581.82	466,910.42	– 7.0
AQFR	88,492.55	101,087.98	99,785.82	98,405.47	96,644.80	11.2
AQFF	65,037.22	65,230.28	65,002.87	64,731.34	64,517.42	
AQD	44,408.70	44,416.99	44,414.84	44,407.74	44,414.73	
AQC	40,260.00	40,260.00	40,260.00	40,260.00	40,260.00	
AQO	92,474.69	82,102.50	76,993.01	71,416.13	65,448.11	–27.8
APFR	8.99	8.84	8.95	9.07	9.21	.9
APFF	18.42	20.38	20.32	20.26	20.16	10.0
AQEL	70,227.20	68,861.58	69,699.64	70,605.29	71,573.10	
APEL	2.63	2.30	2.52	2.76	3.02	
AQCL	65,700.22	65,700.22	65,700.22	65,700.22	65,700.22	
APCL	2.69	2.66	2.85	3.05	3.28	
AQE	7,945.04	7,896.76	8,014.99	8,144.67	8,283.92	
APE	2.88	2.83	2.96	3.11	3.26	
AQI	30,152.69	29,973.64	30,576.76	31,221.08	31,941.07	
API	3.52	3.47	3.60	3.74	3.89	
RAQWL	.47	.48	.47	.45	.43	
RAGRWL	.50	.50	.48	.46	.44	
WAPWL	3.24	2.89	3.08	3.29	3.49	1.5

Table 5. Results of Price Level Increase Policy (average values for 1968-1980)

	Base	Initial level of price goal (5 percent annual increase)				Percent change: Base to $2.46
		$2.16	$2.26	$2.36	$2.46	
AWL	624.80	621.83	598.06	573.89	548.68	-12.2
AQWL	156,648.00	155,570.80	149,598.36	143,549.41	137,204.99	-12.4
APWL	3.18	2.96	3.10	3.24	3.38	6.3
AGRWL	506,903.79	467,450.14	470,532.08	471,581.82	469,375.60	- 7.4
AQFR	88,492.55	100,731.35	99,541.75	98,405.47	97,746.40	10.5
AQFF	65,037.22	65,389.74	65,061.05	64,731.34	64,433.01	
AQD	44,408.70	44,415.34	44,416.99	44,407.74	44,416.99	
AQC	40,260.00	40,260.00	40,260.00	40,260.00	40,260.00	
AQO	92,474.69	78,003.17	74,779.55	71,416.13	67,287.97	-27.2
APFR	8.99	8.94	9.00	9.07	9.14	1.7
APFF	18.42	20.42	20.34	20.26	20.26	10.0
AQEL	70,227.20	69,260.48	69,930.71	70,605.29	71,271.75	
APEL	2.63	2.44	2.60	2.76	2.91	
AQCL	65,700.22	65,700.22	65,700.22	65,700.22	65,700.22	
APCL	2.69	2.79	2.92	3.05	3.20	
AQE	7,945.04	7,946.23	8,045.55	8,144.67	8,251.73	
APE	2.88	2.92	3.01	3.11	3.21	
AQI	30,152.69	30,321.87	30,784.50	31,221.08	31,715.67	
API	3.52	3.55	3.64	3.74	3.83	
RAQWL	.47	.47	.46	.45	.44	
RAGRWL	.50	.48	.47	.46	.45	
WAPWL	3.24	3.00	3.15	3.29	3.42	5.6

price which was increased at various rates in the tests (Table 4). Hence, the results in Table 5 under the $2.36 initial price are identical to those in Table 4 under the 5 percent rate of annual increase in price goal and will not be reiterated. Instead, the initial price goal of $2.46 is used as the comparison level in Table 5, although the average gross revenue for the western producers was down slightly from the maximum attained under the $2.36 initial level for the price goal.

The revenue per hundredweight produced was substantially higher under stability at $2.46 than in the base run. Greater quantities were sold fresh and at a slightly higher average retail price, but slightly decreased quantities were used for frozen products which were sold at a 10 percent higher average retail price. Based on this limited information, it was difficult to assess the effect on processors and handlers. Though they paid an average of over 6 percent more to potato producers, they handled larger quantities and obtained greater revenues at the retail level. Producers in other areas would benefit from this bargaining board policy.

Gross Revenue Increase Policy

A policy to increase gross revenue gave the results shown in Table 6. The 12 percent rate of annual increase in the gross revenue goal gave nearly the highest aggregate gross revenue for the western growers. The levels for other variables were nearly identical under the 12 percent rate with those achieved under higher rates of increase. This result occurred because previously discussed allocation restrictions included in the model became effective in the latter years of the simulated period, making it impossible to satisfy extremely high goals.

Comparing the results under the 12 percent rate of increase with the base results indicates that average aggregate gross revenue was 1 percent lower than under base conditions, but the revenue per hundredweight produced was nearly 18 percent greater. Consumers had fewer fresh potatoes and frozen products available, with a higher retail price on fresh potatoes and a lower retail price on frozen products. The reduced quantities marketed fresh and utilized for frozen products were bought at a higher average price from the producers and sold at only slightly higher prices to consumers. Hence, processors and handlers were worse off than in the base run. Producers in other areas were better off in terms of aggregate gross revenues and revenue per hundredweight produced.

Acreage Control Policy

Attempts of a bargaining board to control growth in western late acreage planted gave results summarized in Table 7. The highest average gross revenue occurred at the 3 percent annual rate of increase in western late acreage. At this rate of acreage increase, the

Table 6. Results of Gross Revenue Increase Policy (average values for 1968-1980)

	Base	Percent annual increase in gross revenue goal				Percent change: Base to 12
		8	10	12	14	
AWL	624.80	558.00	524.67	525.13	525.17	-16.0
AQWL	156,648.00	139,589.99	131,435.04	131,548.88	131,557.56	-16.0
APWL	3.18	3.47	3.75	3.77	3.77	18.6
AGRWL	506,903.79	492,273.03	499,138.67	501,667.80	501,850.48	- 1.0
AQFR	88,492.55	90,727.40	84,925.15	83,928.79	83,854.22	- 5.2
AQFF	65,037.22	64,251.81	63,753.89	63,779.64	63,781.62	
AQD	44,408.70	44,404.68	44,416.99	44,416.99	44,416.99	
AQC	40,260.00	40,260.00	40,260.00	40,260.00	40,260.00	
AQO	92,474.69	76,979.13	77,312.85	78,455.10	78,540.81	-15.2
APFR	8.99	9.14	9.25	9.26	9.26	3.0
APFF	18.42	19.08	18.26	18.09	18.07	- 1.8
AQEL	70,227.20	71,592.36	73.020.69	73,100.70	73,106.85	
APEL	2.63	2.98	3.26	3.28	3.28	
AQCL	65,700.22	65,700.22	65,700.22	65,700.22	65,700.22	
APCL	2.69	3.10	3.24	3.24	3.24	
AQE	7,945.04	8,221.70	8,366.79	8,362.31	8,361.96	
APE	2.88	3.16	3.27	3.27	3.27	
AQI	30,152.69	31,518.74	32,146.13	32,128.41	32,127.05	
API	3.52	3.78	3.89	3.89	3.89	
RAQWL	.47	.44	.42	.42	.42	
RAGRWL	.50	.46	.45	.45	.45	
WAPWL	3.24	3.53	3.80	3.81	3.81	17.6

Table 7. Results of Acreage Control Policy (average values for 1968-1980)

	Base	Percent annual increase in western late acreage				Percent change: Base to 2
		2	3	4	5	
AWL	624.80	584.84	622.19	662.39	705.66	–6.4
AQWL	156,648.00	146,490.41	156,018.08	166,282.42	177,340.61	–6.5
APWL	3.18	3.38	3.19	2.99	2.76	6.3
AGRWL	506,903.79	503,282.31	506,399.14	503,504.32	492,882.35	– .7
AQFR	88,492.55	88,419.90	88,477.04	88,537.73	88,602.14	– .1
AQFF	65,037.22	64,707.67	64,963.74	65,229.30	65,504.72	
AQD	44,408.70	44,416.84	44,416.40	44,416.44	44,416.99	
AQC	40,260.00	40,260.00	40,260.00	40,260.00	40,260.00	
AQO	92,474.69	84,696.78	92,184.23	100,272.12	109,008.52	–8.4
APFR	8.99	9.10	8.99	8.87	8.73	1.2
APFF	18.42	18.59	18.42	18.25	18.05	.9
AQEL	70,227.20	71,234.36	70,360.52	69,425.22	68,424.24	
APEL	2.63	2.87	2.64	2.40	2.14	
AQCL	65,700.22	65,700.22	65,700.22	65,700.22	65,700.22	
APCL	2.69	2.92	2.70	2.45	2.18	
AQE	7,945.04	8,108.21	7,967.32	7,816.96	7,656.50	
APE	2.88	3.04	2.88	2.71	2.53	
AQI	30,152.69	30,967.99	30,255.26	29,490.76	28,670.80	
API	3.52	3.67	3.52	3.36	3.19	
RAQWL	.47	.45	.47	.49	.50	
RAGRWL	.50	.48	.50	.52	.55	
WAPWL	3.24	3.44	3.25	3.03	2.78	6.2

average value over the period was nearly identical for all variables under the control policy and under the base conditions. There was no advantage in establishing a bargaining board acreage control policy at a 3 percent rate of increase. Considering the cost of operating the board and carrying out its policies, the entire system was better off without interference.

A higher per hundredweight revenue was achieved by limiting acreage growth to 2 percent annually. Thus, the comparisons in Table 7 are based on the 2 percent rate of increase. Smaller quantities processed and sold fresh, as well as slightly higher retail prices, implied that a small part of the gain came at the expense of consumers. The contribution of handlers and processors to this producer gain was reflected in slightly reduced quantities utilized and prices to farmers which were relatively much higher than were retail prices compared to base values of each. Limiting acreage increases to 2 percent annually would increase revenue chiefly because substantially fewer potatoes would be utilized for lower-valued nonfood uses.

Effect of Different Levels of Total Food Use

If the decline in fresh potato consumption lessened while the increases in consumption of processed products continued, the total food use of potatoes would increase. All the runs simulated have been based on the assumption that the total annual food use of potatoes is 110 pounds per capita. To determine the effect of other assumptions which seem plausible on the basis of observed consumption in recent years, stable levels on either side of the 110 pounds of the base run were tested. Table 8 indicates the magnitude of the effects. Since increases in total use for food were assumed to occur because of increases in fresh consumption, western producers experienced declines in average revenues in aggregate and on a per hundredweight basis for levels of total food consumption which were greater than the 110 pounds of the base run. Areas producing primarily for fresh sales received slightly higher prices than for the 110 pound level of total per capita consumption. Competition for quantities to be marketed fresh or used for frozen products resulted in higher retail prices for the same quantity of frozen products.

The possibility of gradual increases in total food use of potatoes of one pound per year, starting from 110 pounds in 1968, was also tested. The results of this test were compared to the base values, since greater effects were reflected in this run than for the runs with higher consumption levels which were constant over the period. Western producers did not fare as well when consumption increased one pound annually as when annual consumption was stable at 110 pounds. The greater proportion of production sold fresh apparently came from

Table 8. Effect of Different Levels of Total Food Use of Potatoes (average values for 1968-1980)

	Pounds per capita of total food use annually				Start 110: + 1 pound annually	Percent change: 110 to 110 + 1
	107	110	113	115		
AWL	625.35	624.80	623.67	622.42	620.65	- .7
AQWL	156,792.30	156,648.00	156,347.74	156,030.31	155,566.50	- .7
APWL	3.21	3.18	3.14	3.09	3.01	- 5.3
AGRWL	512,468.37	506,903.79	497,801.43	489,019.66	473,250.87	- 6.6
AQFR	87.049.34	88,492,55	91,013.00	93,570.00	97,831.35	10.6
AQFF	65,037.22	65,037.22	65,040.18	65,032.22	65,032.29	
AQD	44,408.71	44,408.70	44,410.29	44,410.90	44,408.79	
AQC	40,260.00	40,260.00	40,260.00	40,260.00	40,260.00	
AQO	94,120.55	92,474.69	89,540.55	86,550.90	81,648.70	-11.7
APFR	9.00	8.99	8.97	8.96	8.92	- .8
APFF	18.19	18.42	18.82	19.24	19.91	8.1
AQEL	70,297.94	70,227.20	70,072.30	69,900.37	69,662.20	
APEL	2.66	2.63	2.59	2.55	2.48	
AQCL	65,700.22	65,700.22	65,700.22	65,700.22	65,700.22	
APCL	2.68	2.69	2.71	2.73	2.76	
AQE	7,943.26	7,945.04	7,951.34	7,959.53	7,967.97	
APE	2.87	2.88	2.88	2.89	2.91	
AQI	30,142.11	30,152.69	30,191.43	30,233.60	30,284.24	
API	3.52	3.52	3.53	3.54	3.55	
RAQWL	.47	.47	.47	.47	.47	
RAGRWL	.50	.50	.50	.49	.49	
WAPWL	3.27	3.24	3.18	3.13	3.04	- 6.2

processors sorting more potatoes for fresh market sales from about the same production. Reduction of other uses, rather than increased production in any region, supplied the majority of potatoes for increased fresh consumption.

Given the information upon which the model is based, a bargaining board should not adopt programs to increase per capita allocation of potatoes into food use. This conclusion assumes that the increases would occur through adjustments in fresh consumption. The results might differ if consumption of processed products could be increased or if some program were adopted that increased total food demand for potatoes.

Stability of Variables

The mean values of the variables over the simulated period indicate the levels of the variables resulting from different policies. The other information of interest available from the model indicates year-to-year fluctuations in the levels of the variables. The coefficient of variation for selected variables under each of the policy levels discussed in the preceding sections are presented in Table 9. The variables selected are ones for which stability over the simulated period seems desirable. By examining the coefficient of variation for one variable over all the policy alternatives, it is possible to determine whether certain policies resulted in unacceptable variability compared to other alternatives.

Table 9. Coefficient of Variation of Selected Variables Under Alternative Policies

Policy	AWL	APWL	AGRWL	AQFR
Base	10.8	18.9	29.7	22.6
Price stability at $3.10	22.8	1.0	26.5	15.7
Price increase 5 percent annually	5.5	19.4	26.7	17.7
Price level increase from $2.46	5.1	19.5	26.1	17.6
Gross revenue increase 12 percent annually	8.6	16.2	26.2	20.6
Acreage increase 2 percent annually	7.7	20.1	29.0	22.6
Food use: 110 + 1 pound annually	10.1	15.0	24.5	11.5

The variability of gross revenue about its mean was approximately the same for all the policies tested. The variability of quantity marketed fresh differed among alternative policies, and was least under the assumption of one pound annual increase in total consumption of potatoes for food.

Price received by western late producers had nearly the same variability under all the policies except for the policy of price stability.

The result of forcing decreased variability in price received was to increase variability of western late acreage harvested to a significant extent. Unless alternative uses for resources used in potatoes part of the time were readily available, a price stability policy might be undesirable on the basis of that variability. However, the alternative of stabilizing price at $3.10 was concluded to be undesirable on other grounds. Price stability at $3.30 appeared to give results more favorable to western producers than under base conditions. But the coefficient of variation for western acreage harvested, under price stability at $3.30, was 24.3 and might make that alternative unacceptable. Variability of acreage among other policies tested fell in a narrow range.

If a board had reasons to place specific limits on fluctuations, the coefficient of variation could be examined under different levels of policy variables as one means of evaluation. Based on the assumptions made here, the only policy seeming to result in unacceptable variability was that of price stability, which greatly increased variability of acreage harvested. But greater stability in acreage under other policies was associated with much greater price variability than under that price stability policy, and the final evaluation depends on the criteria specified.

An attempt has been made to interpret the results presented in the tables for the individual bargaining board policies tested. The final section will include a general summary of the results for the bargaining board alternatives tested in this section. Conclusions and policy implications pertaining to establishing bargaining boards will also be discussed.

V. SUMMARY AND CONCLUSIONS

The objective of this research was to analyze one approach to attaining farm bargaining power—establishing a farm bargaining board in a commodity system. The National Agricultural Bargaining Act of 1968 proposed a framework to make bargaining effective under producer-elected bargaining boards established to negotiate with processors and other buyers for minimum price and nonprice terms of trade.

To test the results of implementing a bargaining board in a commodity system, a simulation model was developed for evaluating policies of a western late potato bargaining board in the potato production-marketing system. Negotiable production and marketing quotas were assumed to be used to implement necessary restriction and allocation of production to effectuate higher prices through bargaining. Operational goals were established, and a computer program of the simulation model was developed to test alternative bargaining board policies.

Summary of Results of Bargaining Board Alternatives Tested

Bargaining board goals tested were:

1. Increased stability of prices received by producers
2. Increased average level of prices received
3. Annual increases in prices or income received
4. Increased or stabilized per capita consumption
5. Annual increases in western acreage

These goals were evaluated by projecting their operation in the western late potato system for 1968-1980 and comparing the results with the base run. The base run consisted of values of the endogenous variables generated by the model when it was run with no goals or other interference. The effects of various policies relative to results from the system projected as it has operated without a bargaining board are thus indicated. These relative differences from the base allow inferences about the effects of different policies.

To summarize the results from the different policies, percentage differences between the base run and the level of each policy chosen for detailed analysis are presented in Table 10. For example, the second line of Table 10 indicates that smaller quantities of western late potatoes would be produced under any bargaining board policy than if the system continued to operate as presently. The endogenous variables most important to western producers are included for comparison among the policy alternatives.

Table 10. Summary of Results for Various Policies

	Percent change from base level under specified policies					
	Price stability at $3.10	Price increase 5 percent annually	Initial price level $2.46	Revenue increase 12 percent annually	Acreage increase 2 percent annually	Increase food use: '110 + 1
AWL	- 5.7	- 8.1	-12.2	-16.0	- 6.4	- .7
AQWL	- 5.4	- 8.4	-12.4	-16.0	- 6.5	- .7
APWL	- 1.9	1.9	6.3	18.6	6.3	- 5.3
AGRWL	- 8.9	- 7.0	- 7.4	- 1.0	- .7	- 6.6
AQFR	12.0	11.2	10.5	- 5.2	- .1	10.6
AQO	-17.8	-27.8	-27.2	-15.2	- 8.4	-11.7
APFR	- 1.2	.9	1.7	3.0	1.2	- .8
APFF	9.9	10.0	10.0	- 1.8	.9	8.1
WAPWL ..	- 3.7	1.5	5.6	17.6	6.2	- 6.2

Acreage and Quantity Produced

Western late potato acreage (AWL) and quantity harvested (AQWL) changed together, their absolute differences being deter-

mined by yield. The least decrease in acreage from the base run conditions occurred under the policy of increasing total food use by one pound per year, from an initial level of 110 pounds per capita annually. Almost all the additional potatoes utilized for food under that policy came from reducing the amounts of potatoes going into nonfood uses (AQO). There was no acreage control or fresh market allocation mechanism in operation for this test—market interrelationships determined the outcome, with the only difference from the base run being the annual per capita quantity of potatoes used for food.

But achieving the same harvested acreage as would prevail under market operations assumed in the base run would not be a goal of the board. When prices received per unit produced (WAPWL) and the aggregate gross revenue (AGRWL) were evaluated, it became apparent that the food use increase policy would not be favorable to western producers. Adopting a program to increase per capita utilization in conjunction with other programs might be beneficial to western producers, although this possibility was not tested here. Since the food use increase policy was rejected, it will be ignored in further discussions.

Price Received

The average price received by western late producers (APWL) over the tested period was highest for the revenue increase policy and lowest for the price stability policy, compared to base run conditions. The high value under the gross revenue policy arose because of the large percentage increase forced on gross revenue which was directly related to price. The weighted average price (WAPWL) over the period reflected the returns per unit of potatoes produced, and might be a better measure for evaluation. The difference between the base run and the values under each of the policies were of the same general magnitude for both the simple average and weighted average prices. Differences existed in the magnitude of the simple and weighted average prices over the period under a given policy. These differences were caused by the effect on the weighted average price from a decreasing or increasing trend in quantity of western late potatoes produced over the test period.

The highest weighted average price received occurred under the revenue increase policy, because the least amount of resources were used under that policy compared to any other policy tested. That least use of resources was indicated by the largest reduction in quantity of western potatoes produced, compared to the base. The average gross revenue under the gross revenue policy was down very little from the base, although it was down slightly more than under an acreage increase policy. But under the acreage increase policy, the quantity pro-

duced in the West was much larger. Hence, the weighted average price was much lower for the acreage control policy than under the revenue increase policy, even though it was the next highest under the policies tested.

Since no fresh market regulation was assumed under the acreage control policy, the advantage to western producers might be more than shown in the revenue figures, due to reduced costs of operating the board. However, it is doubtful that the additional costs of operating a fresh market quota program in conjunction with production control would offset the large differences in weighted average revenue per unit between the acreage control and revenue increase policies.

Gross Revenue

The average aggregate gross revenue (AGRWL) over the period was greatest under the revenue increase policy and the acreage increase policy. Since the aggregate revenue was less under control policies than under base conditions, the greatest value under control policies was indicated by the smallest decrease from base conditions. All other policies resulted in significantly lower aggregate revenue compared to the base condition, but the differences among them were not great.

Quantity Marketed Fresh

The quantities marketed fresh (AQFR) under the revenue increase policy and the acreage control policy were notably different from those under other policies. While all other policies resulted in at least 10 percent increase in the average quantity available for fresh market compared to the base, the revenue increase and acreage control policies resulted in a reduction of the quantity marketed fresh. Although the reduction under the acreage control policy was negligible, the decrease under the revenue policy was significant. The consumer paid for the increased farm price per unit produced under this policy; higher retail prices for fresh potatoes resulted from the decreased quantity available for fresh use. Note that the quantities going into nonfood uses (AQO) were not reduced as much under the policies showing the greater reductions in fresh sales as under most other policies.

Retail Prices

The greatest increase in retail prices of fresh potatoes (APFR) occurred under the revenue increase policy, where quantities marketed fresh were significantly reduced in comparison to the base. This same policy was the only one for which retail prices of frozen products (APFF) were below those in the base run.

Conclusions and Policy Implications

The above discussion indicates varying degrees of success for the different policies tested, depending on the criterion for evaluating results. Under all control policies tested, the average level of western production and acreage were at least 15 percent above their level in the 1958-1968 period of historical observation. This increase implies that resources currently used in potato production would not be underemployed. However, some restriction on future entry of resources into potato production, indicated by the reduction in acreage and production compared to the base, would result from regulation under a marketing board. In general, the results obtained in this study imply that a bargaining board in the western late potato system could provide higher gross returns per unit produced, compared to the results of the system operating without interference.

Taking total resources employed and return per unit of resource employed as the criteria for evaluation, two policies—the acreage control and revenue increase policies—gave more favorable results to producers than the other policies. Higher revenue per unit produced indicated that the revenue increase policy was more favorable to established producers than was the acreage control policy. However, the revenue increase policy should be adopted only under certain conditions. First, the lower amounts of resources used under the revenue increase policy must be judged as an acceptable magnitude of restriction on entry. In addition, the effects on consumers from smaller quantities and higher prices for fresh potatoes must be judged unlikely to cause repercussions sufficient to alter the predicted outcome. The acreage control policy may give net results closer to those of the gross revenue policy than reflected in this analysis, since operating an acreage or production control program alone should cost less than operating such a program in conjunction with a marketing quota program.

The western late potato system was chosen for analysis of the results from establishing a bargaining board in a commodity system because the industry possesses characteristics deemed conducive to obtaining bargaining board gains. Assuming the western late potato system is representative of commodity systems possessing such characteristics, implications are that any commodity system adopting a bargaining board would need to be willing to accept restrictions on total production and marketing. Use of negotiable production and marketing quotas would permit maximum freedom of individual choice within the limits imposed on the total system. The restrictions would permit some gains to be achieved, but the types of bargaining board actions and the extent of gains would be limited by the supply and demand characteristics of the particular commodity system.

This study assumed that the most significant bargaining gains would generally be associated with production limitation or market allocation. If the marketing sector of an industry had relatively large profit margins or marketing margins, these might provide additional sources of important bargaining gains for producers. Knowledge of costs would then be more important in evaluating bargaining board gains than has been assumed in this study.

The conclusion is reached that bargaining boards may offer a policy tool leading to price and income results more favorable to producers than those obtained under the system operating without interference. This conclusion is applicable to industries having characteristics conducive to gains from a bargaining board operating under the institutional and legal framework assumed in this study. Alternative operating frameworks for bargaining boards were not evaluated, nor were bargaining boards compared with other possible policy tools.

A decision to implement bargaining boards as a policy tool should be based on additional research into some of the assumptions regarding bargaining boards upon which this analysis is based. Assumptions of particular importance include: (1) that the remainder of a commodity system would continue the pattern of past interactions with the sector in which a bargaining board was established; (2) that the legal and institutional framework assumed in this study is effective, efficient, and politically acceptable; and (3) that production and marketing quotas are a desirable means for implementing necessary controls to coordinate bargaining with economic conditions in the system. Analysis of these assumptions should provide a better basis for accepting or rejecting bargaining boards as a policy tool for U. S. agriculture. A study similar to this one should permit evaluation of the usefulness of a bargaining board to any particular commodity system.

Methodological Implications

When analyzing policy alternatives, it is important that all effects of the policy be considered. A systems approach is useful for evaluating effects within the production and marketing sectors, and the interactions between the sectors. A simulation model, as used in this study, provides a means of handling the complex relationships in a systems analysis.

The use of a simulation model to evaluate policy alternatives has the feature of yielding a number of plausible conclusions, depending upon the criteria used for evaluation. This approach permits examination of the effects of one choice criterion on the most important of the numerous other variables generated by the model. Also, large numbers of alternatives and combinations can be evaluated at relatively

little cost once the simulation model is constructed and judged to give acceptable approximations of the actual operating system.

The analysis using a simulation model of a commodity system makes it possible to generate results for a range of a policy variable. The impact of this variable may change over the range of values analyzed. The relevant range of the variable to give the best results for the purpose specified may thus be determined. The results presented in this report include only part of the range tested for each policy variable. This information on the impact over a range of the variable should provide a better basis for making policy decisions than simple elasticities which serve as an indicator of reactions in a static context. The policy will be implemented in a dynamic environment, regardless of whether the analysis upon which it is based is made in a static setting of a partial system or in the dynamic setting of the entire system.

The results derived from the model are only as good as the relationships which are used to formulate the model. Modifications of such relationships could be undertaken on the basis of the judgment of experts in policy formulation and persons associated with the particular industry being studied.

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APPENDIX A. Data Used in Potato System Analysis

Appendix Table 1. Harvested Acreage of Potatoes

Year	Early	Intermediate	Eastern late	Central late	Western late
	Thousand acres				
1951	41.0	304.8	355.0	357.4	290.3
1952	38.7	299.0	396.2	358.0	305.5
1953	54.9	340.2	395.3	398.4	347.6
1954	44.9	283.1	373.4	380.3	330.9
1955	56.0	285.0	365.3	350.1	348.6
1956	59.9	254.3	349.3	345.0	362.5
1957	75.6	259.1	331.8	321.9	371.0
1958	65.7	258.7	345.2	348.1	410.7
1959	51.9	216.4	327.5	346.7	388.2
1960	49.3	227.8	334.2	367.7	407.2
1961	48.9	223.7	331.9	407.1	468.6
1962	46.1	186.8	318.8	359.2	436.2
1963	48.8	189.0	304.9	367.1	413.3
1964	45.6	162.2	305.9	344.2	414.0
1965	54.7	188.7	308.0	353.0	479.1
1966	61.1	200.4	323.8	361.4	517.3
1967	52.7	190.1	316.3	371.2	527.0
1968	55.0	168.7	302.9	339.4	511.6

Source: USDA, Statistical Reporting Service, 1951-1969.

Appendix Table 2. Yield Per Acre of Potatoes Harvested

Year	Early	Intermediate	Eastern late	Central late	Western late
	Hundredweight				
1951	144	107	180	111	185
1952	152	108	171	117	207
1953	142	116	180	112	197
1954	168	117	179	126	193
1955	160	133	200	106	202
1956	155	132	230	139	206
1957	148	148	220	121	219
1958	147	146	222	144	225
1959	138	166	214	139	217
1960	137	180	218	146	204
1961	196	191	231	143	225
1962	164	182	241	157	206
1963	185	189	242	148	237
1964	173	194	234	145	194
1965	157	192	232	171	239
1966	164	198	220	155	251
1967	149	198	233	159	242
1968	162	205	230	173	239

Source: USDA, Statistical Reporting Service, 1951-1969.

Appendix Table 3. Harvested Quantity of Potatoes

Year	Early	Intermediate	Eastern late	Central late	Western late
	Thousand hundredweight				
1951	5,885	32,736	63,975	39,586	53,594
1952	5,895	32,263	67,907	41,775	63,255
1953	7,822	39,634	71,386	44,480	68,357
1954	7,552	33,254	67,023	47,820	63,898
1955	8,975	37,993	73,016	37,248	70,464
1956	9,282	33,462	80,360	48,092	74,596
1957	11,198	38,432	72,906	38,873	81,113
1958	9,674	37,678	76,817	50,238	92,490
1959	7,145	35,931	70,053	48,055	84,088
1960	6,753	40,932	72,859	53,644	82,916
1961	9,612	42,828	76,800	58,327	105,599
1962	7,582	34,089	76,917	56,340	89,882
1963	9,018	35,763	73,779	54,450	98,148
1964	7,877	31,441	71,474	49,848	80,436
1965	8,599	36,183	71,533	60,473	114,381
1966	10,008	39,677	71,283	56,163	129,771
1967	7,834	37,636	73,581	58,978	127,305
1968	8,904	24,512	69,672	58,734	122,370

Source: USDA, Statistical Reporting Service, 1951-1969.

Appendix Table 4. Season Average Price Received by Farmers for Potatoes

Year	Early	Intermediate	Eastern late	Central late	Western late
	Dollars per hundredweight				
1951	2.70	2.32	2.83	2.89	2.58
1952	4.14	4.12	2.97	3.28	2.90
1953	2.95	1.54	1.06	1.42	1.18
1954	2.39	2.60	2.18	1.93	2.01
1955	3.62	1.96	1.62	1.93	1.50
1956	3.43	4.39	1.64	1.48	1.49
1957	1.98	1.52	2.21	2.28	1.66
1958	2.50	1.81	1.28	1.14	1.10
1959	2.66	3.04	2.33	1.93	2.04
1960	3.69	2.43	1.68	1.75	2.07
1961	2.31	1.71	1.34	1.32	1.16
1962	2.76	2.29	1.55	1.54	1.50
1963	2.42	1.87	2.00	1.64	1.59
1964	3.34	3.60	3.71	3.62	3.21
1965	4.97	4.56	2.49	2.03	1.93
1966	3.10	1.98	2.11	2.13	1.87
1967	3.29	2.46	1.66	1.74	1.74
1968	3.27	2.90	2.11	1.90	2.17

Source: USDA, Statistical Reporting Service, 1951-1969.

Appendix Table 5. Utilization of Potatoes

Year	Fresh	Chips	Dehydrated	Frozen	Other[1]
	Thousand hundredweight				
1956	155,360	14,566	3,223	4,675	67,968
1957	156,584	17,356	3,776	4,827	59,979
1958	156,147	17,063	5,917	8,263	79,507
1959	154,410	20,085	7,656	9,918	53,203
1960	154,312	21,018	10,104	15,042	56,628
1961	158,367	22,642	8,518	18,138	85,501
1962	153,665	24,086	9,280	18,400	59,379
1963	150,381	26,693	9,909	22,425	61,750
1964	132,289	28,783	10,801	23,654	45,549
1965	142,139	31,292	20,166	37,302	60,270
1966	136,234	32,729	19,811	39,631	78,497
1967	133,473	32,406	19,084	39,609	80,762
1968	127,414	34,123	22,761	44,562	65,332

Source: USDA, Statistical Reporting Service, 1951-1969.

[1] Other uses include canned potatoes, starch and flour, feed, seed, and shrinkage or loss.

Appendix Table 6. Per Capita Utilization of Potatoes for Food

Year	Fresh	Chips	Dehydrated	Frozen
	Pounds			
1950	100.0	5.7	1.2	.3
1951	106.8	6.0	1.0	.6
1952	93.8	6.7	.5	.9
1953	99.1	7.3	1.3	.8
1954	98.1	7.6	1.1	1.1
1955	98.1	8.4	1.7	1.8
1956	91.1	8.5	1.9	2.7
1957	90.3	10.0	2.2	2.8
1958	88.5	9.7	3.4	4.7
1959	86.1	11.2	4.3	5.6
1960	84.6	11.5	5.5	8.3
1961	85.5	12.2	4.6	9.8
1962	81.6	12.8	4.9	9.8
1963	78.8	14.0	5.2	11.7
1964	68.4	14.9	5.6	12.2
1965	72.6	16.0	10.3	19.0
1966	68.8	16.5	10.0	20.0
1967	66.7	16.2	9.5	19.8
1968	63.0	16.9	11.3	22.0

Sources: 1956-1968 derived by dividing quantities utilized by total population January 1 of the following year.

Prior to 1956: dehydrated data from Talburt, 1967, p. 8; other data from Hanes, 1969, p. 116.

Appendix Table 7. Miscellaneous Data Used

Year	Expenditures for purchased meals and beverages[1]	Total population Jan. 1[2]	Retail price per pound[3]		Potato stocks[4]	
			Fresh potatoes	Frozen french fries	Dec. 1	March 1
	Million dollars	*Millions*	*Cents*	*Cents*	*Thousand cwt.*	
1951	12,467	153.6				
1952	13,093	156.3				
1953	13,350	159.0				
1954	13,363	161.7	5.26		103,290	52,230
1955	13,848	164.6	5.64		104,050	47,630
1956	14,528	167.5	6.77		118,650	58,880
1957	15,171	170.6	5.71		110,615	53,150
1958	15,321	173.5	6.26		129,630	61,480
1959	15,894	176.4	6.33		118,560	58,175
1960	16,182	179.4	7.18	35.0	122,740	62,645
1961	16,365	182.3	6.29	34.8	145,020	72,960
1962	17,020	185.3	6.32	33.8	135,745	70,250
1963	17,545	188.2	6.51	32.3	136,995	67,280
1964	18,766	190.9	7.57	29.5	114,550	54,535
1965	20,068	193.5	9.37	30.2	147,070	74,605
1966	21,981	195.9	7.49	28.1	152,640	79,517
1967	23,223	198.1	7.47	26.7	161,710	86,465
1968	24,926	200.2	7.63	27.4	152,900	81,905

[1] Heimstra, 1968, p. 180.
[2] U. S. Dept. of Commerce, Bureau of Census, 1969.
[3] U. S. Dept. of Labor, Bureau of Labor Statistics, 1954-1969.
[4] USDA, Statistical Reporting Service, 1951-1969. Stocks of late potatoes from the indicated crop year held by growers and local dealers on December 1 and on the following March 1.

APPENDIX B

Equations Used in Potato Simulation Model

The equations used in the simulation model are presented so the reader may evaluate the individual relationships used. Standard errors of all coefficients are presented in the parentheses beneath the coefficient. The least squares regression equations were fitted using a stepwise regression program. The variables are presented in the order of entry into the equation which yields the greatest reduction in variance of the endogenous variable. The variables retained in the equations were chosen on the basis of significance of coefficients as determined by t-tests, contribution to R^2, reduction in the standard deviation of the endogenous variable, and reasonableness according to economic theory. Significance levels based on t-tests are indicated by asterisks beneath the standard errors of the coefficients: * indicates significance at the .10 level, ** at the .05 level, and *** at the .01 level.

$$AWL = \underset{}{258.29250} + \underset{(1.33374)}{\underset{***}{12.45396}}\, T + \underset{(12.70197)}{\underset{**}{30.94961}}\, PWL\ (\text{t-1}) \qquad (1)$$

$$- \underset{(8.02459)}{\underset{*}{15.34092}}\, (PLOW\ (\text{t-1}) - PLOW\ (\text{t-2}))\,,$$

$R^2 = .896,$

AWL = harvested acreage of western late potatoes, thousand acres,

T = time, 1953 = 1,

PWL (t-1) = season average price received by farmers in the previous year for western late potatoes, dollars per cwt., and

($PLOW$ (t-1) − $PLOW$ (t-2)) = change between season average prices received one and two years previously for late potatoes produced outside the West, dollars per cwt.

$$AEL = \underset{}{341.37965} - \underset{(.58253)}{\underset{***}{5.55198}}\, T + \underset{(5.12681)}{\underset{***}{18.83957}}\, PEL\ (\text{t-1}) \qquad (2)$$

$$- \underset{(3.90880)}{\underset{**}{11.51760}}\, (PLOE\ (\text{t-1}) - PLOE\ (\text{t-2}))\,,$$

$R^2 = .898,$

AEL = harvested acreage of eastern late potatoes, thousand acres,

T = time, 1953 = 1,

PEL (t-1) = season average price received by farmers in the previous year for eastern late potatoes, dollars per cwt., and

($PLOE$ (t-1) − $PLOE$ (t-2)) = change between season average prices received one and two years previously for late potatoes produced outside the East, dollars per cwt.

$$AE = 11.67417 + \underset{(.14148)}{\underset{***}{.54463}}\, AE\ (t\text{-}1) + \underset{(1.59058)}{3.76707}\, PE\ (t\text{-}1), \qquad (3)$$

$R^2 = .672$,

AE = harvested acreage of early potatoes, thousand acres,

$AE\ (t\text{-}1)$ = harvested acreage of early potatoes in the previous year, thousand acres, and

$PE\ (t\text{-}1)$ = season average price received by farmers in the previous year for early potatoes, dollars per cwt.

$$AI = 193.91464 - \underset{(1.26315)}{\underset{***}{8.10680}}\, T + \underset{(6.04771)}{\underset{***}{21.69870}}\, PI\ (t\text{-}1) \qquad (4)$$

$$- \underset{(3.52913)}{\underset{**}{11.73415}}\, (PI\ (t\text{-}1) - PI\ (t\text{-}2)),$$

$R^2 = .873$,

AI = harvested acreage of intermediate potatoes, thousand acres,

T = time, 1958 = 1,

$PI\ (t\text{-}1)$ = season average price received by farmers in the previous year for intermediate potatoes, dollars per cwt., and

$(PI\ (t\text{-}1) - PI\ (t\text{-}2))$ = change between season average prices received one and two years previously for intermediate potatoes, dollars per cwt.

$$YWL = 189.35294 + \underset{(.59192)}{\underset{***}{2.80495}}\, T, \qquad (5)$$

$R^2 = .584$, standard deviation = 13.02898,

YWL = yield of western late potatoes, cwt. per acre, and

T = time, 1951 = 1.

$$YEL = 181.96732 + \underset{(.63255)}{\underset{***}{3.51806}}\, T, \qquad (6)$$

$R^2 = .659$, standard deviation = 13.92333,

YEL = yield of eastern late potatoes, cwt. per acre, and

T = time, 1951 = 1.

$$QCL = 38901.79100 + \underset{(186.56035)}{\underset{***}{1186.50155}}\, T, \qquad (7)$$

$R^2 = .716$, standard deviation = 4106.44710,

QCL = harvested quantity central late potatoes, thousand cwt., and

T = time, 1951 = 1.

YE = 157.83333, standard deviation = 15.77507, and (8)

YE = mean yield of early potatoes 1951-1968, cwt. per acre (regression analysis gave unsatisfactory results).

$$YI = 100.69281 + \underset{(.40480)}{6.37152\ T}, \quad (9)$$
$$***$$

R^2 = .939, standard deviation = 8.91010,

YI = yield of intermediate potatoes, cwt. per acre, and

T = time, 1951 = 1.

Per capita utilization of potatoes for potato chips (CC), frozen potato products (FF), and total processed food products (TP), pounds annually. These estimates were obtained by fitting per capita untilization data to a logistic function using a least squares iteration curve fitting technique. The form of the symmetric logistic function used was:

$$Y = \frac{a_1 - a_2}{1 + e^z} \quad \text{where} \quad (10)$$

Y = utilization per capita, pounds annually,
T = time, 1950 = 1, and
$Z = a_3\ (T\text{-}a_4)$
$a_1 \ldots a_4$ are least squares fitted coefficients:
a_1 = upper asymptote, pounds annually,
a_2 = lower asymptote, fixed at zero,
a_3 = exponential factor, and
a_4 = point of inflection, year relative to 1.

Least squares estimates of coefficients

Use	a_1	a_3	a_4
CC	25.69303	–.11094	12.56735
	(1.69567)	(.00656)	(1.26637)
FF	31.58100	–.28947	15.94182
	(3.67648)	(.02609)	(.89616)
TP	88.65856	–.16497	17.56776
	(10.52320)	(.00998)	(1.40620)

$$POPN = 149.91961 + \underset{(.07923)}{3.08927\ T} - \underset{(.00405)}{.01414\ T^2}, \quad (11)$$
$$*** \qquad ***$$

R^2 = .999,

$POPN$ = January 1 U. S. population, including armed forces overseas, millions, and

T = time, 1951 = 1.

$$PWL = 10.71971 - .00002468\ QO - .00004696\ QFR \qquad (12)$$
$$\qquad\qquad (.00000638)\quad\ (.00001375)$$
$$\qquad\qquad\quad ***\qquad\quad\ ***$$
$$\qquad\qquad -.00001689\ QFF,$$
$$\qquad\qquad (.00001162)$$

$R^2 = .878$,

PWL = season average price received by farmers for western late potatoes, dollars per cwt.,

QO = quantity of potatoes utilized for other than food, thousand cwt. annually,

QFR = quantity of potatoes utilized for fresh food, thousand cwt. annually, and

QFF = quantity of potatoes utilized for frozen food products, thousand cwt. annually.

$$PCL = 7.92743 - .00003040\ QO - .00002746\ QFR, \qquad (13)$$
$$\qquad\qquad (.00001002)\quad\ (.00001121)$$
$$\qquad\qquad\quad **\qquad\quad\ **$$

$R^2 = .638$, and

PCL = season average price received by farmers for central late potatoes, dollars per cwt.

$$PEL = 11.96479 - .00002974\ QO - .00005053\ QFR - .00004753\ QD, \qquad (14)$$
$$\qquad\qquad (.00000972)\quad\ (.00001935)\quad\ (.00003481)$$
$$\qquad\qquad\quad **\qquad\quad\ **$$

$R^2 = .773$,

PEL = season average price received by farmers for eastern late potatoes, dollars per cwt., and

QD = quantity of potatoes utilized for dehydrated food products, thousand cwt. annually.

$$SLD = -21723.81400 + .69210\ QL, \qquad (15)$$
$$\qquad\qquad (.02311)$$
$$\qquad\qquad\quad ***$$

$R^2 = .987$,

SLD = quantity of late potatoes in storage December 1, thousand cwt., and

QL = total quantity of late potatoes harvested, thousand cwt.

$$PE = 11.17044 - .62045\ CQE - .07288\ CSLD, \qquad (16)$$
$$\qquad\qquad (.20930)\quad\ (.02560)$$
$$\qquad\qquad\quad **\qquad\quad\ **$$

$R^2 = .525$,

PE = season average price received by farmers for early potatoes, dollars per cwt.,

CQE = per capita harvested quantity of early potatoes, pounds, and

$CSLD$ = per capita quantity of late potatoes in storage December 1, pounds.

$$SLM = -26477.50300 + \underset{(.02810)\ ***}{.41764\ QL}, \qquad (17)$$

$R^2 = .948$, and

SLM = quantity of late potatoes in storage March 1 following year, thousand cwt.

$$PI = 16.10909 - \underset{(.07307)\ ***}{.37968\ CQI} - \underset{(.03692)\ ***}{.16692\ CSLM}, \qquad (18)$$

$R^2 = .751$,

PI = season average price received by farmers for intermediate potatoes, dollars per cwt.,

CQI = per capita harvested quantity of intermediate potatoes, pounds, and

$CSLM$ = per capita quantity of late potatoes in storage March 1, pounds.

$CECH$ = annual increase in per capita expenditure for purchased meals and beverages, dollars (estimated, using the logistic function presented in Equation 10—the coefficients have the same interpretation as in Equation 10, except a_1 is in dollars annually and $T = 1$ in 1958). (19)

Least squares estimates of coefficients

a_1	a_2	a_4
6.88546	-1.33732	6.50559
(.87395)	(.74818)	(.49674)

$$QFR = 203528.33000 - \underset{(.40263)\ ***}{3.10528\ E} + \underset{(.05274)\ ***}{.08020\ (QT - QT\ (t\text{-}1))}, \qquad (20)$$

$R^2 = .874$,

E = expenditure for purchased meals and beverages, million dollars, and

$(QT - QT\ (t\text{-}1))$ = change between present and previous year's total quantity of potatoes harvested, thousand cwt.

$$QD = -21962.82800 + \underset{(.15479)\ ***}{1.83537\ E} + \underset{(.02371)\ **}{.06364\ (QL - QL\ (t\text{-}1))}, \qquad (21)$$

$R^2 = .942$, and

$(QL - QL\ (t\text{-}1))$ = change between present and previous year's total quantity of late potatoes harvested, thousand cwt.

$$QFF = 2337.16930 + \underset{(.06935)}{\underset{***}{1.02542}}\ QFF\ (t\text{-}1) + \underset{(.04154)}{\underset{**}{.11930}}\ (QL - QL\ (t\text{-}1)), \quad (22)$$

$R^2 = .961$, and

$QFF\ (t\text{-}1)$ = quantity of potatoes utilized for frozen food products in the previous year, thousand cwt.

$$QC = 2565.88690 + \underset{(.05375)}{\underset{***}{.96109}}\ QC\ (t\text{-}1), \quad (23)$$

$R^2 = .970$,

QC = quantity of potatoes utilized for potato chips, thousand cwt. annually, and

$QC\ (t\text{-}1) = QC$ in the previous year, thousand cwt.

$$PFR = 3.04853 + \underset{(.04970)}{\underset{***}{.19316}}\ TP - \underset{(.16400)}{\underset{**}{.49217}}\ T + \underset{(.24317)}{\underset{**}{.70777}}\ PUS, \quad (24)$$

$R^2 = .835$,

PFR = estimated annual average retail price of fresh potatoes, cents per pound,

TP = per capita utilization of potatoes for total processed food products, pounds,

T = time, 1956 = 1, and

PUS = season average price received by farmers for all potatoes, dollars per cwt.

$$PFF = -.90250 + \underset{(.02813)}{\underset{***}{.40051}}\ FR + \underset{(.41708)}{\underset{*}{.91062}}\ PWL, \quad (25)$$

$R^2 = .976$,

PFF = estimated annual average retail price of frozen french fries, cents per pound, and

FR = per capita utilization of potatoes for fresh food, pounds.