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The National Agricultural Bargaining Act of 1968 proposed creation of farm bargaining boards at the request of and referendum approval by producers of a given commodity. This proposal provided the legal framework assumed in this analysis of a bargaining board in a commodity system. The objective of bargaining boards as proposed is to provide producers with more effective bargaining power as a means of negotiating more favorable terms of trade.

Theoretical sources of bargaining gains under a board were specified in the research, and control of total production and allocation of production into different uses were selected as the most promising sources of bargaining gains. To test the results of implementing a bargaining board in a commodity system, the western late potato system was chosen for analysis. Results of several economic studies dealing only with portions of the potato

production-marketing system were examined. Due to their inadequacies, an economic model of the complete potato system was developed and the interrelationships estimated statistically. A simulation model of the economic system was constructed. The simulation model consisted of a production sector composed of five production units and a marketing sector incorporating five alternative uses for potatoes. A Fortran program of the simulation model was used in computer tests of alternative bargaining board policies in the western late potato system.

Operational goals for a bargaining board were specified and evaluated on the basis of effects on the average level of variables important to the western late potato industry. Of the policies tested, the acreage increase policy and the gross revenue increase policy gave results most favorable to western late potato producers. The results obtained imply that establishing a bargaining board in the western late potato industry could result in higher gross returns per unit of potatoes produced compared to the results of the system as it currently operates. The gains would come at the cost of restricting resource use in the system.

Assuming that the western late potato system is representative of commodity systems possessing characteristics conducive to bargaining board gains, the conclusion is reached that bargaining boards offer a policy tool which can lead to results more desirable for producers than those obtained under the system operating without interference. The types of bargaining board actions and the extent of gains are limited by the supply and demand characteristics of the particular commodity system. The costs of operating a bargaining board need to be researched to allow evaluation of the net effect of establishing a bargaining board. A decision to implement bargaining boards as a policy tool for U.S. agriculture should be based on additional research into some of the noneconomic factors affecting the assumptions upon which this analysis is based.

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

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SIMULATION OF FARM BARGAINING BOARD POLICIES IN THE WESTERN LATE POTATO SYSTEM

I INTRODUCTION

An income problem and an inefficient allocation of resources, each resulting from numerous interacting forces, are the two major components of the persistent problem faced by commercial farms (Cochrane, 1958). A variety of farm programs have been used in attempting to deal with the problem. But federal management of farm prices designed to sustain farm income through activities and controls such as price support, surplus disposal, and production control have generally failed to achieve the desired results. This conclusion is evidenced by falling farm income, the exodus of small farmers, overproduction, and rising federal expenditures for price support, storage, and surplus disposal (U.S. Agricultural Policy, 1963; Hathaway, 1963, p. 293). These results led to program modifications in the latter part of the 1960's designed to decrease production incentives and increase movement of surpluses through commercial international channels. Consequently, formerly burdensome stocks have dwindled to the point of approaching minimum desirable levels for many commodities included in the programs.

Freeman claims that the Emergency Feed Grain Act of 1961 and the Agricultural Acts of 1961 through 1964 prepared the way for the Food and Agricultural Act of 1965. The 1965 legislation set up voluntary programs through 1969 enabling farmers to act together in an effort to effectively control production. Some successes noted include reduction of surpluses and rising farm incomes, but many other factors also contributed to these results (Freeman, 1968, p. 4). The emphasis on voluntary programs reflects increasing interest in reducing treasury costs and exploiting market supply-demand conditions. Despite its similarity to previous legislation the Agricultural Act of 1965 embodies some important shifts toward greater program flexibility. Provisions for pricing grains and cotton around world market levels, with farm incomes maintained by direct payments to cooperators, exemplify this shift. Such pricing practices move the government a big step toward ". . . a role of referee in the market place rather than an active participant." (Daly, 1969, p. 46)

Declining Farm Influence

The waning political power of farm interests will lead to greater stress on general society goals in farm programs. The problem will be to help farmers maintain adequate incomes while protecting consumer interests.

> The over-all objective of our commodity programs after 1969 should be to provide adequate food and fiber at a minimum social cost. The term 'adequate' refers to the quantity, variety, and quality of farm products. The term 'social cost' refers to a reasonable compromise of taxpayer costs, consumer costs, and farm income. (Tweeten, 1968b, p. 149).

It is doubtful that the types of programs used in the past, and even more importantly the goals which these programs supported, will be appropriate as the policital power of farm interests continues to decline.

Society's goals for the cheapest possible food have not significantly changed, but the foods demanded are much changed over earlier periods and the effects on farmers are profound. Inclusion of greater quantities of marketing services in foods sold at retail have made farm-level demand increasingly more inelastic, forcing the major burden of clearing markets onto adjustments in production (Brandow, 1966, p. 1323). The pressure for a more orderly supply of specified-quality agricultural products, arising from trends toward mass distribution and input requirements of food processors, have led to a market orientation in the food industry. Production is now geared to the market rather than the market taking whatever the farmer produces. There have been accompanying changes in the decision-making process and structure of the market for agricultural products.

Production decisions are increasingly made upon the basis of stimuli transmitted by direct methods of some form of vertical integration rather than the traditional market price method (Breimyer, 1965a, p. 8). Due to technological developments in marketing which make vertical and horizontal integration so attractive, departures from competitive markets are becoming more the rule than the exception. Horizontal integration may result in acquisition of power and a reduction in competition. Vertical integration creates more interdependence between the producer and processor.

> The interdependence between the successive stages in the production and marketing sequence is the crux of the significance of marketing to agriculture . . . . Interdependence is always an invitation to a contest for advantage. (Breimyer, 1965b, p. 96)

Changes in the institutions of the marketing system, as when vertical integration or horizontal integration occur, may result in a strategic advantage being gained by one party.

Lack of Bargaining Power

According to Cochrane (1968, p. 157), this shift in market structure will result in a shift of bargaining power away from producers. Contract production theoretically puts the individual farmer in a position to bargain over terms of the contract. However, the generally much larger size of purchasers with whom he contracts puts the producer at a relative disadvantage in bargaining power and this is often blamed for lowering farm prices and income.

Under these conditions, the individual farmer lacks the protection of his interests afforded by a competitive market structure. Attempting to achieve some protection, farmers themselves have integrated horizontally to form bargaining associations to conduct negotiations with buyers. The appeal of bargaining associations may be directly attributable to the growth of contracted production. Bargaining associations apparently have been most successful in commodity areas where processors contract most of the production to assure their plants the desired volume and quality of raw material.

The lack of farmer bargaining power has brought forth expressions of concern on several fronts. The National Commission on Food Marketing (1966, p. 110) stated:

> There is frequent need for group action by farmers to adjust sales more uniformly to market demands at reasonable prices, to improve product quality and uniformity, to negotiate with buyers, and to protect themselves against trade practices and abuses of market power to which they are otherwise vulnerable. . . . Producers frequently are not able to coordinate sufficiently their individual production efforts, or to negotiate effectively with other buyers, by means of cooperatives or under the usual marketing order or agreement.

The Commission concluded that a new approach was needed and proposed creation of Agricultural Marketing Boards structured to avoid problems which have historically plagued self-help programs.

Secretary of Agriculture Freeman also voiced concern and proposed legislation to facilitate group action by farmers.

> We've gone about as far as we can under existing programs. Further progress toward parity of income for farmers will depend primarily on what they can do for themselves through group action--on their ability to maintain supply-demand balance--on their ability to show some economic muscle at the bargaining table. (Freeman, 1967a, p. 5)

He pointed out the need for legislative action to help farmers become price-makers rather than price-takers. The legislation should create a legal climate to enable farmers to participate in marketing decisions through self-help collective actions. (Freeman, 1968, p. 24).

The concern of the major farm organizations over the loss of bargaining power is evident in their recent actions attempting to organize or facilitate bargaining activities. The expansion of the National Farmers Organization into many parts of the country indicates interest of farmers from a variety of geographic and commodity areas in increasing bargaining power relative to purchasers of their commodities. Methods of achieving bargaining power and the economic potential of bargaining have been among the most frequent program topics of annual farm group meetings in recent years.

The growing concern of Congress over bargaining power has become evident in proposed legislation incorporating many of Freeman's ideas. The Agricultural Fair Practices Act of 1967[1/] was designed to enhance bargaining power by eliminating some unfair trade practices affecting agricultural producers and associations of such producers. The National Agricultural Bargaining Act of 1968[2/] was designed to create a national collective bargaining system for determining fair farm prices. It offered

> two approaches toward providing greater economic muscle for farmers. Title I of the bill enables farmer-elected marketing committees to bargain and negotiate with processors and other buyers for decent and adequate prices on a commodity-by-commodity basis. Title II makes all commodities eligible for marketing orders, and provides for a broad new range of power for farmers under market orders--including collective bargaining for minimum price and nonprice terms of sale of the particular commodity involved. (U.S. Congress. Senate. 1968, p. 3090)

Thus, collective bargaining is increasingly suggested as an alternative to government programs to deal with the price and income problems for agriculture. Breimyer (1965b, p. 117) suggests that mutual assistance through group action to assure fair treatment for all individuals in agriculture may be necessary as direct

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1/ Introduced as Senate Bill S. 109 by Aiken of Vermont and passed in amended form as Public Law 90-288 in April, 1968.

2/ Introduced as Senate Bill S. 2973 by Mondale of Minnesota.

contact between producers and processors increases. The sociological benefit to farmers participating in self-help bargaining programs may make them preferable to government-operated programs, even though both are subject to the same economic limitations (Tweeten, 1968a, p. 10).

Research Objective

There are several alternatives for increasing farmer bargaining power through collective action. The objective of this thesis is to evaluate farm bargaining boards, one of the alternatives, as a means of increasing farmer bargaining power.
In Chapter II the concepts of bargaining are defined and attempts to gain such power are analyzed. The theoretical basis for farm bargaining boards and potential sources of bargaining gains are discussed in Chapter III. The choice of the western late potato industry for analysis of a bargaining board in a commodity system is discussed in Chapter IV. Economic studies providing partial information on interrelationships within the potato industry are reviewed and an economic model is developed for evaluating actions of a bargaining board in the system. A simulation model to be used in the evaluation is developed in Chapter V and analyses of bargaining board policies using the simulation model are undertaken in Chapter VI. Chapter VII contains conclusions of the analyses and a discussion of policy implications.

II FARM BARGAINING POWER

Market Power and Bargaining Power

An important distinction must be made between bargaining power and market power, the two components of the economic power sought by farmers. Market power may be defined as the ability to alter terms of sale in the market (Farrell, 1968, p. 2). Or it may be defined as the ability to initiate and maintain control over such factors as market supplies, demand expansion, and market competition to influence farm prices and income (Christiansen, 1963, p. 1). Market power is the ability to influence the outcome of a transaction rather than merely accepting whatever terms are forthcoming from the market.

The extremes of market power are represented by the absolute power of monopoly or monopsony and the absolute lack of power in pure competition. Most agricultural commodities are sold in markets where neither of these extremes are present, but some intermediate degree of market power exists on the part of producers as well as processors. Producer market power may result from producer organizations performing market functions, including such things as product differentiation, or from self-help programs such as marketing agreements or orders. But many commodity producers have no organization or other methods of achieving market power. Hence, the individual producers approach the competitive norm of absolutely zero power and generally deal with imperfectly competitive firms having much greater market power.

Bargaining power, as distinguished from market power, is the ability to haggle or negotiate with power to purposely obtain more advantageous terms of sale in the market (Farrell, 1968, p. 2). It is "the ability to secure another's agreement on one's own terms" (Chamberlain, 1965, p. 170) or

> the ability to influence the results the other party will experience. . . . The more favorable you can make it for him to accept your offer or the more unfavorable you can make it for him if he refuses to accept and refuses to bargain further, the greater is your bargaining power. (Ladd, 1964, p. 14)

Bargaining power involves interaction between the parties in the form of actual negotiations, while market power may be exercised through unilateral action.

Ladd's (1964, p. 14) classification of bargaining power in terms of its effect on the "opponent" seems relevant to this study since bargaining power is a relative concept dependent upon the economic relationships between the parties involved in the particular industry. Ladd's Type I bargaining power makes it advantageous for the second party to accept the first's offer but does not penalize him for not accepting it. This "opponent-gain" power emphasizes common interests and makes it possible for both parties to benefit. Unless such gains arise entirely from increased efficiency, they may come at the expense of the third party consumer.

Type II bargaining power is the ability to subject the other party to added costs or losses if demands are not met, with the amount of the possible penalty determining the extent of bargaining power. This "opponent-pain" power emphasizes conflicts of interest since any gains are extracted from one's opponent. One party's gain is another's loss; but if the opponent's loss can be passed on to the consumer, the difficulty of obtaining such gains probably is lessened and again the consumer loses.

Both types of bargaining power would probably be employed in each instance that bargaining benefits producers significantly. Initially, Type I bargaining power would be used to achieve the gains easiest to obtain. Rather than actual bargaining, such gains may merely require exercising some elementary market power to improve efficiency of the marketing system. For example, bringing to the processors' attention the development of market power by a producer group may be sufficient to achieve some modest gains. Although product purchasers also would gain in the process, resistance would initially be encountered since the purchasers would not have experienced the gains at the outset. Further, they will tend to view any modification of the status quo as an undesirable encroachment on traditional ways of doing business.

Type II bargaining power would then enter the picture after the easier gains had been exhausted or had become inadequate as a basis for achieving farmers' economic objectives. Gains at the expense of the other party would be much more difficult to achieve and probably require a better legal-institutional framework to accomplish than the gains under Type I bargaining power. Although existing self-help programs such as marketing agreements or orders and cooperative bargaining associations may be sufficient to attain the majority of gains available under Type I bargaining power, they lack the more stringent features probably needed to attain most of the gains available under Type II bargaining power. Enabling legislation setting up a complete bargaining system to establish economic power is probably necessary to achieve Ladd's Type II bargaining power.

Chamberlain claims that bargaining power cannot be equalized by legislation because bargaining power is dependent at least as much on what each party seeks as on their coercive ability, and what is sought is beyond legislative control. He claims that coercive power, obtained by erecting costs of disagreement, is only relative to the objective being sought (Chamberlain, 1965, p. 188). But possibly there is merely an illusion that greater bargaining power exists when objectives are lower because the amount of bargaining power needed is less and, hence, easier to obtain.

Market power does not necessarily imply bargaining power in the absence of legislative support and enforcement provisions. Although the outcome of bargaining depends at least partly on the market power of the negotiators, bargaining power can exist only when there is another party with which to negotiate terms of trade. Suppose that a bargaining association organizes within a market where a marketing order exists. By virtue of the marketing order, the producers will have some market power because they may set quality standards to keep off the market enough of the commodity to raise market price to a more profitable level. However, it is conceivable that the association could lack bargaining power because processors refuse to negotiate with it as a recognized representative of the producers. The processors could thus maintain a superior economic position relative to the individual farmers. The introduction of the Agricultural Fair Practices Act of 1967, aimed at discriminatory practices, indicates legislative concern over such situations.

Achieving effective bargaining power has been the aim of the legislative proposals mentioned previously. They are designed to establish the necessary institutional and legal framework to facilitate producer use of market and bargaining power. The actual establishment of the necessary legal and institutional framework for bargaining requires political power to influence legislators and public administrators.

Past Efforts to Attain Farm Bargaining Power

The existing institutional framework to aid farmers in obtaining countervailing power--bargaining power to counteract that of the firms with which they deal--provides some means of obtaining Type I and Type II bargaining power. One means of obtaining effective bargaining power is through increased size and scale of individual firms relative to the total market size, since it may be argued that such power is chiefly a function of market concentration. This is largely the means by which marketing firms have gained positions of such superior economic power compared to farms. Only extremely large farms relative to the size of local markets can attain any noticeable economic power.

If farmers are unable to attain countervailing power individually, then a number of them may be able to gain it through horizontal integration into a significant economic unit. Horizontal integration efforts by farmers may include: voluntary programs such as cooperative marketing, purchasing, or bargaining associations; and/or government aided and enforced programs such as marketing agreements or orders, and marketing boards. Enabling legislation giving farmers the right to use group efforts to attain economic gains has existed for a number of years and includes: (1) the Clayton Amendment in 1914; (2) the Capper-Volstead Act of 1922; and (3) the Agricultural Marketing Agreement Act of 1937.

The marketing and purchasing cooperatives, as well as marketing agreements and orders, essentially rely on market power as a means of achieving countervailing power. Marketing orders and agreements may make limited use of bargaining power in setting grading standards for different product uses. The bargaining association relies on bargaining power in conjunction with market power, while the marketing board relies on effective bargaining power facilitated by a comprehensive legal and institutional framework to achieve countervailing power.

Establishing operating cooperatives is a means for farmers, integrated horizontally into an association of producers, to integrate vertically into the market for their commodity or supplies to obtain market power. Any gains achieved are derived from reduced costs or increased revenues from nonfarm activities.

In contrast to the vertical integration into physical operation through the marketing cooperative, the bargaining cooperative involves horizontal integration of producers into a selling unit which integrates vertically by negotiating terms of sale with buyers rather than by undertaking physical operations. The formation of a bargaining association creates a dominant seller replacing many smaller ones.[3/] Price negotiations are usually the primary objective, but negotiations over secondary objectives such as grading procedures, quality standards, and uniformity of contract terms may actually result in greater benefits to members.

Limitations to gains obtainable by cooperative bargaining associations are determined by market conditions. "The impacts of cooperative bargaining are constrained not only by survival conditions at the grower and processor levels but also by the competitiveness of the oligopsonistic buyers." (Helmberger, 1965, p. 63). Competitiveness of the processing industry in the finished product market and in the local buying markets, conduct of processors in such markets, and the profits being earned by processors are all important limiting factors. Legislation preventing processors from paying higher prices to nonmembers than to members would aid the cause of the bargaining association.

[3/] Helmberger and Hoos (1965, p. 48-63) develop an economic theory of cooperative bargaining.

The bargaining cooperative suffers two major weaknesses--voluntary membership and lack of control over production. Ladd and Hallberg (1967, p. 18) found that the most important factor affecting North Central Region Grade A milk cooperatives' bargaining power was the portion of the bottlers total milk requirements supplied by the bargaining cooperative. But nonmembers benefit from negotiated prices without bearing costs, assuming sufficient producers join the cooperative to make it effective. Given the lack of control over production, any negotiated price increases beyond a certain level will probably stimulate production of members and nonmembers until the price is again reduced to lower levels.

Market power may also be obtained through government-enforced group action in the form of marketing agreements and orders. Successful use of these methods requires that the market for a commodity can be segmented into parts having different elasticities and that arbitrage can be prevented. Market segmentation may be based on different uses for the same commodity, quality differences, or different seasonal demands. These market discrimination programs may be useful for dealing with income variability for products subject to wide annual or seasonal variation in output. But the portion of total production under control of the marketing order and the lack of control over production response are factors limiting the gains achieved. "The inability of these orders to overcome the supply response problem limits effectiveness prior to when farmers can attain the income equity position sought by economic power" (Garoian and Youde, 1968, p. 6).

In addition to the self-help programs, a number of programs involving direct government intervention in the marketing system have been designed to increase the bargaining or market power of individual farmers. Price support, trade regulation, and grading programs directly affect the economic results the producer obtains in selling his commodity. Market news, outlook reports, and other economic intelligence services are designed to increase the farmer's bargaining power by furnishing him some of the information available to purchasers of his products. The additional gains currently achievable by these means are difficult to determine but probably are small in most cases.

Recent Attempts to Gain Farm Bargaining Power

The growth of the National Farmers Organization (NFO), whose avowed aim is to obtain farm prices high enough to cover production costs, attests to the increasing farmer interest in bargaining to achieve income gains and their despair with traditional approaches to group action. To join the NFO, farmers must sign a three year membership agreement authorizing the NFO to: (1) represent members in collective bargaining over terms of sale of the commodity; (2) negotiate contracts with purchasers of members' commodities; (3) represent members in complaints against processors. The acceptance of the NFO terms indicates willingness of some producers to give up part of their individual decision-making freedom as a prerequisite to obtaining the desired bargaining power through group action.

Interest in bargaining was also evident in the support of all the major farm organizations for the Agricultural Fair Practices Act of 1967 (U.S. Congress. Senate. 1967). This legislation, the first in 20 years on which all organizations were in agreement (Mauch, 1968, p. 7), contained provisions to prohibit any handler or processor from:

1. Interfering with a producer joining a cooperative.
2. Discriminating against a producer because of cooperative membership.
3. Coercing a producer to terminate such membership.
4. Making false reports about, or interfering with, cooperatives.
5. Conspiring with any other person to do any such act.

Farm organizations, political parties, and farmers themselves seem to be in general agreement that farmers face a critical problem in their lack of bargaining power. However, different approaches to gaining this bargaining strength are favored by each of the three major farmer organizations.

The Farm Bureau favors utilizing the price system and has set up the American Agricultural Marketing Association to help improve the economic power of farmers. This approach is aimed at achieving market power as a basis for bargaining power and sets up at least part of the institutional framework to achieve effective bargaining power. The NFO approach is more nearly one of social conflict in the form of a threatened strike or holding action designed to force processor agreement to a contract price which is significantly higher than the current market price. The NFO attempts to obtain, through membership contracts, market power to be used immediately in obtaining the bargaining power which they seek. Their membership agreements also provide at least part of the institutional basis for achieving effective bargaining power. The Farmers Union approaches the problem through political channels by advocating legislation to enable organization similar to that of labor. Their concern is with establishing a legal framework for achieving effective bargaining power.

The NFO approach, which is more controversial and obtains results or failures more rapidly, has commanded the greatest amount of attention of the recent attempts to gain bargaining power. Morrison and Steeves (1967, p. 432) attempted to determine who participates in these NFO actions. They summarized data from 13 studies carried out in the Midwest between 1962 and 1966 and concluded that there is

> evidence that participants in a movement with economic goals are, as expected, more dissatisfied with their economic situation, but are not necessarily among the more economically deprived. . . . movement participators differ from non-participators in belief in structural rather than individual factors restricting their attempts to reach their aspirations. We offer the hypothesis that participators are dissatisfied because they perceive a lower probability that their aspirations will be achieved, and that this is the antecedent condition for receptiveness to belief in structural blockage.

The noncompulsory NFO approach faces problems similar to those of voluntary supply control which might be attempted under bargaining cooperatives. The big problem is the free-rider, since any benefits to members are available to nonmembers who receive the same price but do not share the costs of withholding. When prices start to rise due to withholding, nonmembers will increase their sales in the short run to the limit of their flexibility in the amount put onto the market. It becomes difficult to achieve further price increases and the monetary incentive to join the NFO-type movement is thus quite weak unless the majority of production is represented. Any gains achieved in the short run will probably lead to increased production in future periods because supply control features are absent. Lower prices necessary to move the added product in later periods may offset any immediate gains.

Thus, there have been a variety of approaches attempting to increase farm bargaining power. The continued existence of earlier programs indicate they have achieved some success. The appearance and expansion of recent efforts further removed from traditional approaches indicate dissatisfaction still exists with the prevailing position of farm bargaining power. The farm bargaining board is an approach which may offer some relief from this situation.

Labor Union Effectiveness and Relevance to Farm Bargaining

Withholding actions of the NFO follow the example of strikes by organized labor which employ social conflict as well as economic pressure to force acceptance of their terms. This raises the question of labor union effectiveness and relevancy of the labor union movement to agricultural bargaining. Freeman (1967b, p. 5) pointed out that labor has many of the benefits that farmers seek: (1) control over the price of their product; (2) the right to bargain effectively without fear of reprisal from employers; (3) the right to choose a bargaining unit; and (4) the right to withhold their product (labor) from the market. These are the types of things farm organizations are trying to achieve and farmers would be empowered to do by recent legislative proposals. Freeman went on to draw parallels between farmers' present positions and labor history and organization.

Helmberger and Hoos (1965, p. 26) suggest that because cooperative bargaining takes place in a vastly different legal environment than that of labor markets, comparisons with labor unions are probably unwarranted. However, they pointed out the impact of the National Labor Relations Act of 1935 in considerably strengthening the bargaining effectiveness of labor. The parallels between it and the Agricultural Fair Practices Act proposed in 1967 are apparent when considering the key points of the National Labor Relations Act: (1) employers are prohibited from discriminating against employees because of union membership; (2) employers are prohibited from not recognizing and bargaining in good faith with unions representing employees; and (3) employers cannot dominate or interfere with union affairs.

But precise effects of labor unions are not clearly established. Lewis (1963, p. 4) claims that the average union-nonunion wage rate was about 10-15 percent higher in the late 1950's than it would have been in the absence of unionism. Hildebrand (1958, p. 100) argues that wage gains have not greatly influenced labor's relative position. But Hildebrand feels that the political power of unions has helped shape government policies that indirectly affect income shares through tax and transfer payment legislation, stabilization of employment at high levels, and government intervention to fix or manipulate prices and wages. The main contributions have not been in money wage gains but in nonwage benefits and orderliness of the labor market. Numerous other studies provide a variety of opinions and research findings about unionism's effect of the relative and absolute levels of labor compensation.

Even if agreement existed on unionism's effects, complications may arise in attempting to infer results for agricultural producers based upon those of labor. Ladd (1968, p. 4) sees important differences between farmers and union members. First, there exists a system of unemployment compensation and state and federal employment services to cushion unemployment which might result from unionism increasing labor costs and reducing employment. Secondly, the supposed perishability of labor and nonperishability of major farm products may not be very valid. Overtime before and after a strike is a form of intertemporal substitution of labor and leisure which effectively reduces labor perishability. Many farm crops are quite perishable or at least subject to deterioration in value when held.

A significant difference between the farmer and union member is the pattern of resource ownership. Ladd's third point is that the farmer has a greater incentive to maintain production than does the corporation or its hired employees, since no one shares his costs of shutting down. Shaffer (1968, p. 1) observes that the farmer who withholds his product loses not only the value of his labor as a worker but also the return on his capital and potential profits associated with his role of manager and capital owner.

In summary, past and recent efforts to attain farm bargaining power have had varying degrees of success but have not given farmers the amount of effective bargaining power sought. Labor appears to have achieved some success through comprehensive bargaining programs, but there is disagreement on the extent of gains. Finally, differences between labor and agricultural producers raise doubts regarding inferences about farm bargaining based on results of labor bargaining.

III FARM BARGAINING BOARDS

Legislative Action to Authorize Farm Bargaining Boards

Though conclusions about effectiveness of labor bargaining and transferability to agriculture are not unanimous, recent legislative actions have been taken to facilitate more effective agricultural bargaining through creation of farm bargaining boards. In one such proposal, a producer marketing board would be elected to represent producers in a fairly homogeneous product group or market. The marketing board would operate essentially as an extension of marketing orders, having power to control production and marketing. The board would negotiate prices and other terms of trade and could have full trading powers. The market would consist of the commodity board and representatives of the buyers to which it could sell and would also include consumer representatives.

The National Agricultural Bargaining Act of 1968 proposed the creation of a bargaining system consisting of two levels. The National Agricultural Relations Board (NARB) would focus on the regulatory level and operate in a manner similar to the National Labor Relations Board. At the operational level the Act would have created producer marketing committees, generally called marketing boards, upon the initiative and approval of producers of a commodity nationally or in an appropriate area.

> The National Agricultural Relations Board, an
>
> independent five-member Board, appointed by the President with Senate confirmation, is established to provide administrative, technical, and supporting assistance to farmer Marketing Committees and Purchasers Committees. It does not represent either farmers or buyers. It would administer farm referendums and assist the Committees in holding meetings. (U.S. Congress. Senate. 1968, p. 3091)

The National Agricultural Relations Board would conduct a referendum, at the request of a representative group of producers of a commodity whose price is below a "fair and reasonable" level, to determine whether or not the producers of that commodity favor the establishment of a representative marketing committee. The NARB would define the boundaries, size, and composition of the product area to be included in the referendum. Upon approval by a majority of producers, a committee of producers would be chosen for the purpose of negotiating with purchasers of the commodity to determine a fair minimum price or nonprice terms for the sale and purchase of the commodity. A fair and reasonable price would be determined considering, among other things: (1) the direct cost of production, including hired labor; (2) a reasonable value of the time, skill, and experience of the producer; and (3) a fair return upon essential invested capital (U.S. Congress. Senate. 1968, p. 3093).

Concurrent with announcement of the referendum approval of such a marketing committee the NARB would notify prospective purchasers of the commodity to select a purchasers committee. The NARB would facilitate meetings for negotiation purposes and assure that consumer interests were represented. The NARB would collect a reasonable assessment, as determined by the marketing committee, to cover costs of operating the committee. There would be no direct supply or marketing control by the NARB which would only have facilitative functions. Continuation of the marketing committee would be contingent upon referendum approval at three-year intervals.

The marketing and purchasers committees would be required to bargain in good faith to establish price and/or nonprice terms of sale. If no agreement were reached within a specified time period, the NARB would appoint a joint settlement committee to make binding decisions on disputed issues. This joint settlement committee would consist of a marketing committee representative, a purchasers committee representative, and a neutral member.

A producer marketing committee, as defined in the National Agricultural Bargaining Act of 1968, would be empowered to establish minimum price and nonprice terms of sale through negotiation based upon size, grade, quality, and other appropriate conditions. All producers would share the costs of operating the marketing committee, and all producers and purchasers would be bound by the agreed upon price and nonprice terms.

The marketing committee could establish marketing allotments, with or without acreage or production limitations, subject to approval by producers in referendum. A marketing allotment would be developed to bring supply in line with demand at the negotiated price. Enforcement would be handled by the Secretary of Agriculture and any necessary enabling legislation. The committee, through action of the NARB, could authorize some predetermined amount of commodity production to be marketed for specific uses outside the limitations of this Act.

Bargaining boards are being promoted as a means of obtaining economic power rather than merely market power or bargaining power as defined earlier. The emphasis is on creating the legal and institutional framework for bargaining to be carried out by a group possessing some market power. The bargaining board approach avoids some of the problems of earlier attempts to attain countervailing power: the compulsory nature of membership eliminates the free-rider problem of bargaining associations; and the power to control supply prevents increased production stimulated by any success in raising price, an inherent problem in the market order approach.

Theoretical Basis for Bargaining Boards

Proposed bargaining board legislation would essentially create a cartel on each side of the market by establishing marketing and purchasers committees. Boulding (1966, p. 511) supports this viewpoint:

> . . . collective bargaining is always a sign of cartelization, for a collective bargain is one in which the terms of sale of the product of many buyers and sellers is arranged jointly by their representatives. . . . Unions differ from most business cartels in that the proceeds of the collectively arranged sale are not channeled through the organization but are paid to members directly.

The marketing board is a monopolist concerned with how much the industry as a whole can sell at different possible prices. The relevant demand curve faced by the board is the industry demand curve, rather than the demand curve faced by a single producer. Decisions of the bargaining board must be based on the derived demand of the processors or handlers for the commodity. The decisions thus depend not only upon the demand curve for the final product but also upon the processing and distribution costs of the handlers.

Even if the bargaining board is aware of the processor's derived demand for the commodity, the board is not free to maximize producer returns based on this demand curve. The outcome chosen by a dominant producer marketing board facing a price-taking buyer would surely differ from that which a board facing a monopsonist possessing equal or superior economic strength would be able to achieve. The negotiated outcome will be dependent upon the relative economic strength of the two sides involved. The exact outcome is theoretically indeterminate; a range in terms of trade will be set by negotiators and the exact terms within that range established by independent arbitrators.

The theory of bilateral monopoly may offer some insight into the outcome of the bargaining. Much work has been done on the theoretical analysis, but Fellner's work incorporates most of the possibilities and takes a seemingly plausible approach to the problem. Fellner (1949, p. 241-249) argues that there is a strong tendency toward joint profit maximization resulting in a determinate quantity and a price which is indeterminate but limited to a certain range. Zero profit limits for each party define a range within which the actual price will be determined by the relative strengths of the two parties. Both parties benefit by moving to that output determined by the intersection of the seller's marginal cost and the buyer's marginal net product. The locus of all points showing prices between the average cost and average net product for the joint-profit-maximizing output corresponds to the contract curve. Thus, the criterion of Pareto optimality is satisfied by the joint-profit-maximizing solution. "If the joint profit is maximized, then the contract lies along Edgeworth's familiar contract curve." (Fellner, 1949, p. 246)

Nicholls (1941, p. 166-196) had previously concluded that price was indeterminate from a strictly economic point of view within definite limits when a given quantity was assumed. The price at which the commodity was purchased by the processors was to be settled by bargaining. Both Nicholls' and Fellner's analyses require "all-or-none" offers in which price and quantity are tied together. The assumption of all-or-none contracts provides an institutional mechanism for reaching the joint-profit-maximizing solution.

To obtain determinate price outcomes when a quantity is assumed, assumptions must be made regarding reactions of one party to possible courses of action by the other party. Such reaction functions may involve the limits of price demands which would be tolerated without striking or breaking off all negotiations.

Game theory, which assumes reaction functions in the form of utility frontiers, has been investigated by a number of researchers as a means of determining the outcome of bargaining. According to Bishop (1963, p. 560),

> the essence of a bargaining situation is that, although the parties have conflicting preferences as among the various eligible points on their utility frontier, they

> will both be better off if they can agree on some one such point, as compared with the consequences of nonagreement .... (Both bargainers are assumed to) know all relevant data, including each participant's von Neumann-Morgenstern utility function. This means that the bargaining problem can be analyzed with reference to a known utility frontier.

Bishop argues that Nash's theory is probably the best of the theories based upon assumptions regarding reactions of one party to actions of the other. The unrealistic nature of the knowledge assumptions required make these theories somewhat difficult to adapt to empirical studies until some of their testable features are further refined.

Helmberger and Hoos (1965) have adapted theoretical considerations to define the boundaries of the bargaining outcome in a manner which may be more realistic and empirically useful than other approaches for analyzing bargaining situations. They have analyzed the problem of bargaining by a cooperative bargaining association which faces two serious problems: (1) lack of control over production, and (2) the weak pecuniary incentive for the individual grower to join or remain in a bargaining association. However, problems faced by voluntary cooperatives can be overcome by the bargaining board with its compulsory compliance and authority to control production or marketing.

The market curves for a monopsonistic cartel under a bargaining board are shown in Figure 1. The average net revenue

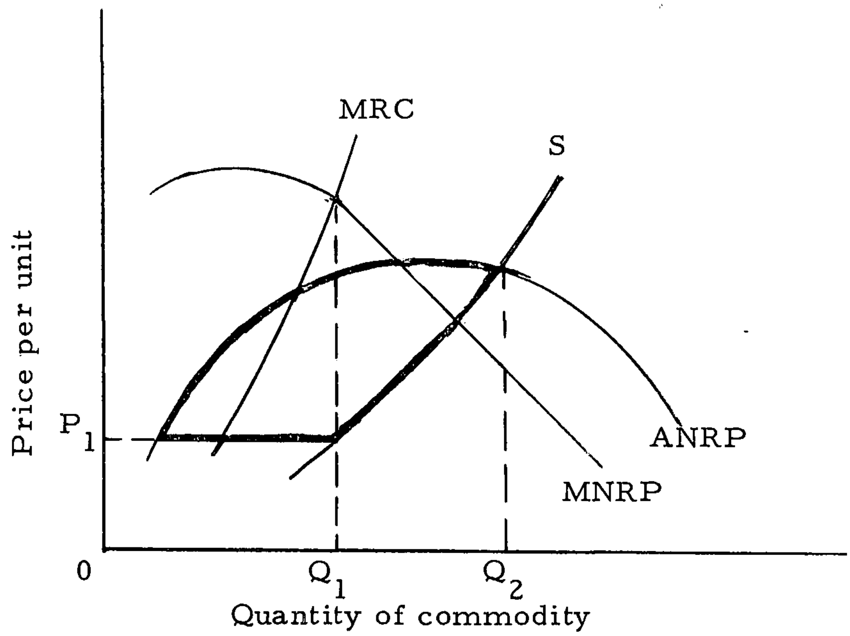

Figure 1. Market curves under a bargaining board.

product curve (ANRP) shows how much the buyers could pay for various levels of raw product and still break even. The associated marginal net revenue product curve is MNRP. According to Helmberger and Hoos (1965, p. 60):

> The ANRP curve summarizes succintly the relevant information on demand conditions of the final product, technology, and prices of other inputs. It is to be interpreted as a long-run function. Let S be the long-run supply curve of the producers of the raw product and MRC a marginal resource cost curve that shows the marginal costs to the monopsonist associated with obtaining various levels of the raw product.

The ANRP function is derived by deducting costs of processing and/ or marketing for each quantity of commodity from the revenue obtainable from the corresponding demand function for the final product.

The thickened lines in Figure 1 enclose the space which contains the long-run equilibrium bargaining solution under a marketing board. The price floor is determined by assuming that the producer marketing committee adopts a price-taking attitude. Then the monopsonistic purchasing committee equates MRC to MNRP, purchases quantity Q_1 and pays producers price P_1 in order to maximize purchaser profits. Hence, P_1 is the price floor.

> The price ceiling is given by the ANRP curve, since any point above that curve would result in the exit of the monopsonist. Survival of the producers of the raw product requires, on the other hand, that the point of long-run equilibrium not be to the right of the supply curve. Any such point would mean that cost per unit exceeds price. (Helmberger, 1965, p. 60)

For any quantity between Q_1 and Q_2 the purchaser might be expected to pay at least the price associated with that quantity along the S curve. The buyer would be making at least normal profits if he paid any price up to that shown by the ANRP curve for a given quantity. The size of the space containing the long-run equilibrium solution thus determines the possible gains to be had by producers forming a marketing board. It is assumed that the outcome prior to establishing a board is the price most favorable to the oligopsonistic processors who deal with price-taking, weak sellers.

The ANRP curve represents the aggregate net revenue product obtained by horizontally summing the individual oligopsonists' curves. It is assumed "that the maximum of each oligopsonists' ANRP curve is the same. This assumption appears to be acceptable in a long-run formulation, although in the short run one might expect considerable variation of the maxima" (Helmberger, 1965, p. 62). The oligopsonists are assumed to maximize joint profit, a condition which might be expected to be closely approximated. The greater the competitiveness of the buyers, the smaller will be the subspace since the minimum price will be higher as competition increases among the oligopsonists, assuming no shift in the supply curve.

The relative strengths of the marketing committee and the purchasers committee will determine the actual outcome and hence the division of profits. The outcome will be influenced by the ability of one party to hold out for terms most favorable to it. The more severe the hardship resulting from failure to reach an agreement, the smaller the gains a party in the bargaining process can be expected to obtain. For example, if producers lack proper storage facilities, they could not withhold a commodity from the market without costly quality losses.

In the situation involving contracted production, the bargaining period is prior to planting. Hold-out ability thus involves delay of planting or willingness of producers to grow the commodity for open market sales. Producers' bargaining strength increases if they judge the possible price at time of sale as likely to exceed the offered contract price. The processors can hold out for their own terms if they expect quantities and prices on the open market more favorable than producers' demands for contract terms. Producers suffer less from nonagreement if the production decision is annual, profitable alternative resource uses exist, and fresh market outlets are also available for commodities normally contracted for processing. Producers of crops which are grown only for processing, which cannot be stored, or which require lengthy periods before realization of production, are in a much weaker bargaining position.

Theoretical Sources of Bargaining Gains

There are several theoretical sources of gains from establishing a marketing board. The limits of these sources affect the location of the various segments of the bargaining area boundary depicted in Figure 1.

Increased Efficiency

One possible source of gain is efficiency increases from consolidation of some marketing functions under the control of a single agency. For example, bargaining for uniform grading practices in the whole market might be expected to reduce variability and uncertainty of commodity quality. Reduced processing costs through increased recovery rates could result if uniformity of grading practices did not exist prior to the establishment of the bargaining board. Further efficiency gains for the system might arise from reduced costs of transferring ownership. All transactions would be carried out at the negotiated price and probably with more uniform nonprice terms of sale. Such things as delivery schedule and methods would not have to be specified individually. Bargaining for uniformity in contract terms may benefit producers chiefly through the effect of eliminating arbitrary buyer procedures in dealing with individual producers. Lack of uniformity in contract terms make it nearly impossible for producers to evaluate alternatives effectively.

Regardless of their specific source, the effect of efficiency gains is to shift the ANRP curve in Figure 1 upward. Purchasers can pay a higher maximum price for each quantity of the commodity since operating costs are reduced. Any increase in conversion percentage resulting from better grading might partially offset unit revenue gains to producers because smaller quantities of raw commodity are now required for a given quantity of final product.

Reduced Marketing Margins

Reduced marketing margins are a frequently mentioned source of potential gain from bargaining. Paarlberg (1967, p. 9) claims that higher prices to producers can be achieved only by offering additional services such as better quality, scheduling of deliveries, and product standardization. Further, the price increases will approximate the costs of added services provided, representing an earned return based on market power rather than a gain achieved by bargaining power. Shaffer (1968, p. 6) hypothesizes that eliminating organizational slack to decrease processing and distribution costs may provide a source of collective bargaining gains. Savings arise from removing excess employees, reducing excessive salaries and wages, or eliminating competitive waste such as offsetting promotional efforts. These gains all involve opponent pain and can be extracted only if the producer bargaining committee has sufficient bargaining power.

Forcing consolidation of smaller than optimal scale plants is a possible gain representing both opponent pain and opponent gain. This might be considered elimination of marketing system slack as opposed to organization slack of the individual firm. Consolidation or elimination results from negotiated contract prices being above those which can be afforded by firms operating less than optimal scale plants or by small firms operating optimal scale plants but unable to achieve economies of distribution which exist in their industry. This situation violates the assumption upon which Figure 1 was constructed--that the maximum of each of the oligopsonistic processors' ANRP curves is at the same height. However, it is probably realistic to expect actual firms to exhibit different cost functions and hence different ANRP functions in the short run. Application of the model to an industry requires use of empirical data which may be considered representative of "average" firms in the industry and abstracts from the assumption. But in the long run, firms could be expected to move toward optimal scale plants and ANRP functions which approximated the assumption.

Evaluation of potential gains from efficiency increases or reduction of marketing margins requires measurement of processing, selling, transportation, and similar costs. Unavailability of detailed information on selling costs precludes evaluating this cost element for most industries. Variation among regions, among facilities employing various technologies, and among different sizes of operations greatly complicate any attempt to analyze processing costs. Studies are available which analyze such costs for specific situations. The nature of their simplifying assumptions would make any attempt to generalize, from these studies, lead to very tenuous or misleading conclusions. Competition among processors may be expected to result in efficient operation as they strive to lower costs and attain maximum profits. Therefore, it is doubtful that gains to be achieved from efficiency increases through bargaining would be of sufficient magnitude to justify the costly and detailed data collection and analysis necessary to support negotiations.

Reduced Excess Profits

Theoretically, reduction of excess profits is a source of gain from establishing collective bargaining. A shift in market structure occurs on the selling side to a monopsonist powerful enough to extract some of the oligopolistic processors' excess profits. However, the National Commission on Food Marketing (1966) found little evidence of excess profits for food processing firms when analyzed by industry averages. The implication for bargaining may be that to identify excess profits and seek to bargain them away is more expensive than warranted by the potential gains. But reduction of organizational slack may actually be reduction of the excess profits that exist in theory. Ladd (1964, p. 112) points out that the exercise of opponent-pain power is related to shifting the zero-profit limits which determine the limits to price negotiations. In Figure 1, zero-profit limits for purchasers are defined by the ANRP curve and for producers by the S curve.

Any reduction in operating costs has the effect of raising the ANRP level at each quantity. Elimination of organizational slack would be a pure gain for producers. In contrast, provision of additional services by producers will increase their costs and hence the net gain may be quite small. If processors were previously performing the functions as efficiently as possible, gains may be only the profit levels associated with the functions producers provide. Difficulties in determining operating costs for various processing firms under different conditions makes empirical analysis of this factor presently impossible. It may be assumed that the profit motive and competition between processors forces operating costs to near their minimum for a given output.

Regulated Supply

The source of bargaining gain with the largest potential is probably higher prices to the consumer. Monopoly profits can be created by restricting and allocating supplies. The extent of such gains is dependent upon demand characteristics for the final product: price elasticity of demand in markets, cross elasticities with substitutes for the commodity in the short run and potential entry of new products--including synthetics--in the longer run, and whether or not demand for the product is expanding are all important factors.

Means of extracting higher prices from the market are diversion of different commodity grades to uses requiring different qualities, regulation of rate of flow onto the market, and restricting production. The extent of possible gains from these activities are determined by the elasticities of demand for the commodity in different uses or in different seasons of the year. In addition to thorough knowledge of market demand and supply conditions, economic power is required to use these methods of obtaining gains. Both diversion to different uses and regulation of flow operate through shifting the ANRP curve upward or changing its shape to increase possible returns to producers. Restricting production affects the location of the S curve in Figure 1.

Hathaway (1963, p. 69) suggests that perhaps the ability to influence final product price is a necessary, but not sufficient, condition to achieve goals through supply management. Necessary conditions for price gains in the long run may include the presence of monopsonistic or oligopsonistic elements in processor procurement policies. Sufficient conditions may include continued increases in demand over a period of time.

Even if supply management increases total incomes to agriculture, the farmer may not receive greater returns on his labor. Distribution of resulting gains among factors of production could make income distribution even more dependent upon asset ownership than presently. Capitalization into production quotas and sales quotas is possible under a negotiable quota system of production and marketing control. Such a result of a supply management program to increase economic power raises a question whether it is an improvement over land retirement programs. Supply management with marketing quotas may at least be more in line with the desire for efficiency. The more efficient producers are able to bid the production and marketing quotas away from less efficient growers and even transfer the quotas to more productive geographic regions if economically feasible. Production and sales quotas also are more effective in actually controlling volume than is regulation of one production input for which others are substitutable.

To evaluate the effects of establishing a marketing board, the extent of gains obtainable from the various sources discussed must be evaluated. Such evaluation requires economic analysis of specific cases. One method of accomplishing this is to attempt to analyze the results of establishing a marketing or bargaining board in a commodity system. That approach has been adopted in this study and the analysis is presented in the following chapters.

IV A FARM BARGAINING BOARD IN A COMMODITY SYSTEM

Choice of the Western Late Potato System

The western late potato production-marketing system has been chosen as a basis for analysis of the results of establishing a bargaining board. Factors contributing to this choice include: (1) price fluctuations due to relative inelasticity of demand for potatoes and variation in yearly production; (2) different final market forms for fall 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 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 is assumed to be comprised of the nine western states included in the USDA Crop Reporting Board's estimates of potato production. The Crop Reporting Board's late summer production is included with the dominant fall production for each of these states in determining late potato production. The storage and use patterns of these two types of potatoes 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 groups based on harvest time--early potatoes, including the Crop Reporting Board's winter and early spring crops; 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 about 80 percent of total potato production in the U.S. and the nine western states produce about 45 percent of the total late crop. The year-to-year variations in production, price, and sales value of late crop potatoes in the western states are shown in Table 1.

The potato marketing season may be categorized into three groupings corresponding to the seasonal production categories--the early period from December through April, the intermediate period from May through August, and the late period from mid-August through November. Late potatoes are the sole market influence during the late marketing period. Winter and early spring crops provide about ten percent of total consumption during the early period in which late crop potatoes from storage are the principal market influence. The intermediate period consumption is provided by: (1) slightly more than half late spring potatoes, with the remainder coming from storage stocks of the late crop

Table 1. Variation in Quantity, Price, and Sales Value of Late Crop Potatoes in the Western States.

Year	Production (1000 cwt.)	Quantity sold (1000 cwt.)	Price ($/cwt.)	Sales value (1,000 dollars)
1951	53,594	46,404	2.58	119,827
1952	63,255	55,503	2.90	160,939
1953	68,357	58,347	1.18	69,091
1954	63,898	55,536	2.01	111,803
1955	70,464	60,476	1.50	90,467
1956	74,596	65,245	1.49	97,534
1957	81,113	71,668	1.66	118,749
1958	92,490	81,895	1.10	89,682
1959	84,088	74,615	2.04	152,007
1960	82,916	73,681	2.07	152,656
1961	105,599	93,607	1.16	108,749
1962	89,882	80,848	1.50	121,262
1963	98,148	89,500	1.59	142,595
1964	80,436	72,942	3.21	233,944
1965	114,381	103,173	1.93	199,631
1966	129,771	106,729	1.87	199,105
1967	127,305	112,730	1.74	195,589
1968	122,370	109,830	2.17	237,985

Source: U. S. D. A., S. R. S., 1951-1969.

during the May-June period; and (2) about half from the early summer crop during the July 1 to mid-August period (Hee, 1967, p. 5). Western storage potatoes are a factor through June, although the June carlot shipments from Idaho are only about 20-25 percent of the shipments in May (U. S. D. A., F. S. M. N. S. 1963-1967).

Large portions of western late potatoes are processed into starch and food products. About 50 percent of Idaho's production has gone into processed products each year since 1964. Some unprocessed western potatoes shipped to other areas are used for potato chips manufactured in those areas, but the proportions being processed in Idaho are of more importance to this study. 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, also contribute to the U. S. total of processed products, and Washington's share is rapidly increasing.

The processing industry is a dominant influence in the market for the western late potato crop. The processor has even more influence on the potato market than reflected in the quantities processed. Much of the processing potato crop is raised on contracts with the processors who often sort the field-run potatoes and sell suitable grades on the fresh market.

Economic Interrelationships in the U.S. Potato System

The possibility exists of using directly the relationships derived by Hee, Simmons, and others to develop a model designed to evaluate alternative marketing board actions. A review of some of the results obtained in several economic studies of the potato industry are presented in this section. One factor indicating a necessity of updating their analyses is the tremendous shift during the 1960's from fresh to processed utilization of the crop and the accompanying shift in location of potato production.

Hee's study (1967), one of the most thorough available, was based on 1947 to 1960 data using separate models for the late crop and for each of three early season crops. Results indicated an inelastic demand for the late crop and an elastic demand for some of the early crops. Hee further concluded that varying degrees of substitution occur in a seasonal market between different types of potatoes but there is some differentiation between types of potatoes. His analysis considered three possible uses for potatoes: food, livestock feed, and starch.

> This study showed that price elasticities for different utilizations of late summer and fall potatoes during 1947-60 were: starch, -1.0; livestock feed, -0.5; and food, -0.2. Utilization is most variable in the outlet with the highest elasticity, which is starch; and least variable in the outlet with the lowest elasticity, which is food. (Hee, 1967, p. iv)

These results indicate the differences which may exist in the demand for potatoes in alternative uses. The interrelationships between various uses, as well as between various seasonal crops, must be considered in any marketing board action designed to alter allocation or total supply.

Hee found price elasticities of -0.25 for starch, -0.8 for feed, and -0.25 for food based on 1921-41 data. Comparison of these results with his results for the 1947-60 period implies changing elasticities in different uses over time. These changes further emphasize the need for updating the analysis.

Hee also reported a price elasticity greater than -1.0 for processed potatoes based on analysis of quarterly price and consumption data for frozen french fries during 1956-63. This compares with an inelastic demand found for most seasonal fresh potato sales based on 1947-60 data. Estimates of elasticity for the various food uses over comparable periods of time would avoid problems of differences due merely to changes which have taken place over time.

Hee analyzed the demand for late potatoes for food using one equation involving consumption during August to April. Allocation between food and nonfood uses was considered to be jointly determined with prices in each outlet. His price equations for potatoes used as food included a marketing cost variable to allow for changes in marketing costs, since farm prices were used in this analysis. Conceptually, Hee claimed this variable shifted retail demand to the farm level, but the results obtained were mixed.

Hee did not treat seed utilization as a variable to be estimated in the statistical analysis because variability in seed utilization was judged to be equal to or less than the error associated with the data. However, an exploratory analysis for utilization for seed gave a price elasticity of -0.19.

In developing a model for the early market period, Hee used data for January to April and took account of interrelationships among demands for potatoes in that period. He estimated the price for storage potatoes used for food during the period and the quantity of fall potatoes to remain in storage for consumption in a later period. The May 1 storage quantity was found to be influenced by sustained monthly price changes, processing volume, and January 1 storage.

Hee's late spring model estimated price for late spring potatoes and for storage potatoes during May-June. Reduced form equations were used to account for joint determination of the two prices.

On the supply side, Hee (1967, p. 11) estimated the elasticity of yield with respect to the previous year's price to be about .10 for late crop potatoes. Elasticity of acreage was .12

using 1930-41 and 1951-56 data. Hee (1958, p. 132) claimed that elasticity of supply with respect to price is an additive function of the elasticity of acreage and the elasticity of yield. Hence, the elasticity of supply would be .22.

But Hee (1958, p. 134) found elasticity of acreage with respect to expected price to range from .3 to .5 for two different "free-market" periods and elasticity of yield with respect to expected price from .4 to .6. His conclusion was that production of potatoes is more influenced by farmers' expectations of long-run "normal" prices than by the most recent price change. Expected prices were derived from past years' prices.

According to Zusman's findings (1962, p. 600), short-run elasticity of acreage response for late crop potatoes was .12, identical to Hee's finding. He derived a long-run elasticity of acreage response of .43 for late crop potatoes. Based on western late crop data for 1952-60, Simmons (1962, p. 78) confirmed Hee's supply elasticity of .21 with respect to previous year's price.

Production in each of the three late crop regions for 1952-60 was analyzed by Simmons. He derived the relationship of acreage planted in each area to the previous year's: average price received, acreage planted, and index of technology. Simmons' (1962, p. 51) analysis showed that prices for the western late potato crop were affected by supplies in competing areas more than did supplies in competing late areas affect the prices for potatoes from the central or eastern late area. A one percent quantity change in the late crop in central and eastern states was associated with -5 percent change in prices received in the western states. Increased production of winter and spring crop potatoes was associated with higher prices for the western late crop. Hence, raising prices for the late crop may encourage production in competing early crop areas.

Simmons' price analysis was developed from 1951-60 data for total U.S. production, the early crop, the late spring crop, the early summer crop, and the late crop in total and for the three production regions. Simmons expressed all variables in the price equations as first differences. He related prices of the various crops to production of competing crops, but the only explanatory variable used to account for utilization of the crop was percent processed for food. This variable was not statistically significant at the ten percent level in any of the equations that included it.

Simmons' analysis for the total U.S. crop assumed price to be influenced by per capita production of all potatoes and the percent of total U.S. crop processed for food. For the early and late spring crops, he considered price to be influenced by production of the particular crop, January 1 storage stocks of late potatoes, and per capita disposable income. In his analysis for the total late crop, Simmons treated price as a function of the quantity of that crop, all other seasonal production, and percent of total U. S. crop processed. His equations for the three late crop regions included as explanatory variables the quantity produced in the particular region, late crop production in other regions, and quantities of other seasonal crops believed to compete with the particular late crop. The quantity diverted under government programs in the western region was used as an explanatory variable in the western region price equation. It was the only nonproduction variable statistically significant at the ten percent level in the regional equations.

Simmons found a supply elasticity with respect to the previous year's price of .21 for the western late crop and .13 for the total late crop. Hence, price changes may be expected to have different effects on the following period's production in the various regions. Implied price elasticities with respect to own production of -0.13 for the eastern late crop and -0.20 for the total late crop were derived by Simmons. Such a difference between price elasticities indicate that changes in western region production may affect the price received in the West differently than it influences prices received by other late producers.

Simmons found a different effect from a one million hundredweight change in Maine production than from an identical change in diversions under the marketing order in Maine. This has implications when considering whether a bargaining board should control production, or control marketing through withholding or reallocation.

In his econometric analysis of the market for California early potatoes, Zusman divided the market into winter (September through February) and spring (March through August) markets. His study was based on data for the two periods 1930-41 and 1950-58. He set up a jointly determined subsystem for the winter market.

> This set of relations determines for a given production of late crop potatoes the quantities that are consumed as food; quantities fed to livestock and lost; quantities carried over to the following spring; retail prices of potatoes; and prices received by farmers during the months of September-February. (Zusman, 1962, p. 593)

Zusman reached the conclusion that his analysis supported

> the view adopted by Gray, Sorenson, and Cochrane that the incentive to expand production during the price support period was provided not by higher prices but by the reduction in risk afforded by announced prices. (Zusman, 1962, p. 633)

Therefore, negotiated prices and bargaining board control of supply may have important effects on production through reduced price risk to growers.

Shuffett (1954) undertook analysis of prices for early commercial crop and late crop potatoes during 1920-41 based on first differences in logs. Elasticity of demand at the farm level was estimated to be -.25 and about -.40 at retail (Shuffett, 1954, p. 64). Production and personal disposable income were found to be important factors in explaining prices received by producers of late potatoes. The analysis was at such an aggregate level that it was not very enlightening regarding various interrelationships within the potato system.

None of the available studies have developed demand analyses for the different food uses of potatoes, although Hee's analysis for frozen french fries was a step in that direction. Greig (1967, p. 76) cites a retail price elasticity of demand of -2.3 for dehydrated mashed potatoes. But his analysis was based on a 1958 study of response in a few stores for a short period during the introduction of potato flakes, a new retail item at that time. Miller (1966, p. 29) and Perry (1956, p. 33) have conducted studies which indicated differences in retail price elasticity of demand between premium packs of fresh market potatoes and other fresh potatoes. The meager information available leads to speculation that differences in elasticities for different food uses of potatoes do in fact exist, although quantification of the relationships is not available in directly usable forms. If such differences do exist, then a producer group could restrict sales of regular fresh potatoes and increase sales of processed products and premium quality fresh potatoes to increase total dollar returns from retail level sales.

The analyses discussed above are useful in formulating a model of the western late potato system. However, each of these studies deals with parts of the system or relationships needed rather than with the complete production-marketing system. A model of the total system requires relationships estimated from a comparable set of data in order to assure internal consistency of the model. An economic model of the western late potato system is discussed in the following section.

Economic Model of the Western Late Potato System

Production and marketing decisions in the western late potato system are each based on both marketing and production variables. Therefore, analysis of a bargaining board in the market 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.

Production Sector

In general, late crop production decisions 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. The production decisions must be based on expectations regarding the market at harvest time and during the following storage months. The expectations are based on available information which includes prices received for quantities produced in the past and demand information such as consumption trends, processed product inventories, and exogenous variables that may affect the market. Western producers must also consider the expected production in other late crop areas and in the early and intermediate crop areas for the following season, since they compete for the same total U.S. market.

Marketing Sector

In the marketing sector of the system, the potatoes that have been produced are utilized for a variety of purposes. Major portions of the crop are used for food, but feed, seed, flour, and starch uses also compete for potatoes. The allocation into various uses, dependent on a number of interacting factors, determines prices at different levels in the system. Among these factors are consumer preferences and processing technologies, two important factors in determining the proportions of potatoes used for food in processed and fresh forms. Processors and handlers may be assumed to make most of the 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. It could be argued that all economic relationships in the system are influenced at least indirectly by variables considered as elements of the other sector. Segmentation does exist in the system, however, since producers make the production decisions while processors and handlers have the primary influence in marketing decisions.

One of the most readily apparent inter-sector relationships is that between price received for potatoes marketed and the production in following periods. The sectors are also interrelated through the effect of variations in quantities produced on quantities going into different uses. Quantities of processed products in storage influence price expectations and, hence, production. Processing and other marketing costs might be considered to tie the two sectors together because they form a connection between farm level and final product prices. Under contract production, the contract base price is an important factor on which price expectations may be partially based. The contract price is a direct result of interaction between the processors of the marketing sector and the growers of the production sector.

Any reallocation of western late potatoes among products will also affect the average prices received for potatoes produced in other areas. The resulting price will influence production in the areas in the following year, assuming that acreage planted is some function of price expectations which are based on past prices received by farmers. Thus, it is necessary to analyze the effects of any action taken by a bargaining board in the western late area on average prices received by other producers.

Processing and selling costs are also important elements affecting interregional competition in the potato market. Detailed data are unavailable for assessing the impacts of these costs on western production and marketing and on interactions between areas. The shifting of potato production and processing locations, development of new processing technologies, and varying market structures among regions also rules out the simplifying assumption of unchanging relationships between processing and selling costs for different regions. It will be necessary to assume that demand and supply relationships derived from past data implicitly and satisfactorily include the changing cost relationships. This assumption seems reasonable since the data were generated by the system operating within the limitations imposed by these changing interregional differences in costs. The assumption that the same general trends will continue is probably better than trying to explicitly include relationships based on inadequate data.

The Complete System

The sectors of the system and interactions between the sectors are indicated in the late crop system model presented in Figure 2. 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 shown in the 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 interrelationship between the production and marketing sectors is

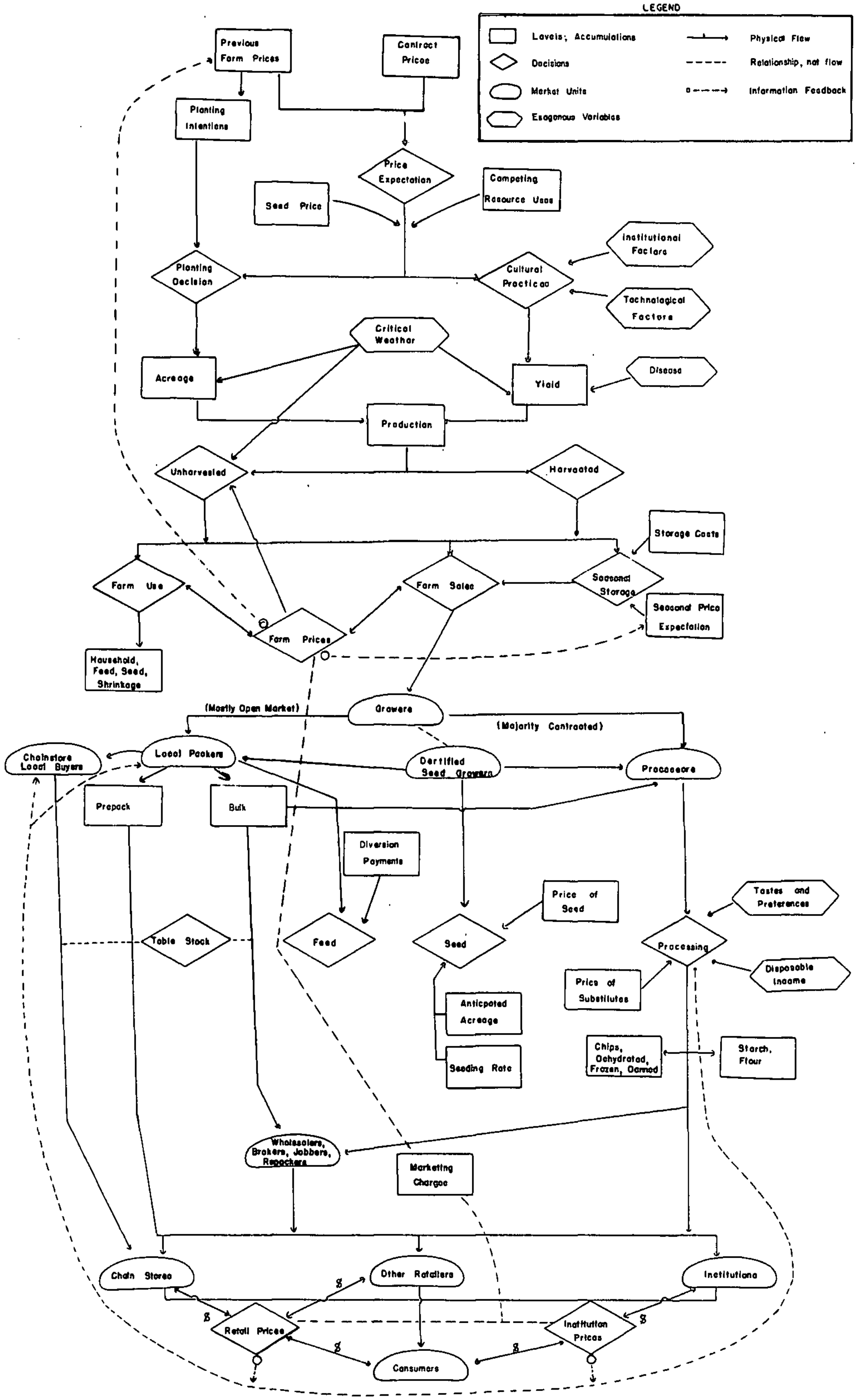

Figure 2. Late crop potato system model

consummated by growers contracting production for sale to processors at a predetermined base price. Processors can assure themselves of potatoes better suited to their quantity and quality needs for processing through contracts. 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 potatoes. For example, the base price may require 50 percent U.S. #1's with one-cent price adjustments for each percent variation in the portion grading U.S. #1. Contract terms vary annually as well as among processors for a given year.

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

The existence of a price risk in potato production generally works to the disadvantage of producers. The greater financial resources of processing firms make them better able to absorb the price risk than are individual producers. The combination of price risk and geographic location puts individual producers at a disadvantage in bargaining with processors. The potential benefits of establishing a bargaining board under such conditions have been discussed. The next step is to analyze the actual outcome of adopting a bargaining board in this situation.

Operation of a Bargaining Board in the Western Late Potato System

Sources of Bargaining Gains

The preceding discussions of the economic model of the late potato system and economic interrelationships in the U.S. potato system provide insights to bargaining board actions which might benefit producers. Functions and powers of the bargaining board assumed to be established in the system must be specified to permit evaluation of obtainable results. It will be assumed that a bargaining board negotiates with processors or first handlers in the western states to establish price and other terms of trade. Terms negotiated are expected to be more favorable to producers than if producers negotiate individually with the relatively powerful economic units to which they sell their potatoes.

The negotiations are assumed to take place prior to planting time. Theoretically this gives the board some bargaining power for use in the producers' favor in the form of encouraging producers not to plant until satisfactory terms have been agreed upon. Pre-planting bargaining permits production control to help achieve desired prices, while bargaining at harvest time would only permit maximization based on actual production. The necessity to maintain some minimum flow of final products onto the markets exerts pressure on processors to complete contracts prior to planting deadlines to assure availability of sufficient potatoes for processing. In addition, the fresh market outlet provides an alternative to selling to processors and thus increases producers' strength. However, necessity of planting by a certain date and inelasticity of demand in the fresh market also put pressures 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 theoretical sources of bargaining gains, only a few lend themselves to actual bargaining and empirical evaluation due to the difficulty of measuring the values or levels involved, as discussed in Chapter III.

Increases in consumer prices through control of supply put onto the market is the source of gain which offers the greatest possibility of increasing producers' income. Such control may involve reducing 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. Such restriction and allocation of supply will be necessary to effectuate higher prices through bargaining since negotiations cannot be isolated from the influence of demand which is reflected in the price-quantity sales combination which the market will accept. Finally, fresh sales could be regulated between the marketing seasons if economic conditions warranted this action. Shifting potatoes from one use to the other 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 organized under a bargaining board.

Assumed Bargaining Board Actions

In actual operations, a board will need to set goals which are 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 will be dependent upon the proportions of potatoes processed and sold fresh by processors.
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 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. Control production by limiting total acreage planted, taking account of expected yields, to a level that will permit regulation of fresh sales to meet goals under expected market conditions. Such control is assumed to be implemented through negotiable production quotas. The quota for each year would be expressed in terms of the base period's quota.
2. Control 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 would be specified each year prior to harvest when production could be 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 more effective in controlling supply than are acreage allotments which do not guarantee control 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 will also 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 are also necessary to avoid repercussions from destruction, waste, and nonfood use of large quantities of potatoes.

The marketing quotas covering only fresh market sales fail to cover a large portion of the crop. However, regulation of fresh market sales and processor awareness of quantities which can be sold as processed potato products would limit total food use of potatoes. There is no method for determining appropriate allocation of fresh market sales quotas to individual processors or handlers other than on the basis of historical sales. Negotiable marketing certificates will allow the market to make this inter-firm allocation and provide a convenient means of market entry and exit of 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, goals which seem obtainable and capable of evaluation may be analyzed. Analysis of results of operating a bargaining board will be undertaken for the following goals which are assumed as plausible alternatives:

1. Increased stability of prices received by producers.
2. Increased average level of prices or income received regardless of fluctuation.
3. Annual increases in prices or incomes 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, reduction of processor profits, or reduction of organizational slack may be implicitly represented in these operational goals in the form of higher prices to producers without proportional increases in consumer prices. Although these operational goals do not correspond exactly with the theoretical sources of gain, they may represent all the possible gains since the true source of some of the neogitated gains cannot be isolated for measurement.

These testable policy alternatives are formulated on the basis of assumptions stated in the previous sections of this chapter. The assumptions are derived from the theoretical sources of bargaining gains discussed in Chapter III and adapted to the potato system in the present chapter. The economic model of the western late potato system presented in the earlier sections of this chapter provides the framework for the assumptions and for the analyses which follow.

V 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 interrelationships between production, processing, and marketing decisions affecting farmers, marketing firms, and consumers. Models based on mathematical optimizing methods often fall far short of realistically representing the complexities of an economic system. A research technique known as simulation can be utilized to build a model suitable for the desired evaluation of alternative bargaining board policies in a complex, dynamic environment. The model's behavior over time is generated on a computer, parameters are 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. "The functional relationships describing the interaction of the variables and components of an economic model . . . are used to generate the behavior of the system." (Naylor, et al., 1966, p. 12) According to Naylor, 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 only be derived 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.

The simulation model differs from traditional econometric models which are one-period-change models. In both types of models the values of the endogenous variables are generated based on exogenous variables, predetermined endogenous variables, and random disturbances. However, values of the predetermined endogenous variables in a simulation model are the values generated by the model in previous time periods. Thus, the simulation model perpetuates any errors made in the model rather than having automatic resetting of error terms to assure a correct starting point for each period as in the one-period change model

(Cohen, 1960, p. 13).

Economic systems are generally dynamic and stochastic and are influenced by noneconomic variables according to Naylor (1966, p. 20). Models designed to evaluate such systems should possess the same characteristics. Mathematical models which deal with time-varying interactions are dynamic models. If one or more of the operating characteristics involves random variation, the model is stochastic.

In addition to possessing characteristics similar to the system being modeled, certain other features of a simulation model are desirable. One such feature is that the model be recursive.

> A model is fully recursive if it is possible to sequence one-at-a-time computation of successive values of endogenous variables in such a way that for any time period the value of each endogenous variable may be computed, given only exogenous variables, lagged endogenous variables, and preceding current endogenous variables in the sequence. (Orcutt, 1963, p. 232)

Two important advantages of using recursive simulation models are cited by Naylor (1966, p. 231). First, estimation of the parameters of the structural equations is simplified because it is possible to obtain unbiased and consistent estimates of parameters by applying ordinary least squares to each equation. Second, generating the time paths of endogenous variables does not require solution of simultaneous equations.

Although simplification of estimation may be one criterion, the theoretical economic model must be the dominant influence on choice of model type. Little is known about the relative forecasting properties of simultaneous-equation compared to single-equation methods, and forecasting is one concern in simulation. Hee (1967, p. 39) contends that an order of priority exists for different uses of potatoes and hence a single-equation method can be used to estimate relationships. Simultaneity appears appropriate for a few relationships, but efforts to formulate a simultaneous system lead to relationships which cannot be estimated because necessary information is unavailable. The majority of the endogenous variables can be theoretically determined based on exogenous and lagged endogenous variables. Ordinary least squares is the appropriate technique for fitting such equations and is used in this study to derive relationships for the potato system.

Regardless of the estimation technique used to derive operating characteristics, the model as a whole must be verified. Verification is one of the most difficult problems associated with simulation techniques, according to Naylor (1966, p. 310). Naylor suggests use of multistage verification consisting of three elements:

1. Formulating a set of hypotheses describing the nature of the system.
2. Attempting to verify the hypotheses on which the model is based, subject to limitations of existing statistical

tests such as t-tests and F-tests.

3. Testing the model's ability to predict the behavior of the system under study.

Verification of the hypotheses on which the model is based takes the form of evaluating the individual relationships used in constructing the model. The data from which the supply and demand relationships used in the model were derived are presented in Appendix A. The production and marketing equations estimated from the data are presented in Appendix B for the reader's evaluation. The stepwise least squares regression relationships may be evaluated by using t-tests to determine significance of the coefficients. Another criterion of evaluation is the R^2 value as an indicator of the extent to which the endogenous variable is influenced by the explanatory variables of the equation. The coefficients estimated for the other relationships may be roughly evaluated by comparing the values of the coefficients and their standard errors.

Testing a model's ability to predict the behavior of the system under study may be done in several ways. If a model is required to predict specific events, most models of any complexity would fail to meet such rigorous standards. However, Forrester (1961, p. 128) suggests that a useful model "should predict and reproduce the behavior characteristics of a system, not specific events or particular, unique sections of actual system time history." The characteristics of the system referred to by Forrester include stability, growth, and general time relationships between changing variables. Direction of major changes in system performance resulting from change in system structure or policy and the approximate extent of the changes is of primary importance (Forrester, 1961, p. 116).

It is impossible to test predictive results beyond the time period for which historical data exists. As in the present case, it is usually necessary to use most or all the years of data available in estimating equations from time series data. Thus, the model must be tested against the data from which it is derived--a generally undesirable approach, especially if one is interested in using tests of statistical significance. But to undertake tests of statistical significance on data generated from a simulation model is not a sound procedure, since some of the basic assumptions of such tests are violated by simulation data. One problem arises because simulated data are generated based on relationships derived from sample data and no population variance exists for the data generated from the simulation model. Also, according to Fishman and Kiviat (1967, p. 526), simulation data are generally autocorrelated and hence statistical tools commonly used for studying independent observations are inapplicable.

Tests of a more general nature may indicate the model's predictive powers. Naylor (1966, p. 317) claims that the simulation procedure itself provides the basis for severe tests. The repetition of the solution process would be anticipated to cause forecast performance of the values calculated to worsen as errors accumulated. Hence, comparing model results and observed values is a severe test even when the model has the advantage of being tested against the data used in its estimation.

One means of improving the forecast ability of a model may be to attempt to reduce residual variation among computer runs. The interest in computer simulation experiments is usually in measuring differences in average response for various combinations of factor levels. It is therefore desirable to have estimates of the average response positively correlated to reduce random error in the measurement of differences. Using the same sequence of random numbers at each combination of factor levels is one means of accomplishing this, since stochastic variates generated from the same set of random numbers are likely to be positively correlated (Naylor, 1966, p. 335; Conway, 1963, p. 53).

Elements of the Potato Simulation Model

Given these procedural considerations, data limitations for the potato system, and the policies to be tested, a simulation model was constructed. The logic of the simulation model is derived from the model of the western late crop system presented in Figure 2 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 purpose of the model is to analyze the results of terms negotiated by a bargaining board. 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 their effects 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 given in Figure 3.

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

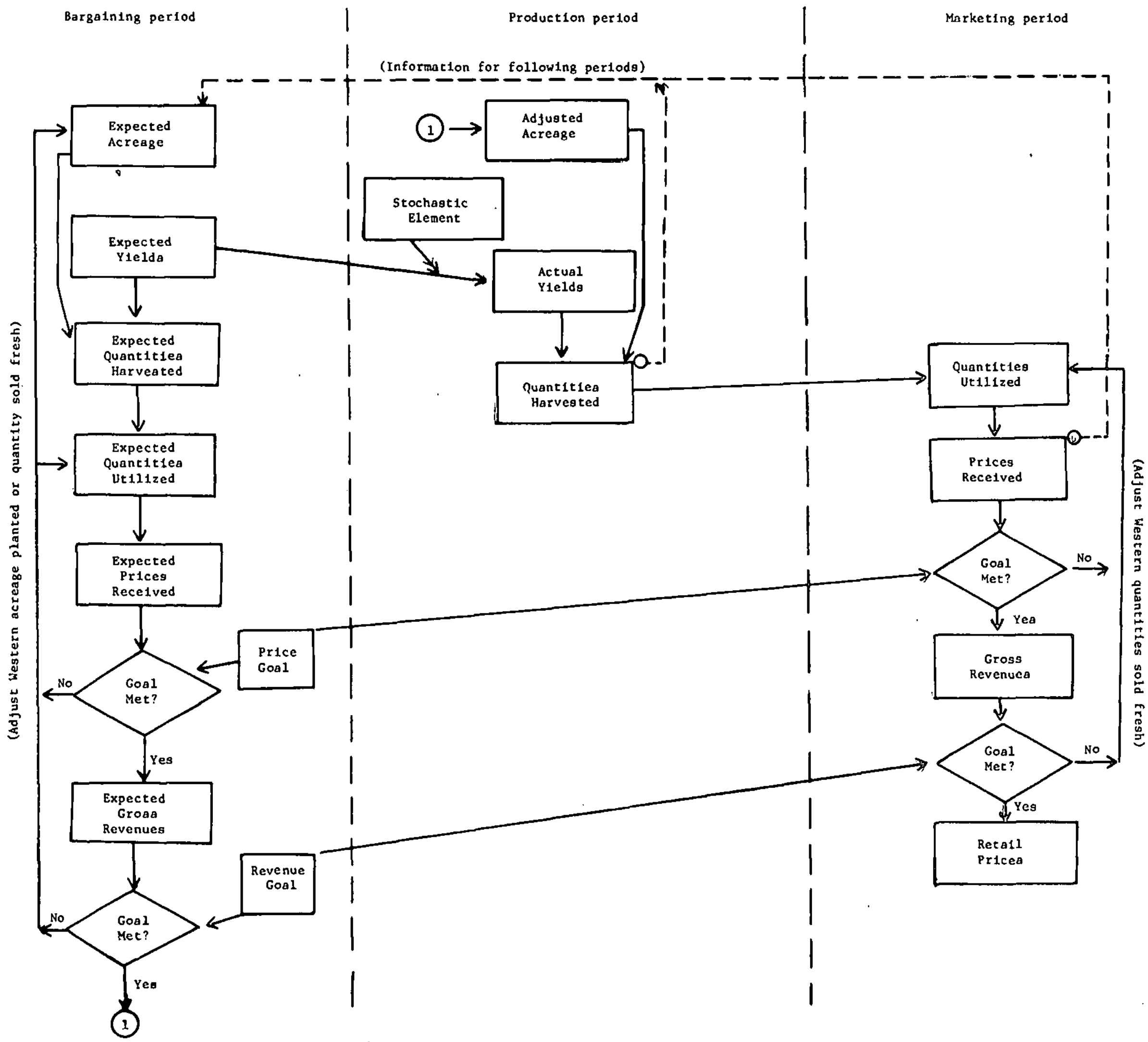

Figure 3. Simulation model for evaluating bargaining board policies

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 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 assumed to be specified. If these goals are not met, the computer program adjusts the western acreage and/or quantity marketed fresh from the West and again compares the resulting endogenous variables with the goal. This process is continued for each 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 the goals.

In the production period section of the simulation model, actual production in the system is determined for the crop year. At this point, the expected acreage from the bargaining section, including bargaining board adjustments in western acreage, are assumed to have been planted. 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 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 harvested in the system.

The marketing period section of the model deals with disposition of harvested production. The board would need to adjust fresh sales of western late potatoes to obtain desired goals based on actual production and demand conditions. The adjustments are currently accomplished by marketing firms and growers during the marketing season and are coordinated through open market prices. Under the bargaining board, the quantity marketed fresh from the West would be controlled through marketing quotas to meet established goals.

The marketing section of the computer program calculates quantities utilized, based on the actual production quantities calculated in the production section. The resulting values of appropriate endogenous variables are then compared with the specified goals. If the goals are not met, the quantity marketed fresh is adjusted and the resulting values of the endogenous variables calculated. This process is continued for each year until the goals are met. The difference between the original value calculated for fresh sales and the final value indicates the magnitude of adjustment required through marketing quotas for western late potatoes. Due to variations between expected and actual yields, it may be impossible to meet goals through manipulation of fresh market sales from the West while satisfying certain restrictions built into the model. Such restrictions are included to keep the adjustments within limits judged to represent realistic conditions in the system.

After having estimated the endogenous variables for all segments of the simulation model for one 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 keep 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 module of the simulation model presented in Figure 3 are discussed in this section. An attempt is made to indicate the underlying logic of the various relationships and explain the limitations placed on the range of possible values. Supply and demand relationships were hypothesized on the basis of factors indicated in the economic model presented in Figure 2. Some of the hypothesized variables were eliminated from the final equations in accordance with accepted statistical practices. The resulting production and marketing equations given in Appendix B are incorporated in the computer program used to simulate the system. The Fortran program of the model is given in Appendix C. The relationships of the model are discussed under headings which correspond to the seasonal periods and modules illustrated in Figure 3.

Bargaining Period

The bargaining period section of the computer simulation program generates expected values of the endogenous production and marketing quantity variables. These values are generated using equations based on exogenous and lagged endogenous variables. This information is available to the board during the pre-planting 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 are then 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 are then 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 to incorporate production and marketing quotas which can be used by the bargaining board to help meet goals. If adjustments are necessary, the affected endogenous variables are recalculated, and the 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 planted acreage to be 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.

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.

The resulting regression estimates are used to calculate the expected acreages (Appendix B, equations 1-4; Appendix C, lines 81-89). For western and eastern late potatoes, lagged price of the same crop and the change between weighted average lagged prices from one and two years previously for competing late potatoes were statistically significant explanatory variables. Time was important as an explanatory variable representing influences not explicitly included in the equations, such as increases in irrigated acreage. 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 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 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. Dept. 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; Appendix C, lines 94-101).

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 was 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 would lead 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 (Appendix C, lines 95-106). The exception is the quantity harvested of central late potatoes, 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 would 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 in major uses are available for the total U.S. on a yearly basis. It was hypothesized that relating average prices received by farmers to utilization data might 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 price 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 may well be justified. 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 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 per capita utilization. Dehydrated utilization was then obtained by deducting chip and frozen utilization from this total processed. 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 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 (Appendix C, lines 110-127). This approach assumes that trends in per capita consumption will not change significantly in the near future. Population is projected based on time (Appendix B, equation 11; Appendix C, line 118). 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 late crop quantities stores.

Expected Prices Received: The quantities utilized are employed to estimate prices received for each of the late crops. Prices are 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 potatoes used for canning, starch and flour, feed, seed, and shrinkage or loss. The resulting regression equations are used to calculate the expected prices received (Appendix B, equations 12-18).

Quantities for other uses and fresh use 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. Quantity of potatoes used for frozen products is included in the price equation for western potatoes, and quantity dehydrated in the equation for eastern potatoes, since they 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 based on 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 (Appendix C, lines 128-129) and then, if there is no price goal indicated, proceeds to calculate prices for the other crops (Appendix C, lines 206-216). 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 (Appendix C, lines 133-184). 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 further necessary adjustments can be made by controlling sales of fresh potatoes from the West. If the calculated price is below the price goal, acreage or quantity fresh 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 1956-68 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 total 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.

This calculated price received is not the price which would be established by a bargaining board. The average price received is dependent upon the distribution of utilization of the actual production. 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 used 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 (Appendix C, line 186). The other gross revenues are then calculated (Appendix C, lines 220-224) unlêss a gross revenue goal has been established.

If a revenue goal has been established, adjustments are made (Appendix C, lines 187-203) 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 (Appendix C, line 189). 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 final values of expected acreage from the bargaining section are assumed to have been planted. Actual yields are generated by the computer program and used to calculate the actual production in the system for the crop year.

Adjusted Acreage: The block for adjusted acreage is included in Figure 3 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 (Appendix C, lines 227-236). 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.

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. Since the actual harvested quantities will usually differ from the expected quantities, utilization, prices received, and gross revenues will also reflect this difference.

Marketing Period

The actual values of the marketing sector variables may also differ from their expected levels upon which bargaining was based. The difference results from actual harvested production deviating 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 of the program.

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 (Appendix C, lines 251-259).

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 ten percent of the expected utilizations for fresh, dehydrated, and frozen products. These limits were imposed to allow reasonable fluctuation while acknowledging the necessity of maintain 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 multiplied by population to determine total annual expenditure (Appendix C, lines 245-247).

Prices Received: Based on the actual quantities utilized, the average price received for western late potatoes is calculated (Appendix C, line 264). If a price goal has been established, any necessary adjustments are 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 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 (Appendix C, lines 267-305) 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 (Appendix C, lines 308-317).

Gross Revenues: Gross revenues are derived from quantities harvested and actual prices received for each of the crops (Appendix C, lines 318-321). If a goal is established for gross revenue in the western late area, adjustments are carried out subject to the restrictions discussed regarding attempts to achieve price goals (Appendix C, lines 281-305). The provision to stop adjustment when the absolute change is less than .2 percent of the previous level of gross revenue 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 processors and marketing firms determine quantities individually 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 (Appendix C, lines 322-327).

Using retail prices for frozen 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; hence, derivation of a consistent weighted average price for retail and institutional sales is impossible. 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 2. 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 using it to simulate and evaluate alternative bargaining board actions. Inferences cannot be made about 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 mentioned earlier is ability to duplicate behavior characteristics of the system under study--stability, growth, and time relationships between changing variables. Two different methods have been used to test the model's ability to reproduce behavior 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 between the changing endogenous variables of the model.

Table 2. 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.

Continued

Table 2--Continued.

Symbol	Variable	Units
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.

Historical Comparison

Model results were generated for an 11-year period representing the 1958-68 crop years and compared to observed data from that period. The 1958 crop year was the first for which model results could be generated, since 1956 data were the earliest available for certain variables which are 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 are obtained by generating the endogenous variables based on the relationships discussed previously. No bargaining board goals are set in generating these results. 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 is also run substituting historic yields for each year for the stochastic values generated in the production section of the model. For the central late crop, historic quantity is substituted for the stochastic quantity. This procedure is expected to lead to model results more closely duplicating behavior characteristics of the system over the 11-year period than when stochastic yields are used. The mean values of the variables observed for the actual system and each of the two simulated runs for the 1958-68 crop years are presented in Table 3.

For most of the variables, the mean of simulated values based on historic yields are as good as or better than simulated values using stochastic yields as predictors of the observed values of the actual system. This is in accord with expectations. But the improvement in the estimates using historic rather than stochastic yields are generally small relative to the observed actual system values. Hence, the conclusion is drawn that the stochastic yield generation is not unduly affecting the model's ability to duplicate the actual system.

The relative difference between the means of the simulated results based on the stochastic yields and those of the actual system indicate that the model duplicates the behavior characteristics of the system reasonably well. Of the ten quantity-harvested

Table 3. Comparison of Simulated and Observed Results, 1958-1968.

	Observed	Simulated with yields based on		Percent change: observed to simulated		Coefficient of variation		
							Simulated	
	Observed	Stochastic	Historic	Stochastic	Historic	Observed	Stochastic	Historic
AWL	452.10	452.81	449.82	.2	- .5	11.2	10.3	10.1
AQWL	102,490.00	103,167.27	101,803.92	.7	- .7	18.0	16.5	14.4
APWL	1.85	1.92	1.86	3.8	.5	30.8	17.7	12.0
AQFR	145,348.00	145,625.31	145,563.08	.2	.1	7.8	7.1	6.9
AQFF	25,177.00	22,168.28	21,916.54	-12.0	-13.0	51.3	49.0	49.6
AQD	13,092.00	12,404.50	12,371.84	- 5.3	- 5.5	46.2	45.1	44.4
AQC	26,447.00	27,349.29	27,349.29	3.4	3.4	22.1	18.5	18.5
AQO	66,034.00	64,402.93	67,115.10	- 2.5	1.6	19.8	10.2	15.0
APFR	7.13	6.84	6.75	- 4.1	- 5.3	13.2	5.9	4.7
APFF	30.90	31.64	31.58	2.4	2.2	10.4	10.4	10.7
AQEL	73,161.00	70,368.03	72,548.61	- 3.8	- .8	3.7	5.0	6.1
APEL	2.02	2.10	2.02	4.0	.0	34.2	16.3	11.4
AQCL	55,023.00	54,154.27	55,022.73	- 1.6	.0	7.6	7.6	10.6
APCL	1.89	1.97	1.89	4.2	.0	34.4	15.9	11.2
AQE	8,441.00	8,392.53	8,648.22	- .6	2.5	12.7	11.4	10.4
APE	3.18	3.23	3.10	1.6	- 2.5	24.2	12.8	12.1
AQI	36,706.00	35,868.21	36,292.37	- 2.3	- 1.1	9.0	6.8	6.7
API	2.68	2.94	2.77	9.7	3.4	32.8	22.0	18.4
RAQWL	.37	.38	.37	2.7	.0	0.4	7.5	11.0
WAPWL	1.83	1.92	1.88	4.9	2.7			

and price-received variables, only the simulated mean price received for intermediate crop potatoes deviates more than five percent from its value in the actual system. Other variables which approach or exceed five percent deviation between simulated and observed values are weighted price for western late potatoes and quantities of potatoes 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 data exists for comparison.

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 3. 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, cause these observed prices to fluctuate widely with relatively small changes in the quantities influencing them. Hence, differences in stability between model estimates and observed quantities are magnified in determining price estimates and the spread in stability increases.

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 six percent annually, and a price goal increasing three percent annually. These tests were made to assure that untenable results were not obtained when the model was run for an extended period and served as a basis for model revision incorporating restrictions on actual quantities marketed fresh and for other uses. The criteria of judgment must be apparent reasonableness of the estimates, since there is no way of knowing what levels should be expected for most of the variables. The model used here was judged to give reasonable results over the extended runs in addition to acceptably duplicating growth and stability of the system.

No attempt is made to test the model's ability to duplicate yearly results of the system and it is not expected to do so. In using the model to test alternative bargaining board policies, relative levels of the variables and their stability may be determined under alternative policies. The absolute level of the variables calculated each year should not be treated as precise estimates of actual levels. Using the means and standard deviations of the variables to evaluate results under simulated policies over a period of time should give reliable results.

VI ANALYSES OF BARGAINING BOARD POLICIES

Method of Analysis

Assuming the model gives reasonable results over the 11-year period tested against actual data, a decision needs to be made on the length of time which can be simulated beyond that period. To test policies of a bargaining board it is necessary to project operation of a board in the system. The approach used here is to assume that a board is established starting in 1968. Operation of the system is simulated only to 1980, since all projections assume the general trends and relationships observed in the past will continue basically unchanged over the projection period.

No comparable historical data exists for the 1968-80 period without a bargaining board. A basis for comparison of results simulated under assumed bargaining board alternatives is provided by a base run for 1968-80. The base run, against which all other runs are compared, consists of values of the endogenous variables generated by the model when it is run with no goals or other interference. The base run represents projection of the present system into the future. The base run will not precisely duplicate the results expected from the actual system over that period. However, the previous comparison of simulated and actual results for

1958-68 indicates that the base run values should be reasonable estimates of the actual system values. The important point is that all alternatives will be evaluated by comparison with this base run and the relative results will be used to evaluate the alternatives.

Bargaining Board Alternatives Tested

Most of the goals previously specified as reasonable for a bargaining board 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. Reduced yearly price fluctuations, implied by price stability, were obtained by setting the price goal at a constant level over the entire period. The model mechanism then forced adjustments in other variables to result in an average price received for the western late crop which 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 five percent annual rate of increase for testing the goal of increased level of prices received regardless of fluctuation. 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 five 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 food consumption was tested by using different values at which total per capita food consumption was fixed. Another test of this goal was conducted in which per capita consumption 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 stabilized 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 which would result in the most stability of quantity processed or marketed fresh.

Results of Tests

The results of the tests of various policy alternatives are presented by tabulating the mean values of the variables over the 13-year period for several levels of the alternatives being tested and for the base run. 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 shown for variables most important to western late 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 presented to give an indication of the variation in results under alternative levels of the policy variable being tested.

The mean of the aggregate gross revenue for western potatoes over the simulated period generally reaches a maximum for one of the policy levels. This result occurs because percentage changes in production exceed percentage changes in price in the opposite direction after the point in adjustment where farm price elasticity of demand switches from elastic to inelastic. Then, further reductions in production do not increase price enough to raise gross revenue. The maximum average gross revenue under bargaining board policies never attains the level achieved in the base run, at least partly because greater amounts of resources are used for potato production in the base run. The bargaining board is assumed to limit resource use through production quotas to achieve the goals specified.

Using the mean aggregate 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. Lacking information on production costs, the return on resources committed to achieve a given gross revenue can be evaluated by assuming that a larger quantity produced indicates use of greater amounts of resources. Then, the weighted average price received, which is the gross return per hundredweight of potatoes produced, can be used as a criterion of evaluation.

The weighted average price received generally increases as prices are raised under more restrictive production limits imposed by a bargaining board. If some economies of size in potato production are 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 can be chosen on the sole basis of weighted average price received if it continues to increase as western production is further restricted. This measure should be used in conjunction with aggregate 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 4. The largest aggregate gross revenue for any level of price stability tested occurred when the goal was set at $3.10 per hundredweight. Western late potato producers would fare 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 is down nearly nine percent and the average revenue per hundredweight is down nearly four percent from the base run.

Processors would use less than three percent fewer potatoes for frozen products, but the retail price for frozen products would

Table 4. Results of Price Stability Policy.

	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

be ten percent higher than in the base run. Greater fresh sales from smaller quantities available probably lead to higher prices paid by processors for potatoes for freezing, and this is reflected in the smaller quantity processed and the higher average price passed on to retail. The consumer would gain 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 would also benefit processors and handlers. Generally it appears that a policy of a bargaining board to increase price stability may benefit the other parties concerned at the expense of the producers.

But stabilizing price received at $3.30 per hundredweight may be desirable for the producers. Total gross revenue would be 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 about be 2.5 percent above the base, compared to a weighted average price which would be 3.7 percent below the base under the $3.10 level. There would still be substantially more fresh potatoes marketed at approximately the same price as the base, although consumers would not fare quite as well as at the $3.10 level. The price of frozen products would be slightly higher at retail and the quantity slightly less than for the $3.10 level.

Processors and handlers would not fare as well as under the $3.10 level since slightly smaller quantities would be handled but prices paid farmers would be up by a greater percentage than retail prices. Hence, under this price stability policy at the $3.30 level, producers could fare better on the basis of revenue per hundredweight produced while fresh handlers and consumers of fresh potatoes would be better off than in the base. The consumers of frozen products would have smaller quantities available at higher retail prices. Prices paid to farmers by processors, indicated by the average price received by farmers, would increase less than the retail price increase 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 is reduced utilization of potatoes for lower-valued nonfood uses. This source is apparently important under most of the policies tested, as will be seen in the tables.

Under either level of price stability, producers of other potato crops would gain over the base run conditions. They would produce the same or greater quantities and sell 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 5. A five percent rate of annual increase gave the largest aggregate gross revenue over the period, but the mean value for the western producers was seven percent less than under the base conditions. However, the five percent annual increase in price results in a slightly higher average price per hundredweight produced than for the base run. Consumers would have about 11 percent more fresh potatoes based on the mean quantity over the period. The greater quantity marketed fresh would result 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 would also be about one 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. But the price and quantity variables listed in Table 5 are average values over the period, and the quantity and price movements within a given year may still be consistent with expectations.

Under this policy of increasing the season average price received by farmers, consumers would pay ten percent higher

Table 5. Results of Policies to Increase Price at Various Rates.

	Base	Percent annual increase in price goal: 3	4	5	6	Percent change: base to 5
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

average price for nearly the same quantity of frozen products as in the base run. Since the retail price of frozen products increases substantially more than the farm price received, processors of frozen products should fare better given a board with such a policy. Fresh handlers would pay an average price to farmers which is 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 regardless of fluctuations leads to the results shown in Table 6. Based on the results of the previous test of increasing price at various rates, the five percent rate of increase is used in this test. Varying the initial price level leads to different average price levels over the period. The highest average gross revenue for the system is attained with a price initially set at $2.36 per hundredweight. This is the same price as the initial price which was increased at various rates in the

Table 6. Results of Price Level Increase Policy.

		Initial level of price goal (5 percent annual increase)				Percent change: base to $2.46
	Base	$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

tests presented in Table 5. Hence, the results in Table 6 under the \$2.36 initial price are identical to those in Table 5 under the five 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 6, although the average gross revenue for the western producers is down slightly from its maximum which is attained under the \$2.36 initial level for the price goal.

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

Gross Revenue Increase Policy

Gross revenue increase policies give the results shown in Table 7. The 12 percent rate of annual increase in gross revenue goal gives nearly the highest aggregate gross revenue for the western

Table 7. Results of Gross Revenue Increase Policy.

	Base	Percent annual increase in gross revenue goal				Percent change: base to
		8	10	12	14	12
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

growers. The levels for other variables are nearly identical under the 12 percent rate with those achieved under higher rates of increase, since restrictions built into the model become effective in the latter years of the period when goals become too high to be met.

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

Acreage Control Policy

Attempts of a bargaining board to operate by controlling growth in western late acreage planted give results summarized in Table 8. The highest average gross revenue occurs at the three percent annual rate of increase in western late acreage. At this

Table 8. Results of Acreage Control Policy.

	Base	Percent annual increase in western late acreage				Percent change: base to
		2	3	4	5	2
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

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

A higher per hundredweight revenue could be accomplished by limiting acreage growth to two percent annually. Thus, the comparisons in Table 8 are based on the two percent rate of increase. Lower quantities processed and sold fresh, as well as slightly higher retail prices, imply that a small part of the gain would come at the expense of consumers. The handlers and processors would contribute to this producer gain as reflected in slightly reduced quantities utilized and prices to farmers which are relatively much higher than are retail prices compared to base values of each. If an acreage control policy establishing a two percent annual increase were established, producers could apparently derive a higher revenue chiefly because the limited production would result in substantially fewer potatoes being 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 of 110 pounds per capita total annual food use of potatoes. 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 9 indicates the magnitude of the effects. Since increases in total use for food are assumed to occur because of increases in fresh consumption, western producers experience declines in average revenues in aggregate and on a per hundredweight basis for levels of total food consumption which are greater than the 110 pounds of the base run. Competition for quantities to be marketed fresh and for frozen products results in higher retail prices for the same quantity of frozen products. Areas producing primarily for fresh sales receive slighly higher prices than for the 110 pound level of total per capita consumption.

The possibility of gradual increases in total food use of potatoes of one pound per year, starting from 110 pounds annually is also tested. The results of this test are compared to the base

Table 9. Effect of Different Levels of Total Food Use of Potatoes.

	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

values, since greater effects are reflected in this run than for the runs with higher consumption levels which are constant over the period. Western producers would not fare as well when consumption increased one pound annually as when consumption is stable at 110 pounds annually. The greater proportion of production sold fresh increases competition for potatoes from about the same production and results in higher prices for processed potatoes. Processors would probably pay more for about the same quantities of potatoes for freezing and pass the price along to consumers through higher retail prices. Reduction of other uses, rather than increased production in any region, supplies the majority of the increased fresh consumption.

Given the information upon which the model is based, it does not appear that a bargaining board should adopt programs which attempt to increase per capita consumption of potatoes in total. However, 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.

Stability of Variables

The means of the variables over the simulated period, as presented in the preceding tables, indicate the levels of the variables which result 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 10. The variables selected are ones for which stability over the simulated period seems desirable. By examining the coefficient of variation for one

Table 10. 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

variable over all the policy alternatives, it is possible to determine whether certain policies result in unacceptable variability compared to other alternatives.

The variability of gross revenue about its mean is approximately the same for all the policies tested. The variability of quantity marketed fresh is least under the assumption of one pound annual increase in total consumption for food, but the variability is not greatly different among the various policies tested with total food consumption assumed constant at 110 pounds annually.

Price received has nearly the same variability under all the policies except for the policy of forced price stability. The result of decreasing variability in price received was to increase variability of western late acreage harvested to a significant extent. Thus, a price stability policy might be undesirable from the viewpoint of resource allocation. If alternative uses for resources used in potatoes part of the time are not readily available, such a policy may be undesirable on the basis of this variability. However, the alternative of stabilizing price at $3.10 was concluded to be undesirable on other grounds. The possibility of 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 is 24.3 and may make that alternative unacceptable. Variability of acreage is generally in the same range among the other policies tested.

If a board had reasons to place specific limits on variability of these or other variables, the coefficient of variation could be examined under various levels of policy variables as one means of evaluation. Based on the assumptions made here, the only policy seeming to result in unacceptable variability is that of price stability which greatly increases variability of acreage harvested. But greater stability in acreage under other policies is associated with much greater price variability than under this policy and the final evaluation is dependent upon 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 chapter will include a general summary of the results for the bargaining board alternatives tested in this chapter. Conclusions and policy implications pertaining to establishing bargaining boards will also be discussed.

VII SUMMARY AND CONCLUSIONS

The objective of this thesis was to examine one approach to attaining farm bargaining power--establishing a farm bargaining board in a commodity system. Bargaining power was defined as the ability to negotiate terms of trade given the necessary institutional and legal framework to make bargaining effective. Legislative proposals furnish a basis for speciying the general nature of the operation of a bargaining board to attain the bargaining power desired. The National Agricultural Bargaining Act of 1968 proposed creation of farm bargaining boards at the request of and referendum approval by producers of a given commodity. This act provided specific proposals to establish a framework to make bargaining effective under bargaining boards.

Theoretical sources of gain from establishing a bargaining board designed in accord with the legislative proposals were specified. But most of these sources of gain were judged to be not measurable or of insufficient magnitude to provide gains worthy of a bargaining effort. To test the results of implementing a bargaining board in a commodity system, the western late potato system was selected for analysis. Results of several economic studies were examined to determine economic interrelationships in the potato system. Each of these studies dealt with partial relationships within the system and thus could not be used directly for analyzing the entire system.

An economic model of the western late potato system was specified and potential sources of bargaining gains in the system were discussed. Control of total production and allocation of that production into alternative uses were chosen as the most promising sources of bargaining gains. Control of these variables would be necessary to effectuate higher prices through bargaining which cannot be isolated from the influence of market relationships. Assumptions regarding the operation of a bargaining board in the western late potato system were made. Negotiable production and marketing quotas were assumed to be used to effectuate the desired control. Then operational goals were established as the basis for evaluating possible alternatives for a board.

A simulation model was developed for evaluating policies of a western late potato bargaining board in the potato production-marketing system. The production sector of the model consisted of five production units: western late potatoes, central late potatoes, eastern late potatoes, early potatoes, and intermediate potatoes. The marketing sector of the model incorporated five alternative uses for potatoes: fresh sales, frozen products, dehydrated products, potato chips, and nonfood uses. The model was based on least squares regression relationships developed to represent the decision mechanisms of the actual system. A Fortran computer program of the simulation model was developed to allow computer testing of alternative bargaining board policies. The model was judged to give reasonable duplication of historical relationships in the system and, hence, to be usable for the desired analysis.

Summary of Results of Bargaining Board Alternatives Tested

Policy alternatives for a bargaining board were tested by evaluating results of different levels of assumed operational goals of a board in the western late potato system. Bargaining goals tested were:

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

Each of the tests were summarized by presenting mean values of resulting endogenous variables under selected levels of the policy variable being tested. Results from one level of the policy variable were chosen for detailed comparison with the base run, which served as the benchmark for evaluation.

To summarize the results for the different policies, percentage differences between the base run and the policy level chosen for detailed analysis for each policy are presented in Table 11. The endogenous variables most important to western producers are included for comparison among the policy alternatives and are discussed in the following pages.

Table 11. 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) change together, their absolute differences being determined by yield which might be viewed as a coefficient of proportionality between the two. The least decrease in acreage from the base run conditions occurs 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 under this policy come from reduction in potatoes going into nonfood uses. 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 quantity used for food per capita.

But achieving the same harvested acreage as would prevail under market operations assumed in the base run would hardly be a goal of the board. When prices received per unit produced and the aggregate gross revenue are evaluated, it becomes apparent that the food use increase policy would not be favorable to western farmers. However, adopting a program to increase per capita utilization in conjunction with other programs could be beneficial to western producers, although this possibility was not tested here.

Price Received

The average price received by western late producers (APWL) over the tested period is 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 arises because of the large percentage increased forced on gross revenue which is directly related to price. The weighted average price (WAPWL) over the period reflects the returns per unit of potatoes produced and may be a better measure for evaluation. The difference between the base run and the values under each of the policies are of the same general magnitude for both the simple average and weighted average prices. Differences exist in the magnitude of the simple and weighted average prices over the period under a given policy. These differences are 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 greatest weighted average price received occurs under the revenue increase policy because the least amount of resources are used under this policy compared to any other policy tested. This is indicated by the largest reduction in quantity of western potatoes produced compared to the base. The average gross revenue under the gross revenue policy is down very little from the base, although it is down slightly more than under an acreage increase policy. But under the acreage increase policy, the quantity produced in the West is much larger. Hence, the weighted average price is much lower for the acreage control policy than under the revenue increase policy, even though it is the next highest under the policies tested. Since no fresh market regulation is assumed under this acreage control policy, the advantage to western producers may be more than is shown in the revenue figures due to reduced costs of operating the board. However, it does not appear reasonable 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 is greatest for tested policies under the revenue increase policy and the acreage increase policy. Since the aggregate revenue is less under control policies than under base conditions, the greatest value under control policies is actually the smallest decrease from base conditions. All other policies result in significantly lower aggregate revenue compared to the base condition, but the differences among them are not great.

Quantity Marketed Fresh

The quantity marketed fresh (AQFR) is notably different under the revenue increase policy and the acreage control policy than under other policies. While all other policies resulted in at least ten 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 pays for the increased farm price per unit produced under this policy, not only through higher retail prices for fresh potatoes but also through decreased quantity available for fresh use. It is interesting to note that the quantities going into nonfood uses (AQO) are not reduced as much under these policies showing the greatest reduction in fresh sales as under other policies.

Retail Prices

The greatest increase in retail prices of fresh potatoes (APFR) comes under the revenue increase policy where quantities marketed fresh are significantly reduced in comparison to the base. This same policy is the only one for which retail prices of frozen products (APFF) are below that in the base run. The explanation apparently lies in reduced competition for potatoes at the farm level as fresh sales are reduced, even though total production in the West is also reduced to the greatest extent under this policy.

Conclusions and Policy Implications

The above discussion indicates varying degrees of success for the different policies tested, depending on the particular variable chosen for evaluating the results. Under all control policies tested, the average level of western production and acreage are at least 15 percent above the level in the 1958-68 period of historical observation. This implies that resources currently used in potato production would not be underemployed. However, some restriction on future entry of resources into potato production results from regulation under a marketing board compared with base conditions. The extent of these restrictions are indicated by the reduction in acreage and production compared to the base. But establishment of a bargaining board by referendum would imply an assumption that unregulated production and marketing is less acceptable from the viewpoint of western producers.

If the combination of total resources employed and return per unit of resource employed is established as the criterion for evaluation, the acreage increase policy seems to offer the best results of those tested in terms of benefits to producers and acceptability to other parties concerned. While acreage and production are below the base, the reductions are moderate compared to all the tested policies. Under the acreage increase policy, aggregate gross revenue is higher relative to the base than under any of the policies tested and weighted price per hundredweight produced is second only to that under the revenue increase policy. The consumer seems to be penalized less by the acreage control than by the gross revenue policy, except for the lower retail price for frozen products which occurs under the revenue policy. Reasonable revenue increases per unit produced could be obtained by controlling acreage expansion while not causing serious repercussions from greatly increased prices to consumers or reduced quantities available to handlers and consumers.

If it is judged that the lower amounts of resources used under the revenue increase policy are an acceptable or desirable magnitude of restriction on entry, and that the effects on consumers through lower fresh quantities and higher retail price for fresh potatoes are not enough to cause repercussions, the gross revenue policy should be chosen. That policy is more favorable to the producers in the western late potato industry. The acreage control policy may give results closer to the gross revenue policy than reflected in this study, since the cost of operating an acreage or production control program alone is less than that of operating such a program in conjunction with a marketing quota program as required by the alternative policies. The acreage control policy must be adjusted yearly, allowing for changing yields, to attain the desired limits on actual production.

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 without interference. But the gain comes at the cost of restricting resource use in the system. Controlling resource use may imply reduced efficiency of resource allocation. The higher income per unit of production also comes at the expense of reducing management freedom in determining total production for the system. However, the assumed negotiable production and marketing quotas allow freedom of internal allocation of resource use under the restrictions on total quantities. Lower cost producers would be expected to bid away production certificates from higher cost producers. The result may be larger individual farms, since potato production costs have been shown to be lower on larger farms in at least one area (Maier and Loftsgard, 1964, p. 25). The bidding away of production quotas from higher cost producers may drive those producers into production of uncontrolled crops--a problem inherent in any type of single-commodity control program.

The western late potato system was chosen for analysis of the results of establishing a bargaining board in a commodity system because the industry possesses characteristics deemed conducive to obtaining bargaining board gains. Among these characteristics are: (1) price fluctuations due to relative inelasticity of demand for the commodity and variation in yearly production; (2) different final market forms for the commodity; (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 income and share of the total U. S. market represented by the bargaining board area; and (5) previous experience with market order programs, which might indicate ability to affect system results through manipulation of quantities marketed. 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 marketing and production 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 will be limited by the supply and demand characteristics of the particular commodity system.

The higher returns may be distributed to nonlabor factors of production in the form of higher prices for land most productive for potatoes, installation costs of irrigation systems, and other production resources designed to lower production costs. Gains in other commodity systems may also be distributed to productive factors important to the system. Capitalization of the production and marketing quotas is another problem which could lead to lower returns to labor than desired from instituting a bargaining board. However, the model used here allows no conclusions regarding the distribution of returns. Elaborate production and marketing cost data and projections would be needed to accurately evaluate distribution of gains resulting from manipulation of production and marketing variables under a bargaining board in a commodity system.

Drawing conclusions from the average data used in this analysis about the distribution of the cost of raising farm prices is also speculative. Precise evaluation of processor and handler prices paid for potatoes on the basis of the average price received is impossible. Assuming that an indicated increase in the average price received implies higher costs to processors or handlers ignores the possibility that most of the gain may come from merely reallocating sales into higher-valued uses. Refinement of this analysis is dependent upon collection and release of data regarding processor and handler prices paid for potatoes. It is improbable that such data would be available for many commodity systems.

The judgment that a marketing board could be a useful policy tool is based on the criteria specified regarding revenue per unit of production and aggregate revenue. The costs to be assessed for board operation must be deducted from the weighted average price received to determine the actual benefit to producers, but it should not affect the general conclusion. However, the costs of operating a board under different policies may affect the choice of the best policy to use. No claim is made that all reasonable policies have been tested nor that combinations of the tested policies might not lead to better results. Specific policies appropriate to other commodity systems might lead to better results, but the policies tested here include those which seem to be generally applicable to bargaining board operations.

Use of the Model for Further Research

The model developed here could be used to test other policy alternatives specified by interested parties. The policy alternatives tested are perhaps the most apparent possibilities but not necessarily the most practical from the viewpoint of political and social acceptability. The individual policies could be combined and tested as deemed appropriate for policy purposes.

One policy alternative not tested in this analysis is regulation of seasonal market flow of potatoes for fresh use. To test that possibility, relationships between seasonal quantities sold and average western price received need to be estimated. Data availability is a problem but some approximation of the relationships may be obtainable, although assuming acceptability of available data could result in misleading conclusions if it is not a good approximation of the true variables affecting the allocation.

Specification of criteria for choice of the best alternatives can greatly affect the conclusions drawn. If reasons exist for setting specific criteria for the choice, the analysis of results can be made more definitive. 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 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 model is constructed and judged to give acceptable approximations of the actual operating system.

The results derived from the model are only as good as the relationships which are used to formulate the model. Revisions of these relationships could be undertaken based on the judgment of experts in policy formulation and those associated with the industry. One important criterion for judging the policy conclusions derived from the model is the realism of the results obtained. The judgment here was based on comparisons between simulated and observed results for the 1958-68 period. It was then assumed that the relationships would generally remain reasonable predictors through the 1968-80 period. It would be desirable to obtain the judgment of potato industry members as to the reasonableness of the projections based on their analysis of the industry's future.

Simulation of policies based upon model revisions could lead to somewhat different results. Refinement of results and conclusions drawn therefrom are dependent also upon being able to quantify the relationships involved. Unless greater detail in data is available from industry sources, such as might be the case under an actual bargaining board composed of industry members, the relationships derived here are based on the best data available. Some adjustments may need to be made for non-quantitative factors that were omitted in the model developed here.

Additional research which could be valuable in judging the merits of a western late potato system bargaining board includes assuming a board simultaneously established in the eastern late potato system. That area competes with the western system for fresh and processing markets to a large extent. Assumption of identical policies or conflicting policies in the two areas could lead to interactions giving quite different results than the results under the interactions assumed in this research. Even without assuming a board in the eastern area, different plausible assumptions than used here could be incorporated for further analysis. This study assumed that the responses of other areas would retain the same characteristics after establishing a western bargaining board as exhibited in the absence of such a board.

Development of a similar model for another commodity system could permit appropriate bargaining board policies to be evaluated for that industry. The additional analysis might provide a more sound basis for judging the appropriateness of bargaining boards as a policy tool, since peculiarities of one system which affect the analysis would carry less weight in the final evaluation.

Farm Bargaining Boards as a Policy Alternative

Implications beyond the potato industry are important, since evaluation of bargaining boards as a federal farm policy alternative is the objective of this research. Discussion of the general theoretical sources of gain in Chapter III led to the conclusion that the most significant bargaining gains would generally be associated with production limitation and/or market allocation. The amount of restriction necessary for a bargaining board to coordinate bargaining with market conditions would depend on the supply and demand relationships in the particular industry. If the marketing sector of an industry has relatively large profit margins, marketing margins, or organizational slack, these sources may allow 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 offer a policy tool which can lead to results more desirable for producers than those obtained under the system operating without interference. This conclusion is applicable to industries having characteristics conducive to a bargaining board operating under the institutional and legal framework assumed in this study.

Limitations on the extent of gains obtainable are determined by supply and demand characteristics of the particular commodity system. These characteristics measure repercussions arising from the effects on other producing areas, marketing entities, and consumers from any actions taken by a bargaining board.

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. The assumption that the remainder of a commodity system would continue the pattern of past interactions with the sector in which a bargaining board was established should be researched. For example, noneconomic as well as economic impacts of a bargaining board could alter the pattern of interactions between the production unit establishing the board and competing production units, as well as between the production unit and the marketing units.

The legal and institutional framework assumed in this study may not be the most effective one for establishing a bargaining board. Alternative formulations for the institutional and legal framework establishing bargaining boards should be researched to determine costs of operating a board under various enabling systems. The costs of operation would depend not only on the legal-institutional framework, but also on the policies adopted by a board. The relative political and social acceptability of alternative methods of operating a bargaining board also need to be evaluated.

Negotiable production and marketing quotas were assumed as part of the operating mechanism of a bargaining board. Research is needed on different methods of implementing such quotas and on other possible methods of obtaining the necessary control to make a bargaining board effective. The effects of using different control mechanisms should be evaluated for their impacts on distribution of costs of operating a bargaining board and their impacts on distribution of any gains achieved.

This study shows that some benefits to producers could be derived from establishing a bargaining board under the assumed operating mechanisms and economic conditions. The additional research cited should provide the basis for rejecting or implementing bargaining boards as a policy tool for U. S. agriculture.

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APPENDICES

APPENDIX A

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: U. S. D. A., S. R. S., 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: U. S. D. A., S. R. S., 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: U.S.D.A., S.R.S., 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: U.S.D.A., S.R.S., 1951-1959.

Appendix Table 5. Utilization of Potatoes.

Year	Fresh	Chips	Dehydrated	Frozen	Other[a/]
			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

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

Source: U.S.D.A., S.R.S., 1951-1969.

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/ Fresh potatoes	Retail price per pound 3/ Frozen french fries	Potato stocks 4/ Dec 1	Potato stocks 4/ Mar 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. D. C., B. C., 1969.

3/ U. S. D. L., B. L. S., 1954-1969

4/ U. S. D. A., S. R. S., 1951-1969. Stocks of late potatoes from the indicated crop year held by growers and local dealers on Dec. 1 and on the following Mar. 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 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.

1. $$AWL = 258.29250 + \underset{\substack{(1.33374)\\ ***}}{12.45396}\ T + \underset{\substack{(12.70197)\\ **}}{30.94961}\ PWL(t-1) - \underset{\substack{(8.02459)\\ *}}{15.34092}\ (PLOW(t-1) - PLOW(t-2))$$

   $R^2 = .896$

   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.

   (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.

2. $$AEL = 341.37965 - \underset{\substack{(.58253)\\ ***}}{5.55198}\ T + \underset{\substack{(5.12681)\\ ***}}{18.83957}\ PEL(t-1) - \underset{\substack{(3.90880)\\ **}}{11.51760}\ (PLOE(t-1) - PLOE(t-2))$$

   $R^2 = .898$

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.
(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.

3. AE = 11.67417 + .54463 AE(t-1) + 3.76707 PE(t-1)
(.14148) (1.59058)

R^2 = .672 ***

AE = harvested acreage of early potatoes, thousand acres
AE(t-1) = harvested acreage of early potatoes in the previous year, thousand acres
PE(t-1) = season average price received by farmers in the previous year for early potatoes, dollars per cwt.

4. AI = 193.91464 - 8.10680 T + 21.69870 PI(t-1)
(1.26315) (6.04771)
*** ***

- 11.73415 (PI(t-1)-PI(t-2))
(3.52913)

R^2 = .873 **

AI = harvested acreage of intermediate potatoes, thousand acres
T = time, 1958=1
PI(t-1) = season average price received by farmers in the previous year for intermediate potatoes, dollars per cwt.
(PI(t-1)-PI(t-2))= change between season average prices received one and two years previously for intermediate potatoes, dollars per cwt.

5. YWL = 189.35294 + 2.80495 T
(.59192)

R^2 = .584 *** standard deviation = 13.02898

YWL = yield of western late potatoes, cwt. per acre
T = time, 1951=1

6. $YEL = 181.96732 + 3.51806\ T$
$(.63255)$
$R^2 = .659$ *** standard deviation = 13.92333
YEL = yield of eastern late potatoes, cwt. per acre
T = time, 1951=1

7. $QCL = 38901.79100 + 1186.50155\ T$
(186.56035)
$R^2 = .716$ *** standard deviation = 4106.44710
QCL = harvested quantity central late potatoes, thousand cwt.
T = time, 1951=1

8. YE = 157.83333 standard deviation = 15.77507
YE = mean yield of early potatoes 1951-1968, cwt. per acre (regression analysis gave unsatisfactory results)

9. $YI = 100.69281 + 6.37152\ T$
$(.40480)$
$R^2 = .939$ *** standard deviation = 8.91010
YI = yield of intermediate potatoes, cwt. per acre
T = time, 1951=1

10. 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 utilization data to a logistic function using a least squares iteration curve fitting technique. The form of the symmetric logistic function used was:

$$Y = \frac{a_1 - a_2}{1 + e^{a_3(T-a_4)}}$$ where

Y = utilization per capita, pounds annually
T = time, 1950=1
$a_1 \ldots a_4$ are least squares fitted coefficients
a_1 = upper asymptote, pounds annually
a_2 = lower asymptote, fixed at zero
a_3 = exponential factor
a_4 = point of inflection, year relative to 1

Use	Least squares estimates of coefficients 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)

11. POPN = 149.91961 + 3.08927 T - .01414 T^2
    (.07923) (.00405)
    R^2 = .999 *** ***
    POPN = January 1 U.S. population including armed forces overseas, millions
    T = time, 1951=1

12. PWL = 10.71971 - .00002468 QO - .00004696 QFR
    (.00000638) (.00001375)
    *** ***
    -.00001689 QFF
    (.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
    QFF = quantity of potatoes utilized for frozen food products, thousand cwt. annually

13. PCL = 7.92743 - .00003040 QO - .00002746 QFR
    (.00001002) (.00001121)
    R^2 = .638 ** **
    PCL = season average price received by farmers for central late potatoes, dollars per cwt.

14. PEL = 11.96479 - .00002974 QO - .00005053 QFR
    (.00000972) (.00001935)
    ** **

$$- .00004753\ QD$$
$$(.00003481)$$

$R^2 = .773$

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

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

15. $SLD = -21723.81400 + .69210\ QL$

$$(.02311)$$

$R^2 = .987$ ***

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

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

16. $PE = 11.17044 - .62045\ CQE - .07288\ CSLD$

$$(.20930) \qquad (.02560)$$

$R^2 = .525$ ** **

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

CQE = per capita harvested quantity of early potatoes, pounds

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

17. $SLM = -26477.50300 + .41764\ QL$

$$(.02810)$$

$R^2 = .948$ ***

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

18. $PI = 16.10909 - .37968\ CQI - .16692\ CSLM$

$$(.07307) \qquad (.03692)$$

$R^2 = .751$ *** ***

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

CQI = per capita harvested quantity of intermediate potatoes, pounds

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

19\. 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).

Least squares estimates of coefficients

a_1	a_2	a_3
6.88546	- 1.33732	6.50559
(.87395)	(.74818)	(.49674)

20\. $QFR = 203528.33000 - 3.10528\ E + .08020\ (QT - QT(t-1))$

$$\qquad\qquad\qquad\qquad (.40263) \qquad (.05274)$$

$R^2 = .874$ ***

E = expenditure for purchased meals and beverages, million dollars

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

21\. $QD = -21962.82800 + 1.83537\ E + .06364\ (QL-QL(t-1))$

$$\qquad\qquad\qquad\qquad (.15479) \qquad (.02371)$$

$R^2 = .942$ *** **

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

22\. $QFF = 2337.16930 + 1.02542\ QFF(t-1) + .11930\ (QL-QL(t-1))$

$$\qquad\qquad\qquad (.06935) \qquad\qquad (.04154)$$

$R^2 = .961$ *** **

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

23\. $QC = 2565.88690 + .96109\ QC(t-1)$

$$\qquad\qquad\qquad (.05375)$$

$R^2 = .970$ ***

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

QC(t-1) = QC in the previous year, thousand cwt.

24. $PFR = 3.04853 + .19316\ TP - .49217\ T + .70777\ PUS$

$$\qquad\qquad (.04970) \qquad (.16400) \qquad (.24317)$$

$R^2 = .835$ ***   **   **

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.

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

25. $PFF = -.90250 + .40051\ FR + .91062\ PWL$

$$\qquad\qquad (.02813) \qquad (.41708)$$

$R^2 = .976$ ***   *

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

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

Fortran Program of Potato Simulation Model

```
      PROGRAM POTATO
      DIMENSION V(90),OUT(90,50),SUM(25),SUM2(25),HEAD(5)
      EQUIVALENCE (AWL,V(1)),(AYWL,V(2)),(AQWL,V(3)),(APWL,V(4)),
     1     (AGRWL,V(5)),(AYWL,V(6)),(AQWL,V(7)),(APWL,V(8)),(AGRWL,V(9)),
     2     (AEL,V(10)),(BYEL,V(11)),(BQEL,V(12)),(BPEL,V(13)),
     3     (AGREL,V(14)),(AYEL,V(15)),(AQEL,V(16)),(APEL,V(17)),
     4     (AGREL,V(18)),(BQCL,V(19)),(BPCL,V(20)),(BGRCL,V(21)),
     5     (AQCL,V(22)),(APCL,V(23)),(AGRCL,V(24)),(AE,V(25)),
     6     (BYE,V(26)),(BQE,V(27)),(BPE,V(28)),(BGRE,V(29)),(AYE,V(30)),
     7     (AQE,V(31)),(APE,V(32)),(AGRE,V(33)),(AI,V(34)),(BYI,V(35)),
     8     (BQI,V(36)),(BPI,V(37)),(BGRI,V(38)),(AYI,V(39)),(AQI,V(40)),
     9     (API,V(41)),(AGRI,V(42)),(BQT,V(43)),(BQCC,V(44))
      EQUIVALENCE (BQFF,V(45)),(BQD,V(46)),(BQTF,V(47)),(BQFR,V(48)),
     1     (BQC,V(49)),(BPFR,V(50)),(BPFF,V(51)),(AQT,V(52)),
     2     (AQC,V(53)),(AQFF,V(54)),(AQD,V(55)),(AQTF,V(56)),
     3     (AQFR,V(57)),(AQC,V(58)),(APFR,V(59)),(APFF,V(60)),
     4     (BCC,V(61)),(BFF,V(62)),(BD,V(63)),(BTP,V(64)),(BFR,V(65)),
     5     (POPN,V(66)),(CE,V(67)),(F,V(68)),(RAWL,V(69)),(RBQWL,V(70)),
     6     (RBGRWL,V(71)),(RAQWL,V(72)),(RAGRWL,V(73)),(GBPWL,V(74)),
     7     (GBGRWL,V(75)),(BSLD,V(76)),(BSLM,V(77)),(BQL,V(78)),
     8     (AQL,V(79)),(BPUS,V(80)),(APUS,V(81)),(ASLD,V(82)),(ASLM,V(83))
     9     ,(BTF,V(84))
100   READ (1,101) T,NYEARS,IGOAL,IRAND,ISWITCH,HEAD
101   FORMAT (F4.0,1X,I2,1X,I1,1X,I10,I1,5A8)
      IF (EOF(1)) CALL EXIT
      YFIRST=T
      YLAST = T + NYEARS - 1.
      DO 110 I=1,25
110   SUM(I) = SUM2(I) = 0.
      IYEAR = 1
      GINC = FFIN(1,61,80)
      ACHNG = FFIN(1)
      QFRCHG = FFIN(1)
      GBPWLT1 = FFIN(1)
      GBGRWLT1 = FFIN(1)
      PWLT1 = FFIN(1)
      PWLT2 = FFIN(1)
      PELT1 = FFIN(1)
      PELT2 = FFIN(1)
      QELT1 = FFIN(1)
      QELT2 = FFIN(1)
      PCLT1 = FFIN(1)
      PCLT2 = FFIN(1)
      QCLT1 = FFIN(1)
      QCLT2 = FFIN(1)
      QWLT1 = FFIN(1)
      QWLT2 = FFIN(1)
      AET1 = FFIN(1)
      PET1 = FFIN(1)
      PIT1 = FFIN(1)
      PIT2 = FFIN(1)
      AQT1 = FFIN(1)
      AQFFT1 = FFIN(1)
      AQFFT2=FFIN(1)
      AQLT1 = FFIN(1)
      AQCT1 = FFIN(1)
      PBTF = BTF = FFIN(1)
      CET1=FFIN(1)
      WRITE (2,102) HEAD,T,NYEARS,IGOAL,IRAND,GINC,ACHNG,QFRCHG,GBPWLT1,
     1     GBGRWLT1,PWLT1,PWLT2,PELT1,PELT2,QELT1,QELT2,PCLT1,PCLT2,QCLT1,
     2     QCLT2,QWLT1,QWLT2,AET1,PET1,PIT1,PIT2,AQT1,AQFFT1,AQFFT2,AQLT1,
     3     AQCT1,BTF,CET1
102   FORMAT (1H1 // 30X,5A8 // 45X,'INITIAL VALUES' // 19X,'T=',F15.0,
     1     8X,'NYEARS=',I15,10X,'GOAL=',I15,9X,'IRAND=',I15 /
     2     10X,'GINC=',F15.3,9X,'ACHNG=',F15.3,8X,'QFRCHG=',F15.3,4X,
     3     'GBPWL(T-1)=',F15.3 / 3X,'GBGRWL(T-1)=',F15.3,6X,'PWL(T-1)=',
     4     F15.3,6X,'PWL(T-2)=',F15.3,6X,'PEL(T-1)=',F15.3 /
     5     6X,'PEL(T-2)=',F15.3,6X,'QEL(T-1)=',F15.3,6X,'QEL(T-2)=',
     5     F15.3,
```

```
      6    6X,≠PCL(T-1)=≠,F15.3 / 6X,≠PCL(T-2)=≠,F15.3,6X,≠QCL(T-1)=≠,
      7    F15.3,6X,≠QCL(T-2)=≠,F15.3,6X,≠QWL(T-1)=≠,F15.3 /  6X,
      8    ≠QWL(T-2)=≠,F15.3,7X,≠AE(T-1)=≠,F15.3,7X,≠PE(T-1)=≠,F15.3,7X,
      9    ≠PI(T-1)=≠,F15.3 / 7X,≠PI(T-2)=≠,F15.3,6X,≠AQT(T-1)=≠,F15.3,
      X    5X,≠AQFF(T-1)=≠,F15.3,5X,≠AQFF(T-2)=≠,F15.3/6X,≠AQL(T-1)=≠,
      1    F15.3,6X,≠AQC(T-1)=≠,F15.3,11X,≠BTF=≠,F15.3,
      2    7X,≠CE(T-1)=≠,F15.3)
C
C ------- ACREAGE -------
C
200    AWL = 258.29250 + 12.45396*(T-1952.)+30.9496*PWLT1-19.34092*
      1    (((PELT1*QELT1+PCLT1*QCLT1)/(QELT1+QCLT1))-((PELT2*QELT2+
      2    PCLT2*QCLT2)/(QELT2+QCLT2)))
       AEL = 341.37965 -5.55198*(T-1952.)+18.83957*PELT1-11.51760*
      1    (((PWLT1*QWLT1+PCLT1*QCLT1)/(QWLT1+QCLT1))-((PWLT2*QWLT2+
      2    PCLT2*QCLT2)/(QWLT2+QCLT2)))
       AE = 11.67417 + .56463*AET1 + 3.76707*PET1
       AI = 193.91464 - 8.10680*(T-1956.) + 21.69870*PIT1 - 11.73415*
      1    (PIT1-PIT2)
       BTF=PBTF
C
C ------- YIELD AND QUANTITY PRODUCED -------
C
       BYWL = 189.35294 + 2.80495*(T-1950.)
250    BQWL = AWL * BYWL
       BYEL=181.96732+3.51806*(T-1950.)
       BQEL = AEL * BYEL
       BQCL = 38901.791 + 1186.50155*(T-1950.)
       BYE = 157.83333
       BQE = AE * BYE
       BYI=100.69281+6.37152*(T-1949.)
       BQI = AI * BYI
C
C ------- TOTAL QUANTITY -------
C
       BQT = BQWL + BQEL + BQCL + BQE + BQI
C
C ------- PER CAPITA CONSUMPTION -------
C
       BCC = 25.69303/ (1.+EXP(-.11094*((T-1949.)-12.56735)))
       BFF = 31.58100 / (1.+EXP(-.28947*((T-1949.)-15.94182)))
       BTP = 88.65856 / (1.+EXP(-.16497*((T-1949.)-17.56774)))
       BD = BTP - (BCC+BFF)
       BFR = BTF - BTP
C
C ------- POPULATION -------
C
       POPN = 149.91961 + 3.08927 * (T-1949.) -.01414*(T-1949.)*(T-1949.)
C
C ------- QUANTITY USED -------
C
       BQCC = BCC * POPN * 10.
       BQFR = BFR * POPN * 10.
       BQFF = BFF * POPN * 10.
       BQO = BD * POPN * 10.
       BQTF = BTF * POPN * 10.
       BQC = BQT - BQTF
       BPWL = 10.71971 - .00002468*BQC - .00004696*BQFR -
      1    .00016887*BQFF
C
C ------- DECISION -------
C
       GBPWL = GBPWLT1 + GINC*GBPWLT1
       ITER = ITER2 = 0
500    IF(IGOAL.NE.1.AND.IGOAL.NE.3) GO TO 600
       PRGBP = (BPWL-GBPWL) / GBPWL
       ITER = ITER + 1
       IF (ITER.GT.100) GO TO 799
       WRITE (3,501) T,ITER,PRGBP,AWL,BQWL,BQT,BQC,BPWL
501    FORMAT (2X,F4.0,5X,I3,≠    PRGBP= ≠,F12.3,≠    AWL= ≠,F12.3,
      1    ≠    BQWL= ≠,F12.3/16X,≠    BQT= ≠,F12.3,≠    BQO= ≠,F12.3,
      2    ≠    BPWL= ≠,F12.3)
```

```
      IF (PRGBP.LT.-.04) GO TO 510
      IF (PRGBP.LE.-.02) GO TO 520
      IF (PRGBP.LE.-.01) GO TO 560
      IF (PRGBP.LE..01) GO TO 600
      IF (PRGBP.LE..02) GO TO 570
      IF (PRGBP.LE..04) 540,530
510   AWL = AWL - 2.*ACHNG*AWL
      GO TO 550
520   AWL = AWL - ACHNG*AWL
      GO TO 550
530   AWL = AWL + 2.*ACHNG*AWL
      GO TO 545
540   AWL = AWL + ACHNG*AWL
545   BQWL =AWL*BYWL
      BQT = BQWL + BQEL + BQCL + BQE + BQI
      BQC = BQT - BQTF
      BPWL=10.71971-.00002468*BQC-.00004696*BQFR-.000016887*BQFF
      GO TO 500
550   BQWL = AWL*BYWL
      BQT = BQWL + BQEL + BQE + BQI + BQCL
      BQC = BQT - BQTF
      BPWL = 10.71971 - .00002468*BQC - .00004696*BQFR -
     1  .000016887*BQFF
      IF (BQC.LE.0.14*BQT) GO TO 600
      GO TO 500
560   BQFR = BQFR - QFRCHG*BQFR
      GO TO 580
570   BQFR = BQFR + QFRCHG*BQFR
      BFR = (BQFR/POPN)*.1
      BTF = BTP + BFR
      BQTF = BTF * POPN * 10.
      BQC = BQT - BQTF
      BPWL=10.71971-.00002468*BQC-.00004696*BQFR-.000016887*BQFF
      IF (BQC.LE.0.14*BQT) GO TO 600
      GO TO 500
580   BFR=(BQFR/POPN)*.1
      BTF=BTP+BFR
      BQTF=BTF*POPN*10.
      BQC=BQT-BQTF
      BPWL = 10.71971 - .00002468*BQC - .00004696*BQFR -
     1  .000016887*BQFF
      GO TO 500
600   BGRWL2=BGRWL
      BGRWL = BPWL * BQWL
      IF (IGOAL.NE.2.AND.IGOAL.NE.3) GO TO 700
      IF (ITER2.EQ.1) GO TO 630
      IF (ABS(BGRWL-BGRWL2).LT..002*ABS(BGRWL2)) GO TO 700
630   GBGRWL = GBGRWLT1 + GINC*GBGRWLT1
      PRGBGR = (BGRWL - GBGRWL) / GBGRWL
      ITER2 = ITER2 + 1
      IF (ITER2.GT.100) GO TO 799
      WRITE (3,601) T,ITER2,PRGBGR,BGRWL,GBGRWL
601   FORMAT (2X,F4.0,5X,I3,' PRGBGR= ',F12.3,' BGRWL= ',
     1   F12.3,' GBGRWL= ',F12.3)
      IF (PRGBGR.LT.-.04) GO TO 510
      IF (PRGBGR.LE.-.02) GO TO 520
      IF (PRGBGR.LE.-.01) GO TO 560
      IF (PRGBGR.LE..01) GO TO 700
      IF (PRGBGR.LE..02) GO TO 570
      IF (PRGBGR.LE..04) 540,530
C
C - - - - - - - PRICE - - - - - - -
C
700   BPCL = 7.92743 - .00003040*BQC - .00002746*BQFR
      BPEL = 11.96479-.00002974*BQC-.00005053*BQFR-.00004753*BQD
      BQL =BQEL + BQCL + BQWL
      BCQE =(BQE / POPN)*.1
      BSLD = -21723.814 + .69210*BQL
      BCSLD =(BSLD / POPN)*.1
      BPE = 11.17044 - .62045*BCQE - .07288*BCSLD
      BCQI =(BQI / POPN)*.1
      BSLM = -26477.503 + .41764*BQI
```

```
      BCSLM =(BSLM / POPN)*.1
      BPI = 16.10909 - .37968*BCQI - .16692*BCSLM
C
C - - - - - - - - GROSS REVENUE - - - - - - -
C
      BGREL = BPEL * BQEL
      BGRCL = BPCL * BQCL
      BGRE = BPE * BQE
      BGRI = BPI * BQI
C
C - - - - - - - - YIELDS AND QUANTITIES - - - - - - -
C
      ADWL = RNOR(IRAND)*13.02898
      AYWL = BYWL + ADWL
      ADEL = RNOR(IRAND)*13.92333
      AYEL = BYEL + ADEL
      ADE = RNOR(IRAND)*16.77507
      AYE = BYE + ADE
      ADI = RNOR(IRAND)*8.91010
      AYI = BYI + ADI
      ADCL = RNOR(IRAND)*6106.4471
      AQCL = BQCL + ADCL
      IF (ISWITCH) READ (5,903) AYWL,AYEL,AYE,AYI,AQCL
  903 FORMAT(3X,4F5.0,F7.0)
      AQWL = AWL * AYWL
      AQEL = AEL * AYEL
      AQE = AE * AYE
      AQI = AI * AYI
      AQL = AQWL + AQEL + AQCL
      AQT = AQL + AQE + AQI
      CECH=6.88546/(1.+EXP(-1.33732*((T-1957.)-6.50559)))
      CE=CET1+CECH
      E = CE * POPN
C
C - - - - - - - - QUANTITY USED - - - - - - -
C
      AQFR = 203528.33 - 3.10528*E + .08020*(AQT-AQT1)
      IF (AQFR.LE.0.9*BQFR) AQFR = 0.9*BQFR
      AQD = -21962.828 + 1.83537*E + .063646*(AQL-AQLT1)
      IF (AQD.GE.1.1*BQD) AQD=1.1*BQD
      AQFF = 2337.1693+1.02542*AQFFT1+.11930*(AQL-AQLT1)
      IF (AQFF.GE.1.1*BQFF) AQFF=1.1*BQFF
      AQC = 2565.8869 + .06109*AQCT1
      AQS = AQT - (AQFR + AQD + AQFF + AQC)
      AQTF = AQFR + AQD + AQFF + AQC
      ITERA = ITERA2 =0
C
C - - - - - - - - PRICE - - - - - - -
C
  705 APWL = 10.71971-.00002468*AQS-.00004696*AQFR-.000014887*AQFF
      AGRWL2=AGRWL
      AGRWL = APWL * AQWL
  710 IF (IGOAL.EQ.0) GO TO 790
  720 IF (IGOAL.EQ.1.OR.IGOAL.EQ.3) GO TO 740
  730 IF (IGOAL.EQ.2) GO TO 755
  740 PRGAP=(APWL-GBPWL)/GBPWL
      ITERA=ITERA+1
      IF (ITERA.GT.100) GO TO 799
      WRITE (3,602) T,ITERA,PRGAP,AQS,AQFR
  602 FORMAT (2X,F4.0,5X,I3,'   PRGAP= ',F12.3,'   AQS= ',F12.3,
     1  '   AQFR= ',F12.3)
      IF (PRGAP.LT.-.02) GO TO 760
      IF (PRGAP.LE.-.01) GO TO 765
      IF (PRGAP.LE.+.01) GO TO 750
      IF (PRGAP.LE.+.02) 770,775
  750 IF (IGOAL.NE.3) GO TO 790
  755 PRGAGR=(AGRWL-GBGRWL)/GBGRWL
      ITERA2=ITERA2+1
      IF (ITERA2.GT.100) GO TO 799
      WRITE (3,603) T,ITERA2,PRGAGR,AQS,AQFR
  603 FORMAT (2X,F4.0,5X,I3,'  PRGAGR= ',F12.3,'   AQS= ',
     1   F12.3,'   AQFR= ',F12.3)
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      IF (ITERA2.EQ.1) GO TO 604
      IF (ABS(AGRWL-AGRWL2).LT..002*ABS(AGRWL2)) GO TO 781
604   IF (PRGAGR.LT.-.02) GO TO 760
      IF (PRGAGR.LE.-.01) GO TO 765
      IF (PRGAGR.LE.+.01) GO TO 790
      IF (PRGAGR.LE.+.02) 770,775
760   IF(AQFR.LE.0.9*BQFR) GO TO 790
      AQFR=AQFR-(2.*QFRCHG*AQFR)
      GO TO 766
765   IF(AQFR.LE.0.9*BQFR) GO TO 790
      AQFR=AQFR-QFRCHG*AQFR
766   AQC = AQT - (AQFR + AQD + AQFF + AQC)
      GO TO 705
770   AQFR=AQFR+QFRCHG*AQFR
      GO TO 780
775   AQFR=AQFR+2.*QFRCHG*AQFR
780   AQC = AQT - (AQFR + AQD + AQFF + AQC)
      IF (AQC.LE.0.16*AQT) GO TO 781
      GO TO 705
781   APWL=10.71971-.00002468*AQC-.00004696*AQFR-.000016887*AQFF
      AGRWL = APWL*AQWL
790   APCL = 7.92763 - .00003040*AQC - .00002766*AQFR
      APEL = 11.96679 - .00002974*AQC - .00003053*AQFR - .00004753*AQD
      ACQE = AQE / POPN * .1
      ASLD = -21723.814 + .69210*AQL
      ACSLD = ASLD / POPN * .1
      APE = 11.17044 - .62045*ACQE - .07288*ACSLD
      ACQI = AQI / POPN * .1
      ASLM = -26477.903 + .41764*AQL
      ACSLM = ASLM / POPN * .1
      API = 16.10909 - .37968*ACQI - .16692*ACSLM
      AGREL = APEL * AQEL
      AGRCL = APCL * AQCL
      AGRE = APE * AQE
      AGRI = API * AQI
      AFR = AQFR / POPN * .1
      APFF = -.90250 + .40051*AFR + .91062*APWL
      APUS = (APWL*AQWL + APCL*AQCL + APEL*AQEL + APE*AQE + API*AQI) /
     1  AQT
      ATP = (AQD + AQFF + AQC) / POPN * .1
      APFR = 3.04853 + .19316*ATP - .49217*(T-1955.) + .70777*APUS
      RBQWL = BQWL / BQT
      RAQWL = AQWL / AQT
      BGRT=BGRWL+BGREL+BGRCL+BGRE+BGRI
      AGRT=AGRWL+AGREL+AGRCL+AGRE+AGRI
      RBGRWL = BGRWL / BGRT
      RAGRWL = AGRWL / AGRT
      SUM(1) = SUM(1) + AWL
      SUM2(1) = SUM2(1) + AWL*AWL
      SUM(2) = SUM(2) + AQWL
      SUM2(2) = SUM2(2) + AQWL*AQWL
      SUM(3) = SUM(3) + APWL
      SUM2(3) = SUM2(3) + APWL*APWL
      SUM(4) = SUM(4) + AGRWL
      SUM2(4) = SUM2(4) + AGRWL*AGRWL
      SUM(5) = SUM(5) + AQFR
      SUM2(5) = SUM2(5) + AQFR*AQFR
      SUM(6) = SUM(6) + AQFF
      SUM2(6) = SUM2(6) + AQFF*AQFF
      SUM(7) = SUM(7) + AQD
      SUM2(7) = SUM2(7) + AQD*AQD
      SUM(8) = SUM(8) + AQC
      SUM2(8) = SUM2(8) + AQC*AQC
      SUM(9) = SUM(9) + AQC
      SUM2(9) = SUM2(9) + AQC*AQC
      SUM(10) = SUM(10) + APFR
      SUM2(10) = SUM2(10) + APFR*APFR
      SUM(11) = SUM(11) + APFF
      SUM2(11) = SUM2(11) + APFF*APFF
      SUM(12) = SUM(12) + AQEL
      SUM2(12) = SUM2(12) + AQEL*AQEL
      SUM(13) = SUM(13) + APEL
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      SUM2(13) = SUM2(13) + APEL*APEL
      SUM(14) = SUM(14) + AQCL
      SUM2(14) = SUM2(14) + AQCL*AQCL
      SUM(15) = SUM(15) + APCL
      SUM2(15) = SUM2(15) + APCL*APCL
      SUM(16) = SUM(16) + AQE
      SUM2(16) = SUM2(16) + AQE*AQE
      SUM(17) = SUM(17) + APE
      SUM2(17) = SUM2(17) + APE*APE
      SUM(18) = SUM(18) + AQI
      SUM2(18) = SUM2(18) + AQI*AQI
      SUM(19) = SUM(19) + API
      SUM2(19) = SUM2(19) + API*API
      SUM(20) = SUM(20) + RAQWL
      SUM2(20) = SUM2(20) + RAQWL*RAQWL
      SUM(21) = SUM(21) + RAGRWL
      SUM2(21) = SUM2(21) + RAGRWL*RAGRWL
      SUM(22) = SUM(22) + BQFR
      SUM2(22) = SUM2(22) + BQFR*BQFR
      SUM(23) = SUM(23) + BQFF
      SUM2(23) = SUM2(23) + BQFF*BQFF
      SUM(24) = SUM(24) + BQD
      SUM2(24) = SUM2(24) + BQD*BQD
      SUM(25) = SUM(25) + BQCC
      SUM2(25) = SUM2(25) + BQCC*BQCC
      DO 795 I=1,90
795   OUT(I,IYEAR)=V(I)
      IYEAR = IYEAR + 1
      T = T+1.
      IF (T.GT.YLAST) GO TO 800
      CET1=CE
      PWLT2 = PWLT1
      PWLT1 = APWL
      PELT2 = PELT1
      PELT1 = APEL
      QELT2 = QELT1
      QELT1 = AQEL
      PCLT2 = PCLT1
      PCLT1 = APCL
      QCLT2 = QCLT1
      QCLT1 = AQCL
      QWLT2 = QWLT1
      QWLT1 = AQWL
      AET1 = AE
      PET1 = APE
      PIT2 = PIT1
      PIT1 = API
      AQT1 = AQT
      AQFFT2=AQFFT1
      AQFFT1 = AQFF
      GBPWLT1 = GBPWL
      GRGRWLT1 = GRGRWL
      AQLT1 = AQL
      AQCT1 = AQC
      GO TO 200
C
C - - - - - - - PRINT RESULTS - - - - - - -
C
799   NYEARS=T-YFIRST+1
800   WRITE (2,801) (J,(OUT(I,J),I=1,9),J=1,NYEARS)
801   FORMAT (1H1,3X,'T',9X,'AWL',10X,'BYWL',10X,'BQWL',10X,'BPWL',
     1   9X,'BGRWL',10X,'AYWL',10X,'AQWL',10X,'APWL',10X,'AGRWL' //
     2   (3X,I2,9F14.3))
      WRITE (2,802) (J,(OUT(I,J),I=10,18),J=1,NYEARS)
802   FORMAT (1H1,3X,'T',9X,'AEL',10X,'BYEL',10X,'BQEL',10X,'BPEL',
     1   9X,'BGREL',10X,'AYEL',10X,'AQEL',10X,'APEL',10X,'AGREL' //
     2   (3X,I2,9F14.3))
      WRITE (2,803) (J,(OUT(I,J),I=19,24),J=1,NYEARS)
803   FORMAT (1H1,3X,'T',8X,'BQCL',10X,'BPCL',10X,'BGRCL',9X,'AQCL',
     1   10X,'APCL',10X,'AGRCL' // (3X,I2,6F14.3))
      WRITE (2,804) (J,(OUT(I,J),I=25,33),J=1,NYEARS)
804   FORMAT (1H1,3X,'T',9X,'AE',11X,'BYE',11X,'BQE',11X,'BPE',11X,
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     1   #BGRE#,10X,#AYE#,11X,#AQE#,11X,#APE#,11X,#AGRE# //
     2   (3X,I2,9F14.3))
     WRITE (2,805) (J,(OUT(I,J),I=94,62),J=1,NYEARS)
805  FORMAT (1H1,3X,#T#,9X,#AI#,11X,#BYI#,11X,#BQI#,11X,#BPI#,11X,
     1   #BGRI#,10X,#AYI#,11X,#AQI#,11X,#API#,11X,#AGRI# //
     2   (3X,I2,9F14.3))
     WRITE (2,806) (J,(OUT(I,J),I=43,51),J=1,NYEARS)
806  FORMAT (1H1,3X,#T#,8X,#BQT#,11X,#BQCC#,10X,#BQFF#,10X,#BQD#,
     1   11X,#BQTF#,10X,#BQFR#,10X,#BQC#,11X,#BPFR#,10X,#BPFF# //
     2   (3X,I2,9F14.3))
     WRITE (2,807) (J,(OUT(I,J),I=52,60),J=1,NYEARS)
807  FORMAT (1H1,3X,#T#,8X,#AQT#,12X,#AQC#,10X,#AQFF#,10X,#AQD#,
     1   11X,#AQTF#,10X,#AQFR#,10X,#AQC#,11X,#APFR#,10X,#APFF# //
     2   (3X,I2,9F14.3))
     WRITE (2,808) (J,(OUT(I,J),I=61,68),J=1,NYEARS)
808  FORMAT (1H1,3X,#T#,8X,#BCC#,11X,#BFF#,12X,#BD#,11X,#BYP#,11X,
     1   #BFR#,11X,#POPN#,11X,#CE#,12X,#E# // (3X,I2,8F14.3))
     WRITE (2,809) (J,(OUT(I,J),I=70,77),J=1,NYEARS)
809  FORMAT (1H1,3X,#T#,8X,#RBQWL#,9X,#RBGRWL#,8X,#RAQWL#,
     1   9X,#RAGRWL#,8X,#GRPWL#,9X,#GBGRWL#,9X,#BSLD#,10X,#BSLM# //
     2   (3X,I2,8F14.3))
     WRITE (2,810) (J,(OUT(I,J),I=78,84),J=1,NYEARS)
810  FORMAT (1H1,3X,#T#,8X,#BQL#,11X,#AQL#,11X,#BPUS#,10X,
     1   #APUS#,10X,#ASLD#,10X,#ASLM#,10X,#BYF#//(3X,I2,7F14.3))
     DO 900 I=1,25
     SUM2(I) = (NYEARS*SUM2(I)-SUM(I)*SUM(I))/FLOAT(NYEARS*(NYEARS-1))
     SUM2(I) = SQRT(SUM2(I))
     SUM(I) = SUM(I) / NYEARS
900  CONTINUE
     WRITE (2,901) (SUM(I),SUM2(I),I=1,25)
901  FORMAT (1H1 // 24X,#MEAN#,12X,#STD DEV # // 5X,#AWL#,F22.3,F20.6/
     1   5X,#AQWL#,F21.3,F20.6 / 5X,#APWL#,F21.3,F20.6 / 5X,#AGRWL#,
     2   F20.3,F20.6 / 5X,#AQFR#,F21.3,F20.6 / 5X,#AQFF#,F21.3,F20.6 /
     3   5X,#AQD#,F22.3,F20.6 / 5X,#AQC#,F22.3,F20.6 / 5X,#AQC#,
     4   F22.3,F20.6 / 5X,#APFR#,F21.3,F20.6 / 5X,#APFF#,F21.3,F20.6 /
     5   5X,#AQEL#,F21.3,F20.6 / 5X,#APEL#,F21.3,F20.6 / 5X,#AQCL#,
     6   F21.3,F20.6 / 5X,#APCL#,F21.3,F20.6 / 5X,#AQE#,F22.3,F20.6 /
     7   5X,#APE#,F22.3,F20.6 / 5X,#AQI#,F22.3,F20.6 / 5X,#API#,
     8   F22.3,F20.6 / 5X,#RAQWL#,F20.3,F20.6 / 5X,#RAGRWL#
     9   F19.3,F20.6 / 5X,#BQFR#,F21.3,F20.6 / 5X,#BQFF#,F21.3,F20.6
     1   / 5X,#BQD#,F22.3,F20.6 / 5X,#BQCC#,F21.3,F20.6 )
     WRITE (4,902) ((OUT(I,J),I=1,90),J=1,NYEARS)
902  FORMAT ( 5E20.10)
     GO TO 100
     END
     FUNCTION RNOR(IR)
     RNOR = -6.
     DO 100 I=1,12
     IR = AND(AND(4099*IR,37777777B)+1220519,37777777B)
100  RNOR = RNOR + IR/8388607.
     RETURN
     END
```