This dissertation has been 61–6166
microfilmed exactly as received

SHAND, Richard Tregurtha, 1934–
THE EFFECTS OF SOME SUPPLY CONTROL PROGRAMS ON AGRICULTURE AND RELATED INDUSTRIES.

Iowa State University of Science and Technology
Ph.D., 1961
Economics, agricultural

University Microfilms, Inc., Ann Arbor, Michigan

THE EFFECTS OF SOME SUPPLY CONTROL PROGRAMS ON AGRICULTURE AND RELATED INDUSTRIES

by

Richard Tregurtha Shand

A Dissertation Submitted to the Graduate Faculty in Partial Fulfillment of The Requirements for the Degree of DOCTOR OF PHILOSOPHY

Major Subject: Agricultural Economics

Approved:

Signature was redacted for privacy.

In Charge of Major Work

Signature was redacted for privacy.

Head of Major Department

Signature was redacted for privacy.

Dean of Graduate College

Iowa State University
Of Science and Technology
Ames, Iowa

1961

TABLE OF CONTENTS

INTRODUCTION

The agricultural sector of the U. S. economy is considerably out of balance with the rest of the economy at present. The average income of farm families is lower than that of their urban counterparts (65, pp. 21-34), despite price levels held artificially high and despite record record production levels. These high production levels are in fact partly responsible for this continuing situation. For many agricultural products, supply far exceeds demand at these prices and as a result huge quantities have built up in storage. Price supports have been lowered in recent years but stocks continue to grow and so do the costs involved for the economy.

The free interplay of market forces in agriculture has not produced equilibrium in the industry. Although total demand for agricultural products remains quite stable, farm prices exhibit great variation with similar effects on farm income. The inelasticity of supply and demand for agricultural products results in great variation in prices and incomes in agriculture for only small changes in supply and demand. The biological nature of agriculture prevents producers from responding quickly in production to changes in the market. The atomistic structure of the industry where any one producer can make a negligible impression on the market often leads to cyclical reaction in total and to unfavourable market situations for the individual producers.

There is some argument against any intervention in agriculture at all, but most controversy occurs over the best way to intervene. Farm policies have been designed both to accelerate agricultural adjustment in order to enable producers to obtain a return on resources comparable to returns in other parts of the economy, and to reduce price and income instability. In many sectors of agriculture, adjustment is slow and policy measures introduced to speed up the process cover a wide area of manipulation. They include attempts to expand domestic and foreign demand, to find new uses for farm products, to prescribe marketing quotas, to introduce compulsory cropland adjustment or voluntary land retirement, to restrict capital and technology and to reduce labor and the number of farmers, using price measures such as free, multiple or supported prices with storage or direct payments.

Since 1929 the Government has made efforts to reduce the instability of prices and incomes. Between 1929 and 1953 no lasting problems were generated by the programs themselves. From 1953 on however, they succeeded in creating a wide gap between supply and demand at the prices maintained. Surplus disposal has proven to be frustratingly difficult so the level of stocks has skyrocketed.

It is then of particular importance to investigate programs of supply control currently being proposed. It is important to investigate these in the widest sense, not only with respect to their efficacy in solving the immediate problems of market imbalance and surplus stocks but also in connection with their consequences for nonagricultural sectors. The implications outside agriculture are important in view of the considerable interdependence between agriculture and the rest of the economy.

This study is specifically designed to investigate the economic "shock waves" that some of these policies would generate in the economy if they were to be implemented. The technique of regional input-output analysis is used for the investigation.

The specific objectives of the study can be stated as follows:

1. To estimate the initial impacts of various land retirement programs for the agricultural products concerned, on a regional basis.
2. To estimate the impacts of the programs on industries related to those initially affected, namely on:
   (a) related agricultural industries,
   (b) industries supplying agriculture with major inputs and
   (c) industries processing agricultural products.
3. To appraise the usefulness of regional input-output analysis as a technique for such policy analysis.

ECONOMIC POLICY

The Role of Government in Economic Affairs

The role of government in economic affairs has fluctuated widely in importance during history.

During the Mercantilist period between the 16th century and the middle of the 18th century, government intervention was strong, as exemplified by Colbert's strong internal regulation in France and by the policies of bullionism and trade regulation in England. During the "laissez-faire" period which followed, there was a reaction away from government control. Classical economists placed great faith in the coordinating and stimulating nature of the market, and generally opposed government intervention. Since then, however, there has been a widespread growth of dissatisfaction with many facets of the market mechanism, partly attributable to the growth of social consciousness during the period. The development of welfare economics within the discipline has both heightened and has been somewhat of a consequence of this.

As the recognition that the aims of society were not being adequately served by the market economy became widespread various types of measures were introduced to remedy this, particularly since the beginning of the 20th century. Johr and Singer (34) distinguish two broad types of remedy, the guided market economy and the socialist economy. In the first category they quote a useful division of measures suggested by Röpke (55):

> (i) Adjustment intervention: This is intended to accelerate and facilitate a development set in motion by the forces of the market economy.
>
> (ii) Preservation intervention: This is designed to maintain certain situations or industries threatened by the course of economic development.

On the other hand the socialist economy is distinguished by a system of coordination by a central authority. Within this category however there is a wide range in the degree of control exercised, ranging at one extreme from regulation and direction of production, allocation of resources and distribution of goods, to the other extreme where there is free consumer's choice, freedom of choice of occupation, and the opportunity to save.

The economic activities of governments have always been intimately connected with the concept of welfare, whether this has been narrowly defined in terms of a class, the State as in Fascism, or in terms of all individuals.

Welfare Economics and Economic Policy

Welfare economics is that part of economic theory most intimately connected with economic policy.

During the "laissez-faire" period economists freely made wide policy judgments. Welfare was identified with the accumulation of wealth and the resulting increase in output, and their main preoccupation was with the growth of the economy. Maximum growth was thought to be consistent with the greatest reliance on the market mechanism and with a minimum of government intervention, unless the latter increased trade and industrial profits.

The principal difference between their position and the modern one is their acceptance of cardinal utility and interpersonal comparisons of utility. They did not lack perception of the value judgments inherent in their advice, but considered that their inclusion among the assumptions was legitimate. Thus perfect competition was expected to provide maximum economic welfare except with respect to income distribution and external economies. Government action was needed to this extent. The assumption of diminishing marginal utility of income would enable the problem of distribution to be solved through policy measures.

Notable attempts were made to separate welfare theory from assumptions of measurability and interpersonal comparisons by Pareto, Barone and Lerner, to mention only a few. Robbins (54) pointed out that if economics was to be an objective science, these comparisons would have to be excluded. Under the influence of these attempts, welfare economics came to assume a position of small importance in the discipline, since policy recommendations were ruled out by all but socialist economists. During this time the same faith in the free forces of competition persisted.

It was not until the late 1930's that welfare economics was revived, when again value judgments became more palatable in that period of economic crisis. Subsequently what is often termed the New Welfare Economics, founded by Pareto, has developed in two schools both attempting to maintain the usefulness of economists in policy matters.

In the first school, two major proponents, Kaldor and Hicks, have attempted to broaden the scope of Pareto's criterion which held that welfare can only be said to have increased when no person is worse off with a change and at least one person is better off. They proposed that if the gainers could overcompensate the losers, welfare was increased even though the compensation may not be given. Controversy then ensued as to whether it was actually necessary to provide the compensation. Scitovsky questioned the criterion on other grounds; e.g. he showed the difficulty in proving welfare improvement has occurred when price changes accompany the change (63).

In general, economists now hold the problem of income distribution to be outside their province of scientific judgment, declaring that economists are justified in making policy recommendations only on the basis of efficiency considerations. Scitovsky and others hold that this is too restrictive, and suggest that equity judgments can be included in recommendations provided that they are made explicit and that they conform to public opinion. Others, such as Smithies (69) hold that it is impossible to avoid value judgments, arguing that the mere selection of economic problems for investigation involves them; also that no economic theory is ideologically neutral, and third, because means and ends cannot be clearly distinguished.

The result of this controversy has undoubtedly been that economists have either rejected normative considerations or have handled them conservatively. For the most part energies have been thrown into analyses of the functioning of the economic system and into accurate prediction work in policy matters. Thus the policy economist generally accepts goals as given and examines means (programs) on the basis of the consequences of alternative means proposed, in order to choose the most effective. In recent years these efforts have been greatly facilitated by the development of econometrics. This study is actually one such analysis of consequences of alternative programs, using modern econometric techniques.

The second school, represented by Samuelson and Bergson, has concentrated on trying to develop a social welfare function, a type of collective utility function, either of the welfare of the individual members of a community or of the services rendered and the quantities consumed by each member. It has not proven possible to specify this function satisfactorily, and the attempt has often been described as a mere restatement of the problems of welfare economics. Arrow (2) claims that any such representative function would not permit a consistent non-contradictory ordering of available alternatives. In a democratic society contradictions would always persist.

Theory of Economic Policy

Thus far we have observed in a historical sense the trends in the modern role of government in economic affairs together with some clarification of the role of the economist in policy matters. This section is concerned with the framework which economists have developed for analysis of economic policy, and the type of policy measures for which this is useful.

Policy analysts can undertake purely descriptive studies, but in order to play a more constructive role, they generally attempt to prescribe and optimize among alternatives within the limits suggested in the preceding section. For this purpose they generally assume a maximising approach, though lately there has been some criticism of the emphatic use of this, e.g. Simon (67). One problem associated with this and foreshadowed in the preceding section is the difficulty in defining an objective function for policy so that some clear definition of the conditions for maximum economic welfare can be derived. It has been summarily suggested above that welfare economics has done more to define the problem than to solve it. It could be said that this is a problem more closely related with long-run considerations of policy since short-run aims are often easier to establish, e.g. in terms of rates of interest and tax levels. However, the need for such definition is still extant even here, in order to avoid policies in the short run which are avoidably inconsistent with long run objectives.

Tinbergen (72, pp. 3-4) suggests that the broadest aim of economic policy is

> ...to determine the optimum policy.....which implies among other things:
> (i) The fixation of a collective preference indicator,
> (ii) The deduction from this indicator of the targets of economic policy generally,
> (iii) The choice of adequate instruments, qualitative and quantitative,
> (iv) The determination of the quantitative values of the instrument variables as far as such instruments are chosen and
> (v) The formulation of the connections between,
> (a) The relation between targets and quantitative values of instrument variables on the one hand and
> (b) The structure of the economy studied on the other hand.

Tinbergen distinguishes three types of policy measures to which such a framework can be applied, according to the type of change they create. First, quantitative policy which is concerned with the most superficial changes in economic variables and facilitates adaptation of the economy to changes which disturb equilibrium. It refers to changes in the values of policy instruments. This type of change lends itself more readily to numerical calculation of effects than the others. Second, qualitative policy which alters the structure of social organisation but not the foundations. These are generally longer run policies; their effects are less amenable to numerical resolution. The most radical policy measures are reforms, i.e. changes in the more fundamental features of social organisation such as social security schemes and changes in the educational structure which affect relations between members of a society and their spiritual welfare.

The most common objectives of contemporary economic policy are maintenance of international equilibrium and a sustained rate of growth in the domestic economy together with full employment and monetary equilibrium. Traditionally the most important means of steering the economy towards these objectives have included tax rates, subsidies, government expenditures, rates of exchange, and lately, more organised economic planning. This last has become a significant Government function even among nations of the Western political bloc, e.g. in France, Norway, Sweden and the Netherlands, although the degree of planning falls far short of that carried out within the Socialist bloc, e.g. U. S. S. R., Poland and China. Here again the development of sophisticated economic and econometric models has greatly facilitated this trend. It is no wild prediction to expect heavy Government participation in the economic development of underdeveloped nations in South and Central America, Africa and South East Asia, and policy analysis should be bread and water for this approach.

In underdeveloped economies with small separated markets and a limited range of goods on the market, the interdependence of the various sectors is comparatively low. Such situations could almost be described as economies within economies. Concurrent with any degree of development, high income, diversified tastes and technology cause a proliferation in goods and processes and firmly enmesh sectors with each other. In considering any policy proposal therefore, democratic governments have had to respect the pressures of increasing numbers of interest groups affected. Correspondingly, analysis of any economic policy must include not only its direct effects on variables related to primary objectives but also the repercussive effects resulting from the interrelationships. Secondary and lesser repercussions become quantitatively more relevant and widespread the more radical and comprehensive the programs are. Disaggregated economic models provide a much needed way of tracing the direction and extent of these repercussions through the economy.

Policy Analysis

Among policy economists there is a great interest in obtaining the numerical effects of alternative measures. A great deal of information on the nature of economic causality and relations has been collected, and it is often described now in terms of economic "models". The development and application of mathematics to economics has both facilitated and extended powers of description and prediction. The application of statistical techniques has aided economic measurement and has helped to define the limits of reliability of results.

Two factors militate particularly against total success in these efforts. First, the multiplicity and complexity of economic relations produce a wide gap between our state and the totality of knowledge. Second, the transitory or relative nature of economic truth quickly reduces much of the assembled knowledge to historical value. In the light of these sobering observations it should be noted that the more far reaching the effects of the policy being analysed are, the less likely it is we can obtain exact measurement of their effects at one time or over time. As a result a significant number of policies are implemented by a trial and error procedure.

This section is devoted to a brief and general review of the analytical methods available to economists for analysis of economic policy. These of course contain economic theory, mathematics and statistics in differing proportions.

There are a number of criteria used for classifying these techniques. Economists distinguish between partial and general equilibrium models, dynamic and static, stochastic and deterministic, aggregated and disaggregated, open and closed and positive versus normative models.

Marshallian partial equilibrium analysis is a well established analytical approach. Where policy or the inquiry is specific to one industry or to one product, the important effects may well be described by considering the statistical demand and supply curves for such limited markets and perhaps also for those industries or products directly related. The exclusive use of this approach gives useful but rather fragmentary information on the economy and on the effects of policy measures. However such studies can be usefully complemented by attaching an analysis of consequences for other parts of the economy in aggregate terms.

Much work is done using general equilibrium analysis, particularly since the development of empirical general equilibrium systems. More recently choice has become possible between using Keynesian aggregates and various levels of disaggregation, largely as a result of these empirical models. The highly aggregated models are useful for investigating those changes which affect all sectors in a parallel manner. To the extent that important variations occur in reactions among sectors, it becomes more appropriate to use disaggregated models to focus on these differences. Among the empirical systems, Leontief's input-output work has provided a strong connecting link between Marshallian micro-analysis and Keynesian aggregates. It provides understanding and numerical identification of the interdependence of all sectors of the economic process at least in a static sense. For policy analysis it is useful for the insights it gives into the transmission of any local change through the complex of the economic system. It provides more detailed information on the repercussions on industries directly and faintly related to the source of change than is possible using only aggregates or studies of restricted markets.

It must be admitted that particular sectors receive rather superficial treatment in Leontief's interindustry models. If a policy concentrates on one or more sectors of the economy, Klein (36) suggests the use of a "master" model onto which a particular sector model can be grafted. He recommends beginning with an aggregative or global model which includes domestic and foreign economies. The domestic economy is described by the household, enterprise and government sectors as in many national accounting schemes. Relevant behavioral, institutional, legal and technological relations are set up to complete the model. Disaggregation is then possible to focus attention on a particular industry or further, on certain firms provided data are available. Thus a study of policy consequences for a commodity can be pursued by aggregating data for firms producing this commodity and by estimating the relations from time series data. This can be further studied on a regional basis or on an individual firm basis. This process of disaggregation is one of going from the macro to the micro, without stressing the complex of inter-industry relations on which input-output analysis concentrates. Klein (36) suggests that further developments will probably close the gap between these approaches.

Tinbergen (71) provides a useful summary of the range of economic models in use for policy analysis. He suggests using closed models for focusing attention on internal considerations; "internal" can of course be narrowly or widely defined. They are also useful as a first approximation to reality. In contrast, open models are better applied where international trade has a strong impact on an economy. At present static models are more useful than dynamic models for policy analysis since most policy decisions are taken with respect to the short run and because dynamic models are by no means well developed. However the greater the degree of government activity in the economy, the more useful dynamic models are likely to become.

Finally it should be pointed out that various combinations of the foregoing categories can be constructed, e.g. open-static-macro models or closed-dynamic-macro models, in order to best analyse a particular problem and to fit the circumstances of the inquiry.

AGRICULTURAL POLICY

Substantial government intervention in the agricultural industry did not occur in the U.S. until the 1920's. This can be attributed in great part to the perpetuation of the Jeffersonian brand of agricultural fundamentalism. This stressed a society based on widely distributed land ownership and a minimum of authority vested in the central government. Negotiation between the farmers and the government in the 19th century centered around disputes on money matters, tariffs and land problems, slavery and transportation.

During the administrations of Theodore Roosevelt, Taft and Woodrow Wilson at the beginning of the 20th century, agriculture enjoyed prosperous conditions. The legislative policies sought by farm organisations were comparatively mild (5) e.g. conservation of natural resources, effective railroad legislation and federal aid for road improvement. These years included the base period 1910-14, that became so important for future agricultural legislation.

The exigencies of the first World War forced the first government interference with the market mechanism with the guaranteeing of some agricultural prices between 1917 and 1920. Then in 1920, postwar boom prices in agriculture collapsed, and by 1921 the call for relief legislation was under way. This legislation included various measures on agricultural credit, cooperative marketing, loans and transportation, but most important, price legislation was developed, related to the slogan "equality for agriculture", coined first by Peek and Johnson. The McNary-Haugen plan introduced the first control of the market where prices were held at or above their free market levels. Formally, Government support of prices and incomes in agriculture dates only from 1929. Price support was then and still remains, the dominant measure in U.S. agricultural policy.

The first attempts made by the Federal Farm Board to maintain prices failed. In 1933 the CCC was formed, and with it, a new measure of production control was introduced to raise prices. Loan rates on farm products were used in conjunction to stabilise prices against fluctuations in production and general demand. In 1936 and 1937, payments were offered for reductions in soil-depleting acreages and for increases in soil-conserving crops. In 1938 the AAA introduced another acreage reduction program, which adjudged unsuccessful (62a).

The operation of these programs did not create any serious problems during the 1930's and 1940's, though World War II and the Korean conflict probably averted serious surplus problems which were building up at the time each war began. At the same time, as Shepherd points out (65, pp. 45-68) the measures were not effective in achieving the objective of parity for farmers, itself a rather vague goal. Acreage reduction programs had little effect on production and none on total agricultural income. Price measures (e.g. loan and purchase operations) stimulated production and precipitated a more pronounced decline in prices.

The criticism can be made that from the 1920's until after the end of the Second World War, the essential problems and therefore the goals of policy for agriculture were not clearly enough defined; the policy instruments used were not effective in achieving even those goals which were specified. Since then there has been considerable clarification of the problems and the desirable goals of policy, together with a better understanding of the effectiveness of the tools available to the policy-maker. Despite these clarifications, however, the problems have not as yet been solved.

Shepherd (65, pp. 69-73) has divided the problems of agriculture into three distinct groups. First there is the problem of instability in agricultural income due to fluctuations both in market supply and demand. For supply fluctuations he suggests a stabilization-by-storage program to smooth out variations in national durable crop production, and a program of crop insurance to protect farmers against local variations; for demand fluctuations, a general policy is required to reduce the cyclic phenomena in the whole economy and thus in agriculture. Second, there is the long run problem of a low level of per capita income in agriculture vis-a-vis per capita income outside agriculture. Third, within agriculture there is a wide disparity in the distribution of income, and important pockets of poverty exist. Past government programs have made no notable impression on the problem of bolstering income of farmers in depressed areas. The solutions to these three problems can be regarded as the most important objective of contemporary agricultural policy. The measures chosen ideally should not conflict with the encouragement of increased farm efficiency and they should be consistent with other national policies.

Policy measures currently being advocated can be divided into three categories according to the location of their application. One group would operate on demand, another on supply and a third group directly on prices.

Demand Measures

Proposals for operating on the demand forces in the market concentrate on increasing domestic and foreign absorption and on finding new uses for farm products, as methods for reducing surpluses and for maintaining farm income. These proposals include promotion and advertising, food distribution programs, trade promotion overseas and research. However, at least in the short run there appears to be little hope of a dramatic rise in demand. Internally, population growth rate in the U.S. is slower than the rate of production increase. The operation of Engel's law with respect to income changes marks the limitations of demand changes inherent in upgrading living standards. The price elasticity of demand for farm products is low, around -0.25 (84), so price reductions result in lower total returns.

The present structure of domestic protection measures among importers (e.g. Western Europe) and the strong trade competition among exporters (e.g. Canada and Australia) in agricultural products suggest small space for optimism in foreign demand in the short run. Rising world population and income and changes in tastes among Eastern countries hold out some hope for long run improvement.

Most emphasis in finding new uses for farm products is placed in the industrial field since new food uses often merely compete with the old ones and no net gain for agriculture results. Some science-worshippers claim that a program of research would be sufficiently successful to eliminate surpluses. On the other hand it is true that in some areas, nonfood use of farm production has declined due to the substitution of non-farm materials (e.g. for cotton, wool, flax and silk and for leather in shoes). The USDA has had some success with research into new uses such as nylon from corn cobs and derivatives of soybeans. Total non-food use of farm products was between 10 and 12 percent of the gross value of farm production in 1954 and it has not changed much since. More realistic estimates of the productivity of research suggest that another 5 percent might be diverted this way. The possibility of startling developments cannot be disregarded but in the short run at least it is difficult to see the solution of the farm problem in these endeavors.

Price Measures

The second broad category of policy measures covers those proposals which would operate directly on agricultural prices. These measures have historically been the most important in agriculture. This category covers proposals for price supports and storage, direct payments, multiple prices, free prices and for marketing quotas. As pointed out above, the first price support and storage programs begun in 1929 with the aim of stabilising prices, failed due to the depression. By 1938 the aims had been changed to permit prices to be raised above open market levels. The two wars prevented any serious problems from developing up until 1952 but since then, this program has contributed to the accumulation of huge and costly surplus stocks. Storage programs are suitable for smoothing out price fluctuations due to production variations but used alone they cannot solve the problem of the long-run decline in agricultural prices and incomes. Loan rates can only be held above open market levels if other programs are used to reduce production or to increase consumption.

Under a program of direct payments, farmers would sell their products on the open market and any difference between that price and the announced support price would be made up by payments from the Federal Government. This permits the free operation of the market; it would not require a storage program, but it would require extensive administrative machinery to police the sales. It would also help to stabilize farm incomes as well, but it is not a method of solving the fundamental problems in agriculture, particularly if incomes are held above long term market levels. The program tends to perpetuate the presence of excess resources in the industry and high costs for the taxpayer and the government.

Another proposal is for multiple pricing in agricultural markets. Multiple prices require the markets to be split. The program could effectively stabilise or increase returns to farmers under certain conditions (e.g. if the elasticities of demand differ in the different markets and substitution between markets is prevented) however in the long run consumers may substitute other products for these higher priced commodities and furthermore the supply-demand imbalance would probably be worsened by the increased production stimulated by the program. Politically this type of program is not popular since home producers generally have to pay these higher prices and overseas competitors complain of "dumping" practices in the secondary market. Furthermore in order to ensure the isolation of the home market, tariffs and quotas may be necessary which may provoke protest and retaliation.

A return to free market pricing with no government intervention is sometimes proposed. Such a move would reduce government expenditures for price supports and it would lower prices for consumers, but it would also lower net farm income considerably. Recently several studies have tried to measure the likely change in farm income. One estimate made by Shepherd, Paulsen et al. (66) suggests an income fall of 21 percent by 1965 from 1955-59 levels of average gross receipts from livestock and livestock products. Another made by the USDA with slightly different assumptions was in substantial agreement (79). The fall in income would probably accelerate the movement of producers out of agriculture but this manner of adjustment is unacceptable to a large proportion of farmers.

One final proposal affecting prices would be to establish marketing quotas to produce prices would would return equitable income to farmers. The plan requires fair prices to be established, a marketing quota to obtain the desired prices and allocation of shares to individual producers. Prices could certainly be raised, thus increasing gross income, but if quotas are allocated on the basis of past sales, the current problem of income distribution would be perpetuated. Competition for negotiable quotas might inflate their value and earnings for agricultural labor may not rise far. Although prices might be high, the effect of reducing output would be lower real national income due to reduced marketings. Consumers also pay part of the costs through higher prices.

Input Measures

The third broad category of policy measures covers proposals for restricting inputs in agriculture. Three alternatives present themselves, at least theoretically: restrictions on capital and technology, on labor, and on land.

The first mentioned resource currently has the highest productivity of the three in agriculture. Its limitation would therefore reduce output the fastest, but from the viewpoint of long run efficiency in the industry, the whole proposal appears retrograde and might involve measures such as restricting research and credit which would prove offensive to the farmer and to the public.

Proposals for reducing the number of farmers in agriculture are less controversial and in various ways this measure is at present in operation. Due to the substitution of capital for labor in the production process there is a continual need for such migration. These programs may only raise individual farm incomes by distributing the same aggregate income over fewer farmers. It is conceivable though that in the short run consolidation of holdings would increase efficiency and raise production which would hold down per capita incomes to some extent. In the long run such a program would contribute to solving the problems of both the level and distribution of per capita incomes in agriculture. In raising per capita incomes it would better enable farmers to accomodate year-to-year fluctuations or the program could easily be supplemented by a specific stabilizing plan as well. The program would also be consistent with the aim of increasing efficiency. Consumer costs would be negligible and government costs would be the short run transfer costs and compensation payments for displaced farmers.

Programs for the reduction of the land input are now commonly advocated. This study is a consideration of some of these proposals. In general land retirement can be on a voluntary or compulsory basis and either way it could be organised according to several different approaches. Land could be retired on a uniform basis from each farm, from each state or from the country as a whole. From an efficiency viewpoint it would be preferable to remove the lowest quality land. In accordance with this criterion, retirement would be best on a national basis, where the most of the least productive land would be removed from production, and it would be worst on a farm basis from the efficiency viewpoint.

The alternative programs can be compared in terms of other repercussions. Retiring part of each farm uniformly across the country spreads the secondary effects and raises the least social, institutional and political problems. It disturbs the existing pattern of dependent relations in local and regional communities least of all. Family living expenditure is not greatly disturbed and the reduction in the scale of operations would make a minimal impact on the input-supplying and product-processing industries. In contrast the repercussions of retirement of the least productive land nationally, which presumably would be on a whole farm basis, raises important problems. There would be a heavy concentration of the programs in certain regions and probably a considerable migration of farmers out of agriculture and out of the region. This would require substantial adjustment not only in industries connected with farm business but also in those dependent on the consumer and living expenditures of these farmers. Such prospects are probably sufficient to persuade the policy-maker to sacrifice a degree of efficiency and choose a less disturbing proposal.

To the extent to which prices are raised by the retirements, incomes would also be raised for those farmers remaining in agriculture. This in itself might stimulate higher production. If the production-increasing effects of technological progress are added, the retirement program might have to be a continuing process unless demand grows at a faster rate. If market prices were held around long term equilibrium levels, the cost to the consumer would not be high. Payments to farmers roughly cover the unavoidable costs of operation and range perhaps from 50-75 percent of the crop value on a partial farm basis. Retirement on a partial farm basis would cost more than on a whole farm basis since the farmer retiring a whole farm can more easily reduce expenditure. Thus the cost to the taxpayer would be the total payments to farmers and the administrative costs together with some compensation for others adversely affected by the program.

ANALYSIS OF AGRICULTURAL POLICY

Analysis of U.S. agricultural policy has been more extensive than that of any other sector in the economy, due largely to the amount of data available for agriculture. Many analytical techniques have been developed and tested on agricultural problems. It is intended in this section to give a general statement on the range of these techniques and to follow this with a consideration of alternative approaches to the particular policies of land retirement. Finally a more detailed discussion of input-output analysis, the technique used in this study, is provided.

The first extensive applications of analytical techniques were the analyses of the demand for food and farm products begun in the 1920's using single equation and multiple regression analysis. These were used both in forecasting work and in preliminary examinations of alternative farm programs. Pioneer work was done by Schultz (61) and Moore (42) amongst others. Early work on supply response to price change was carried out by Warren and Pearson (82). An excellent coverage of analyses of market and administered prices is provided by Shepherd (64) involving both short and long term studies and surveying various techniques now available, ranging from the graphic and single equation methods to simultaneous equations. Later in the development of price analysis it was recognised that uniequational models were often inadequate, and as Fox

(20, p. 3) stated,

> The present view is that a demand function is one of a number of simultaneous relations which act together in determining the price, production and consumption of the commodity in question.

As Shepherd (64) pointed out however, the matter of the relative value of single versus multiequational models is not simply determined. If multiequational models were complete they would in general be superior but in practice, analysts must usually choose between single equation models and less than complete simultaneous equation and other models where the advantage is by no means so obvious.

Considerations of time, funds and the nature of the problem combine to determine the choice of the best analytical technique. The nature of the problem involves decisions as to whether to analyse short or long term effects of a policy, whether single commodities or groups of variously related commodities are involved and lastly it involves the degree of detail desired, i.e. how far through the economy the effects are to be measured and what degree of disaggregation is desired in the variables.

Fox (22) has provided a useful delimitation of models used for measuring short and long run effects of agricultural policies. In the short run, farm production can often be assumed fixed and policy analysis concentrates on the effects transmitted through demand schedules, both domestic and foreign. Models can be constructed for the various cases, where there is only one market, domestic or foreign or where both markets are included. It is also possible of course to analyse the effects on supply through short run elasticities. In general these models represent a partial equilibrium approach to policy analysis.

Aggregative models generally encompass both agriculture and the rest of the economy with varying degrees of detail. A simple aggregation model was prepared by Fox (21) to measure the costs of price support for consumers, the government and the taxpayer as determined by the method and level of support commodity coverage and the proportion of production involved for each commodity. Benefits for farmers can be similarly studied.

Another more comprehensive model by Fox (19) traced the effects of farm price support programs on the rest of the economy. The important economic variables were first identified; they included prices at the farm, retail food prices, the consumer price index, wage rates and gross national product, disposable personal income, farm output, CCC stocks and commercial utilisation of farm products. Methods were then used to obtain the connecting coefficients which enabled the effects of the programs to be quantitatively determined. It should be noted that a wide range of commodities in a program would involve a substantial task to establish all the coefficients reliably.

Fox suggested that it might be possible to build up a complete set of demand and supply relations and production functions for each product group and to obtain the relations which connect agriculture with the rest of the economy.

An even more comprehensive model is possible if the world economy is included. Polak (52) constructed a short run model for measuring the effects of farm price supports on the world economy. On a more restricted plane Polak suggested adapting national aggregates to regions, states and smaller geographical boundaries. It is possible that international trade models may have useful application to such regional areas.

Other comprehensive national models have been constructed, amongst which, the most notable are by Tinbergen (73), Klein (35) and by Klein and Goldberger (37), all of the U.S. economy. Another recent model of the Norwegian economy by Johansen (33) may herald the way to a connection between such highly aggregated models and the various disaggregated models and may prove useful for policy analysis. The model used a breakdown of production sectors, as in input-output analysis, and described the relative growth rates of these sectors, the allocation and reallocation of resources between them and changes in the composition of consumption during growth. Such a model for agricultural policy analysis would combine the advantages of detail and comprehensiveness in a dynamic framework.

Other dynamic models have been formulated which distinguish between agriculture and the rest of the economy. Among such two-sector models, one with relevance to planning was developed by Chand Mal Palvia (49). He attempted to obtain some solution to the problem of balance between agricultural and other industries during growth. Using investment within various industries, the aim was to achieve a certain level of national income within a specified time period. Three-sector models, distinguishing between primary, secondary and tertiary industries have been developed by Colin Clark (11) and by Allan Fisher (17) who have been principally concerned with the changes in the distribution of labor over the three industry groups. The development of such dynamic models sustains the hope that accurate long term analyses of farm policies may yet be possible.

Alternative Methods for Analysing Land Retirement Programs

This section is concerned with alternative methods for analysing the impacts of land retirement programs. In the discussion which follows, the merits of several of these will be discussed, emphasizing input-output analysis.

None of the several ways of analysing the impacts will provide a total, detailed picture. Each has a different emphasis and to this extent they are all complementary. One simple approach would be to assess the total costs of the programs to the consumer, the Government and to the taxpayer. More often though it is desirable to provide a more comprehensive analysis of effects.

An aggregative approach which could be employed would be to trace the impacts of output changes on agricultural processing and input-supplying industries, on consumer goods industries and on employment. A starting point would be to gauge the changes in income for the agricultural industry as a whole. Relations between the level of agricultural cash receipts and the level of production purchases, farm living expenditures and the level of income for agricultural processing industries might be obtained from data, and together with multiplier effects, the total aggregated effects on the rest of the economy might be calculated. It should be possible with such a model to use estimated relationships to measure the changes in employment caused by the programs. The use of aggregative measures in this approach strongly limits its value since neither the relative impact on different industries related to agriculture would be reflected nor would any regional impacts be given. It does have an advantage arising from the fact that aggregate relations are incorporated e.g. the multiplier effects, which are missing from more individual models. This approach would be similar to that suggested by Fox and Norcross (23) and to a model by Fox (19) referred to above.

It would be conceivable to examine each individual commodity affected by the land retirement programs, and by using single equations, to trace through the same range of effects on related industries as is described in the preceding model. But where many commodities are involved greater advantage appears to lie in using either a more sophisticated model combining these relations in detail or by using the above described aggregative approach.

If the impacts on a particular region or state were desired, it would be possible to construct a Keynesian model of aggregative relations for the specified area, incorporating the various multiplier effects. Changes in income could first be calculated for the agricultural sector, then by using the various marginal propensities for investment and consumption, the income and employment changes for other internal sectors could be estimated. Effects external to the region could be determined by using marginal propensities for trading estimated for the region. Assuming adequate data, any desired degree of detail could be included in the model by a breakdown of income and product accounts.

Interindustry Approach

If we allow for the fact that the economic size of the agricultural sector is now small in relation to the total economy (in 1959 gross farm income was a little less than 7 percent of gross national product of the U.S. as a whole) then it can be agreed that the effects of a land retirement program on the rest of the economy in total may be quite small. The terms of the proposed land retirement programs reinforce this argument since payments for retired land will tend to maintain the level of consumer expenditures of the producers. On the other hand the impact of the programs on a limited number of related nonagricultural industries such as the fertiliser industry will be substantial. With a wide range of agricultural products included it is obvious that the analysis of the impacts of such programs is rather well served by the interindustry approach in which these interconnections are emphasised.

The effects of a wide range of agricultural products can be comfortably handled and the crucial interdependencies can be highlighted by selective aggregations in the data. The use of a regional model further permits the impacts of a program to be geographically located.

The theoretical scheme for the study

The economy can be aggregated into n sectors, each sector usually containing a group of industries. From this aggregation an input-output table can be constructed of size n x n. Each row represents the absorption of the net product of the

i^{th} sector ($i = 1, 2, \ldots.n$) by the remaining n-1 sectors of the table. Each column shows the inputs to the j^{th} sector ($j = 1, 2, \ldots.n$) by the remaining n-1 sectors. Totals can be added for columns and for the rows which give the basic relations involved:

$$X_i = \sum_{j=1}^{n} x_{ij}$$

where X_i is the net output of the i^{th} sector and x_{ij} is the output of the i^{th} sector used in the j^{th} sector as an input.

The column total shows the total inputs supplied to the j^{th} sector by the other n-1 sectors. The net output of any sector equals the amount supplied as inputs to other sectors. This table shows only intersectorial flows and shows zero for intrasectorial movements ($x_{ii} = 0$). It could be constructed on a gross output basis to include these latter flows.

Due to aggregation problems, the table is usually expressed in value terms where the unit is common to all industries.

The closed model is essentially a reconstruction of the economy in its entirety. It assumes that all of the outputs are mutually dependent. Households are included as an industry, purchasing the products of other sectors as its inputs and supplying labor as its output. All output not consumed by other industries is consumed by households. In this system free entry and perfect competition are assumed while the dynamic elements of the system are ignored.

The system can be represented in the following set of equations:

$$
\begin{aligned}
X_1 - x_{12} - \cdots\cdots\cdots\cdots -x_{1n} &= 0 \\
-x_{21} + X_2 - \cdots\cdots\cdots\cdots -x_{2n} &= 0 \\
\\
-x_{n1} - x_{n2} - \cdots\cdots\cdots\cdots + X_n &= 0
\end{aligned}
\qquad (1)
$$

From the input-output table, the technical production coefficients are calculated according to these equations:

$$a_{ij} = \frac{x_{ij}}{X_j} \qquad (2)$$

from which it follows that $x_{ij} = a_{ij}X_j$ where X_j is the net output of the j^{th} industry and x_{ij} is the product of the i^{th} industry used in the production of the j^{th} industry. Since $x_{ii} = 0$ then $a_{ii} = 0$. We can now substitute for x_{ij} in the Equation System 1:

$$
\begin{aligned}
X_1 - a_{12}X_2 - a_{13}X_3 - \cdots\cdots - a_{1n}X_n &= 0 \\
-a_{21}X_1 + X_2 - a_{23}X_3 - \cdots\cdots - a_{2n}X_n &= 0 \\
\\
-a_{n1}X_1 - a_{n2}X_2 - a_{n3}X_3 - \cdots\cdots + X_n &= 0
\end{aligned}
\qquad (3)
$$

Representing the technical coefficients in matrix form,

$$A = a_{ij} \quad (i,j = 1, 2, \ldots\ldots n) \text{ and } (a_{ii} = 0)$$

a technology matrix can be formed from Equation 3 allowing

$$M = I - A$$

so the set of Equations 3 becomes,

$$MX = 0 \tag{3a}$$

where X is the vector of outputs.

Using the assumptions of free entry and perfect competition, in the static model general equilibrium is possible with the following conditions:

(a) $X_i = \sum_{j=1}^{n} x_{ij}$

(b) In value terms, the receipts equal the outlays in each industry,

$$p_j X_j = \sum_{i=1}^{n} p_i x_{ij}$$

In order that the system of n homogeneous linear Equations 3a have a nontrivial solution, the determinant of M, (M) = 0. The system can have many relative solutions but if one of the variables is made a numeraire, these can be normed. The variable most commonly used for this is labor, the output of households. Then $X_n = 1$ where n stands for households.

In a similar way the system can be solved for prices where the equilibrium for outlays and receipts is

$$pM = 0$$

with p the vector of prices and M the technology matrix again.

By norming and placing one price equal to 1 (typically p_n the price of labor) relative solutions can be obtained.

The closed model can be used to construct an approximation to reality. It cannot be used to determine the scale of the economy. If the relation of one sector to quantities of final demand for output in other sectors is desired, the open model is used.

The closed model assumes that all the outputs are mutually dependent. This may be modified by assuming that one of the variables is independent. To do this the independent variable is shifted to the right of the equality sign in the Equations 3 and is called the "bill of goods". Since only the dependent variables are to be determined, one equation may be dropped, leaving only m or n-1 in the system. This modified system is called the open input-output model.

The basic set of equations for the open model is as follows:

$$X_i - \sum_{j=1}^{m} x_{ij} = Y_i \quad (i = 1, 2, \ldots\ldots m)$$

where X_i is the net output of the i^{th} industry,

x_{ij} is the net output of the i^{th} industry used by the j^{th} industry,

and

Y_i is the final demand for output of the i^{th} industry.

Since

$$x_{ij} = a_{ij}X_j$$

by substitution

$$X_i - \sum_{j=1}^{m} a_{ij}X_j = Y_i \quad (i = 1, 2, \ldots\ldots m)$$

In matrix notation

$$(I - A)\ X = Y$$

or

$$M_o\ X = Y$$

where $M_o = (I - A)$, an m x m matrix of technical coefficients. X is a vector of outputs and Y is the vector of final demands. From this it follows that,

$$M_o^{-1}\ M_o\ X = M_o^{-1}\ Y$$

therefore

$$X = M_o^{-1}\ Y,$$

i.e. the output of each industry is a function of the final demand for all outputs in the system, which can be solved

$$X_i = f(Y_1,\ Y_2,\ \ldots\ldots Y_m).$$

The elements of the inverse of the technology matrix are the interdependence coefficients. They express the amount by which output in a particular producing sector must change if final demand for a particular sector is changed by a dollar's value.

Using the same conditions and assumptions as in the closed model, where receipts equal total outlays for each industry, a solution to the price system can be obtained if the wage rate w is given,

$$\underline{p} = \underline{w}\, M_o^{-1}$$

where $\underline{p}$ is the vector of prices and

$\underline{w}$ is the vector of wages.

Other results can be obtained such as the total employment given constant labor coefficients.

$$E = \underline{b}\, X$$

where $\underline{b}$ is the vector of labor coefficients and

X is the vector of outputs.

This model is more useful for analysing implications of market and policy-induced changes and for prediction than the closed model. Again, it could be used to discover the impact of a planned Government investment in a specific region.

The number of empirical studies using input-output analysis is growing fast. Leontief developed and first used his theoretical scheme in a descriptive analysis of the American economy in his edition first published in 1941 (39). In this study he divided the economy into ten sectors. Data were used from 1929 and 1919 and results from both years were compared. Firstly the approximate price and output reactions of various commodities to any given combination of primary changes were calculated. Using these Leontief attempted to explain the price and quantity variations which occurred within these years in terms of the underlying structural transformations of the whole economic system.

In the 1951 edition (39) he included an application to the American economic system in 1939 to be used in analysing postwar economic problems. In this study he attempted to "post-predict" the total output of industries in 1929 using the bill of goods of 1929 and the technical coefficients of 1939. Needless to say he employed the open model in this work. After proper adjustments were made computed data compared closely with actual data. The discrepancies which appeared could be explained by,

(a) insufficiently refined industry classification,

(b) disregard of some obvious technological changes and

(c) the inaccuracy of some statistical data.

A study was also published in this edition on the quantity of output and employment in each industry associated with the production of a given final demand. In one case the given final demand was a quantity of household purchases. In another he used foreign trade as the given set.

Peterson and Heady (51) applied a Leontief-type analysis to a model of five economic sectors where interdependence was between primary and secondary agriculture and between agricultural sectors and industrial sectors of the economy. Detailed analysis was made of input coefficients and interdependence coefficients for the years 1929, 1939 and 1949. Some prediction of change in the coefficients in agriculture was possible using these analyses.

In a study mentioned above (60), Schnittker and Heady applied input-output analysis to a 21-sector model of the U.S. economy in 1949. Major emphasis was on the relationships between agriculture and other industries which (a) process agricultural products and (b) provide agriculture with productive factors.

Heady and Carter (28) used the input-output technique as the basis for developing a model of the United States for 1954. The aims of the study were to quantitatively measure the interdependence between agricultural regions and between industrial sectors. Ten type-of-farming regions were distinguished within agriculture and nine product groups were identified in each region. Industry was aggregated nationally into seven agricultural processing industries, five agricultural furnishing industries and one sector to represent "all other industries". This study provided the starting point for the present analysis.

Much discussion has ensued about the problems and uses of the Leontief models. Before we come to any conclusions about the usefulness of the static models, some of these problems should be outlined.

Problem of substitution

Once the level of output has been given in Leontief's models, the quantity of each input used is uniquely determined. In contradistinction, production theory and common sense suggest that factor substitution will occur at different relative factor price levels. Leontief argues that this is unimportant at least in the short run. Both Ryan (56) and Dorfman (13) criticise this minimisation of the problem. Samuelson (57) and Georgescu-Roegen (24) have argued that in an economy where labor is the only production factor not produced within the system, the price structure will lead to efficient utilisation of labor, and since all factors embody labor, there will be no scope for changes in relative factor prices or, therefore, for factor substitution. Samuelson thus assumes that the supply of all factors other than labor can be increased at will. Dorfman (13) criticises Leontief on this point, since the latter permits the element of time to enter insofar as output will react to changes in final demand but not insofar as new techniques are introduced. This contradicts the assumption of the full static equilibrium. On the question of the importance of his assumption of no factor substitution, Leontief suggests that much of what is considered to be substitution in an industry is merely shifts in relative size. Even if an increase in any factor may increase total output, a proportionate increase may bring preferable results, i.e.

substitutability may be possible but the degree of complementarity is so high that even a violent price variation will cause no substitution. He admits though that there undoubtedly is a real problem of substitution but its importance should be empirically decided.

Problem of aggregation

One serious problem which arises in connection with the use of input-output models is that of aggregation. Since each industry does not consist of identical single product firms, the assumption must be made that when output of one product of an industry changes, the outputs of all its other products change in the same proportion. Tintner (74) discusses this problem in some detail. The greater the degree of aggregation there is in the model the more important this problem becomes.

Statistical errors

Quite frequently basic data are faulty or non-existent so productivity coefficients are only estimates of actual coefficients. It is usually impossible to obtain the distribution of these estimates and the assumption of normality cannot be justified so bounds cannot be applied to errors from the use of these estimates.

A further source of error is contained in rounding procedures. The solution involves the manipulation of n x n unknowns. For practical use, n should be 50 at least; if it is less than 50 the concept is too broad to be useful. If it is much greater than 50 there is less justification for assuming the coefficients are constant in the short run. Fifty is a good compromise, but in solving the equations with matrix algebra and electronic computers, rounding off must be done and the error builds up in magnitude to the extent where the number of significant figures required because of this may be greater than the number available.

Ryan (56) also mentions truncation error which may be small in general, and "model error" due to the fact that the model only approximates reality. Smith (68) calls attention to one aspect of the open model which is unrealistic. Any reduction of the bill of goods to zero reduces output and employment of all industries to zero which appears unrealistic. Leontief perceived this and suggested that the linear employment-consumption relationship was probably an overstatement of the volume of employment dependent on any given set of goods.

Another criticism is thrown at the model when it becomes open. There is a loss of information inherent in the change. The model loses its ability to portray the "feed-back" mechanism i.e. the changes caused in the dependent variables by changes in the independent variable are assumed to have no effect back on the independent variable. Only the primary effect of the change in the final bill of goods can be observed.

The investment problem is not handled conveniently by the static model. The assumption of a unique relationship between output of an industry and its purchases from other industries is plausible only with respect to purchases on current account since some purchases are usually for investment purposes.

Other disadvantages include the fact that it is static and therefore has limited application particularly for predictive purposes. Furthermore it deals only with linear relationships.

In defense of the static model, it is very useful for obtaining empirical knowledge about the interrelationships of sectors. Its predictive capacity is uncertain but may be positive in the short run. It does permit the estimation of the impacts of various changes in surrounding circumstances on an economy. It should be mentioned that Leontief has developed a dynamic model to overcome some of these problems of the static model however this has not yet been extensively applied.

For the purposes of this study it is important to note that input-output models can be variously disaggregated. Regional breakdown of agricultural sectors provides an opportunity for examining the differential impacts of land retirement programs in a geographical sense. If nonagricultural sectors can also be disaggregated on such a basis, a useful contribution can be made towards measuring the total interindustry effects on a local basis. It should be recognised that such a model would require a vast amount of detail and may come close to straining the capacities of electronic computers in solving the resulting matrix systems. It may also necessitate greater aggregation in relatively unimportant industries than would be desired.

THE MODEL AND METHOD OF ANALYSIS

An interregional input-output model previously developed (8) is used for this study. This is a model of the U.S. economy for the year 1954. In this model, the U.S. is divided into 10 regions, each with 9 agricultural industries together with 13 nonagricultural industries on a national basis. Agricultural processing industries account for 8 of these national industries, four supply agriculture with inputs, and the other is an aggregate of all other industries in the economy.

The model uses 1954 data to provide final demand and gross domestic output for all 103 sectors. Input-output and interdependence coefficients are available giving quantitative information on economic interrelationships, both interregional and between agriculture and the rest of the economy. This model of 1954 provides the basis for the present study. It would obviously be preferable to have later estimates but a more recent model is not available.

The aim of the study is to estimate the effects of various agricultural supply control programs on those industries which are closely related to agriculture. The programs are interpreted in terms of this model which is used as the means of transmitting the effects of the programs through agricultural sectors and related nonagricultural industries. Such regional models can give useful information on the local impacts of Government policies. This analysis would of course be enhanced if the nonagricultural industries were available on a regional basis as well, but the model was not originally constructed on this basis.

The various components of the model can be first divided into endogenous and exogenous sectors. The endogenous components are the 103 agricultural and industrial producing sectors. The exogenous components are the various final demand sectors. A summary of the construction of these sectors is given below (8, pp. 24-35 and Appendix A).

Definition of Regions and Commodity Groups

The U.S. is divided into 10 regions, corresponding with the ten type-of-farming regions used by the USDA. Each of these produce some of almost every agricultural product. The system satisfies aggregation principles satisfactorily (e.g. input allocation among commodity groups is fairly accurate). Table 1 presents the composition of agricultural regions by states.

Agricultural sectors

The study by Carter used aggregation by products for agricultural industries since the available statistical data were in this form. Several problems are inherent in product aggregation such as the allocation of inputs, the large number

Table 1. The composition of agricultural regions by states

North East Region 1	Corn Belt Region 2	Lake States Region 3	Appalachian States Region 4
Maine	Ohio	Michigan	Virginia
New Hampshire	Indiana	Wisconsin	West Virginia
Vermont	Illinois	Minnesota	North Carolina
Massachusetts	Iowa		Kentucky
Rhode Island	Missouri		Tennessee
Connecticut			
New York	**South East Region 5**	**Delta States Region 6**	**S. Plains Region 7**
New Jersey	South Carolina	Mississippi	Oklahoma
Pennsylvania	Georgia	Arkansas	Texas
Delaware	Florida	Louisiana	
Maryland	Alabama		

N. Plains Region 8	Mountain States Region 9	Pacific States Region 10
North Dakota	Montana	Washington
South Dakota	Idaho	Oregon
Nebraska	Wyoming	California
Kansas	Colorado	
	New Mexico	
	Arizona	
	Utah	
	Nevada	

of agricultural products, and the existence of joint products. However the problems associated with the alternative aggregation procedure by farm enterprises, are by no means less imposing.

Table 2 provides the commodity groupings, together with the products and services contained in each group.

Industry sectors

Thirteen industrial sectors were distinguished on a national basis. For the purposes of this type of study, a regional basis would be more satisfactory since the geographic distribution of the impacts of agricultural programs is important as well as the total magnitude of impacts. However as stated above, the model was not constructed on such a basis. Three categories of industries are identified, (a) those industries processing agricultural products, (b) those furnishing agriculture with major factor inputs and (c) all other industries. Table 3 presents the different sectors used and the components of these sectors.

Final demand sectors

Foreign trade, Government, inventory and household are the component sectors of final demand in this study. In this open model, they are exogenously determined. In foreign trade, imports are considered to be competitive with domestic

Table 2. Agricultural commodity groups within each region

Sector	Commodity group	Components of group
i1.	Livestock and livestock products	Meat animals, dairy products poultry and eggs, miscellaneous livestock products
i2.	Feed grains	Corn, oats, barley and grain sorghums
i3.	Food grains	Wheat, rice, rice and buckwheat
i4.	Forage crops	Hay, pasture and grass and legume seeds
i5.	Vegetables and fruit	Vegetables, fruit and nuts
i6.	Cotton	Cotton lint and cottonseed
i7.	Tobacco	Unmanufactured tobacco
i8.	Oil crops	Soybeans, peanuts, flaxseed and tung nuts
i9.	Miscellaneous agriculture	Sugar crops, miscellaneous crops, forest nursery and greenhouse products. Horse and mule services and agricultural services

products (e.g. bananas and coffee). In the Government sector payments for government services (taxes) are considered as outputs and inputs are the goods and services bought by the government from other sectors. A third component is inventory where net increases to stocks render inventory a purchaser, and net decreases, a supplier of goods. Inventories for agricultural sectors include those in producing sectors, belonging to the CCC and to others held by private

Table 3. National industry sectors and their components

Sector	Commodity group	Components of group
0.10	Meat and poultry processing	Meat packing and prepared meats, products from poultry dressing plants and poultry products with minor processing
0.11	Dairy products	Creamery butter, natural cheese, concentrated milk, ice cream and ices, special dairy products and fluid milk
0.12	Grain processing	Flour and meal, cereal preparations, rice cleaning and blended and prepared flours
0.13	Prepared feeds	Livestock feeds
0.14	Miscellaneous food processing	Miscellaneous food preparations, beverages, bakery and related products, confectionery and related products
0.15	Vegetable and fruit processing	Canned and frozen fruits and vegetables, fruits and vegetables with minor processing
0.16	Tobacco	Cigarettes, cigars, chewing and smoking tobacco, and tobacco stemming and redrying
0.17	Textile products	Woolen and worsted manufacturing, cotton and rayon textiles, carpets, rugs and miscellaneous textile goods
0.18	Fertilizers	Fertilizers and fertilizer mixing
0.19	Chemical products	Chemicals, paints and varnishes, soaps and related products, drugs and medicines, vegetables and animal oils
0.20	Machinery and related services	Tractors, farm machinery, motor vehicles and related services
0.21	Petroleum products	Gasoline, oil and grease

Table 3. (Continued)

Sector	Commodity group	Components of group—
0.22	All other industries	Includes all other products not listed above. The major products purchased by agriculture were wholesale and retail trade, transportation, veterinary services and miscellaneous supplies

industry. National industries include only finished goods sold by the producing sector.

In the household sector, purchasers are the private individual expenditures for goods and services, excluding only those costs of farm operation. Household flows to other sectors are factor payments, including wages and salaries, income of proprietors, depreciation and miscellaneous items.

Mathematical Formulation of the Model

In this section a mathematical summary of the model is given. The production of each sector is distributed to some or all of the other producing sectors and to final demand. Let k and s denote regions, i and j denote commodity groups within regions, and h and r denote national industries. The allocation of outputs X_i^k and X_h to any commodity sector j in region s to industry r and to final demand can be shown as follows

$$X_i^k = \sum_s \sum_j x_{ij}^{ks} + \sum x_{ir}^k + Y_i^k$$

$$X_h = \sum_s \sum_j x_{hj}^s + \sum x_{hr} + Y_h \qquad (4)$$

where $i,j = 1, 2, \ldots\ldots\ 9$ $\qquad h,r = 10, 11 \ldots\ldots 22.$

and $\quad k,s = 1, 2, \ldots\ldots 10.$

Thus X_4^6 signifies the output of forage crops (sector 4) in the Delta States (Region 6); x_{21}^{42} signifies the value of feed grain production from the Appalachian region absorbed by livestock in the Corn Belt; Y_5^6 is the final demand level for fruit and vegetables in the Delta States.

We can obtain input-output coefficients which are assumed constant in the static model. The relation can be shown as follows:

$$x_{ij}^{ks} = a_{ij}^{ks}\, X_j^s \qquad\qquad x_{ir}^k = a_{ir}^k\, X_r$$

$$x_{hj}^s = a_{hj}^s\, X_j^s \qquad\qquad x_{hr} = a_{hr}\, X_r$$

which can be substituted into Equations 4 to obtain

$$X_i^k - \sum_s \sum_j a_{ij}^{ks}\, X_j^s - \sum_r a_{ir}^k\, X_r = Y_k^k$$

$$X_h - \sum_s \sum_j a_{hj}^s\, X_j^s - \sum_r a_{hr}\, X_r = Y_h$$

where $i,j = 1, 2 \ldots\ldots\ 9$ $\qquad h,r = 10, 11 \ldots\ldots 22.$

and $\quad k,s = 1, 2 \ldots\ldots 10.$

or in matrix form,

$$\left[I - A\right] \left[X\right] = \left[Y\right]$$

can be solved to obtain the relation between levels of final demand for each sector and the required output of each sector, as follows:

$$X_i^k = \sum_s \sum_j A_{ij}^{ks} \; Y_j^s + \sum_h A_{ir}^k \; Y_h$$

$$X_h = \sum_s \sum_j A_{hj}^s \; Y_j^s + \sum_h A_{hn} \; Y_n$$

where the A's are the interdependence coefficients, the elements of the input coefficient matrix in . This can be expressed in matrix form:

$$\left[X\right] = \left[I - A\right]^{-1} \left[Y\right]$$

Both relations are used in this study. By specifying final demands and constant input-output coefficients the set of equations can be used to solve for the required outputs. These outputs measure the direct effects of final demands on output levels. Using the set of equations the direct, indirect and circular effects can all be calculated in total. In most analytical applications of input-output analysis, the interdependence coefficients are used with predicted levels of final demand for all sectors, and the equations are used to predict sector output. This study considers some variations of this procedure in an effort to obtain the best for the given task.

Input-output studies can be broadly divided into two categories, those which obtain the structural relations and those involving projections and predictions. Many studies include both aims, and particular studies may be allocated to one or the other on the basis of the relative emphasis desired for each aim. This study can be considered as a predictive study, but it also provides structural insights by the use of technical and inverse matrices.

The principal handicap for prediction here is the unavoidable use of a model with outdated information. Unfortunately, there are no tests of accuracy for the results, a failing common to all structural analyses at present.

Method 1

Method 1 involves the specification of some outputs and some final demands, equal in total number to the number of equations.

The general solution for a problem in input-output analysis where some of the output and final demand levels are specified can be stated as follows.

Let us assume a 4 x 4 input-output matrix where two output levels and two final demand levels are specified. For the moment, we will consider the problem using the matrix of interdependence coefficients. The system of equations is set out below. For ease of explanation, we also assume that the final demands specified are not for those sectors in which the output levels are specified. We will assume an equilibrium situation where, for a certain given set of prices and production coefficients, output satisfies demand for all industries. We also assume constant coefficients.

$$
\begin{array}{c|c}
(1) & (2) \\
X_1 = A_{11}Y_1 + A_{12}Y_2 & + A_{13}Y_3 + A_{14}Y_4 \\
X_2 = A_{21}Y_1 + A_{22}Y_2 & + A_{23}Y_3 + A_{24}Y_4 \\
\hline
X_3 = A_{31}Y_1 + A_{32}Y_2 & + A_{33}Y_3 + A_{34}Y_4 \\
X_4 = A_{41}Y_1 + A_{42}Y_2 & + A_{43}Y_3 + A_{44}Y_4 \\
(3) & (4)
\end{array}
$$

We now allow the outputs of industries 1 and 2 (X_1 and X_2) to be changed and specified at a new level and the final demands for industries 3 and 4 to be specified. The aim is to measure the effects of changing and specifying the output levels on the level of output of sectors 3 and 4 (X_3 and X_4) and on the levels of the unspecified final demands of industries 1 and 2 (Y_1 and Y_2). The insertion of the numerical values of the specified sectors into the equations some simplifications of the problem is possible for finding a solution. The matrix can be partitioned into four sub-matrices, as shown. It can be seen that all values are known in sub-matrices 2 and 4 and the terms collapse to a constant. In the first two equations these can be combined with the specified values of X_1 and X_2 to form two new constants. These two equations are now in a form which will permit the values of Y_1 and Y_2 to be determined by inversion. Once found these can be substituted into the third and fourth equations and the values of X_3 and X_4 can be calculated. The difficulty in finding a solution increases with the size of the sub-matrix to be inverted.

Analogously, a solution can be found using the technical coefficients which measure only the more direct effects. We use the set of equations given by the matrix form:

$$\left[I - A\right] \left[X\right] = \left[Y\right]$$

Actually, the specification of both the output and final demand levels for one sector or more does not engender any additional difficulties.

Mathematically, a solution to this type of problem can be found provided firstly that the matrix is non-singular, and secondly provided that the number of unknowns equals the number of equations. The less correlation that exists in the system, the easier it will be to find a solution. Thus, since no mathematical restrictions prevent a solution being obtained, the choice of which outputs and final demands to specify can be wholly guided by economic desirability in terms of the program to be analyzed.

When the sub-matrix is inverted, values are obtained for all unknown final demands. These values, however, are found to make no economic sense whatsoever in relation to the 1954 situation expressed by the whole model, although mathematically, the procedures and actual calculations are sound.

The reason for such results lies with the nature of the general equilibrium system we use. In our case, all parts of the economy are interdependent within the system. Thus, if the whole economy is in equilibrium, each part will also be so. The reverse, however, is unlikely to hold true under these conditions. If a particular part of the economy is selected and an equilibrium situation is obtained for this part alone, it does not necessarily mean that the whole system is in equilibrium.

The procedure of selecting part of the system for attention actually assumes its independence from the rest of economy. In our case, this is not justified. At the same time as we partition the whole system and we manipulate the submatrix, results are desired which have economic meaning in terms of the whole system. The two are contradictory, unless the part of the economy selected is in fact, independent, i.e., the parts of the economy are independent and their functioning is additive. As explained above, this does not hold in this case. Hence, the results obtained have economic meaning only in terms of the subsystem selected. This explains why they have no meaning in terms of the whole economy, i.e., the 1954 model which is used. As a result, this approach has to be discarded.

Method 2

Method 2 is simpler than the above method. Once again, the matrix of technical coefficients is employed to calculate the direct effects while the interdependence matrix is used for the calculation of total effects.

Direct effects

Direct effects can be considered in two categories which we call "pull" and "push" effects.

"Pull" effects are the effects caused in industries supplying inputs to those industries initially affected in the program. They are obtained by multiplying the change in output for a sector by each coefficient (a_{ij}) in the column of input coefficients representing the production process of that sector. Each calculation gives the changes in outputs required for that sector's input-supplying industries. If these changes for the input-supplying industries are summed for sectors affected initially by the program, the total direct effects are obtained.

To generalize this explanation, if the change in output for a sector $_j$ is denoted by ΔX_j, the effect on any input-supplying industry X_i is given by

$$\Delta X_i = a_{ij} \Delta X_j$$

The change expressed as a percentage of total output of that input-supplying industry is given by $\frac{a_{ij} \Delta X_j}{X_i}$ expressed as a percentage.

If there are n industries affected by the program, then the total direct effect on industry i supplying inputs to these, expressed in dollar terms, is given by the expression

$$\Delta X_i = \sum_{j=1}^{n} a_{ij} \Delta X_j$$

For the economy as a whole, the sum of the direct "pull" effects is given in dollar terms by the expression

$$\Delta X_t = \sum_{i=1}^{m} \Delta X_i = \sum_{i=1}^{m} \sum_{j=1}^{n} a_{ij} \Delta X_j$$

where m input-supplying industries are affected by the changes in output of n industries and where X_t is the total output of the economy in a given time period.

"Push" effects are forward effects caused by a change in output of a sector initially affected by a program. They are the changes caused in the output of sectors dependent on the inputs from the sectors initially affected. In reality, the extent of the change caused this way must depend on the importance of the sector initially affected as an input to dependent industries. It is also dependent on the time period over which the effects are considered.

At one extreme, the degree could vary from pure scale effects where the percentage change in the inputs to an industry using these inputs causes the same percentage change in the output of that industry. At the other extreme, it might be of such minor importance as an input to an industry that it would cause a negligible change in its outputs. A reduction in an input could cause a similar absolute reduction in the output of the industry employing it. This, of course, means a less-than-scale effect. In input-output analysis, a scale effect is assumed, and in the analyses which follow, this assumption is adhered to.

Total effects

In order to calculate the total effects of initial changes in output in sectors of the economy, these initial changes are translated into changes in the values of final demand sectors. These final demands are so altered that when the model is applied, the correct output changes in sectors initially affected are generated. Since total effects are being measured, the calculated outputs will also reflect the intrasector direct and indirect effects as well.

The principal problem in using this method is in anticipating or ensuring the correct changes in final demand sectors.

This first requires detailed knowledge of which final demand sectors in the model will be altered by the initial output changes. It then ensures the correct changes in output when the model is used.

In general, if a program requires initial changes in output in industry i to the extent ΔX_i, it may result in calculable changes in final demand levels for industries i and j (e.g., $\Delta_1 Y_i$ and $\Delta_2 Y_j$). The model is then applied, with final demand for industry i reduced by $\Delta_1 Y_i$ and for industry j by $\Delta_2 Y_j$, and the calculations show that the output of industry i is reduced at least by the amount ΔX_i. Actually, it should generally be reduced by an amount greater than ΔX_i which represents the added intrasector direct and indirect effects.

In order to apply this method, all final demands are specified either constant or at a level resulting from the consequences of changes in output of some sectors.

The relation, $X = A^{-1}Y$, is then used to obtain the whole array of outputs.

The use of a model with 1954 data introduces some special problems. If the effects of the land-retirement programs were measured through the 1954 model, and the results were related exclusively to the 1954 data, the value of the study would be limited to its methodological considerations. The practical significance of the results might be small since conditions have altered considerably since that time. The application of the technique in this study is therefore designed to afford the highest contemporary significance to the results possible.

To this end, 1960 data for the regional sectors are collected and the changes in the regional agricultural outputs are measured by applying the land-retirement programs to these data. The 1960 changes caused by the programs are expressed in percentage terms for all the affected sectors. These relative effects are then introduced to the 1954 data of the model and are introduced in 1954 absolute terms.

The model is then solved to obtain the absolute levels of output for all sectors. These figures are then compared with the original 1954 output and final demand levels for these sectors and the percentage changes are again calculated. It is then possible to apply these calculated changes to 1960 output levels to determine the absolute changes which would occur in these industries.

It should be noted that 1954 prices are used throughout, even in calculating the 1960 output levels for the agricultural sectors directly affected by the programs. The reason for this will be explained below.

Thus the method can begin and end with current data but use a method with historical data. The vehicle of transference between the 1954 model and current data is that of relative magnitudes. This transfer and retransfer cannot be carried out without some sacrifice of information, however. If the intersectoral relations were the same in 1954 as in 1960 no loss would occur, but for several reasons this is hardly likely.

In the first place the various sectors of the economy grow somewhat unevenly. This is principally due to the diverse rates of growth among final demands responding to changes in income and tastes over time. We can observe the effects of different growth rates among sectors on the relations between sectors in the following examples. We use a 2-sector model and its interdependence matrix, assuming fixed prices and technology.

Let

$$X_1 = 1.42\ Y_1 + 0.12\ Y_2$$
$$X_2 = 1.73\ Y_1 + 1.82\ Y_2$$

where X_1 is the output of sector 1, Y_1 is the final demand for sector 1, X_2 is the output of sector 2, Y_2 is the final demand for sector 2, and we define an equilibrium situation where for $Y_1 = 20$ and $Y_2 = 10$, $X_1 = 29.6$ and $X_2 = 32.8$. Now if we reduce X_1 by 10 percent and hold Y_2 constant we can solve for X_2 and Y_1.

$$26.6 = (1.42)\ Y_1 + (0.12)\ (10)$$
$$Y_1 = 17.92$$

so

$$X_2 = (0.73)\ (17.9) + (1.82)\ (10)$$
$$= 31.28.$$

This is a reduction of 4.63 percent in X_2 for the 10 percent reduction in X_1 and the assumed conditions with respect to Y_2. Thus a 1 percent fall in X_1 produces a 0.46 percent fall in X_2.

Let us now permit changes in the size of each producing sector such as might occur normally in time. These changes might occur in two ways:

(a) with proportional changes

(b) with different rates of change in sector size.

(a) We will assume a 10 percent growth in all sectors. It will easily be shown here that subsequently the same relation between a change in X_1 and the resulting change in X_2 will hold assuming the same conditions.

For a 10 percent increase in all sectors,

$$X_1 = 32.56 \qquad X_2 = 36.08$$
$$Y_1 = 22 \qquad Y_2 = 11$$

Now we permit a 10 percent fall in X_1 and holding Y_2 constant at 11 solve for Y_1 and X_2,

$$29.30 = (1.42)Y_1 + (0.12)(11)$$
$$Y_1 = 19.71$$
$$X_2 = (0.73)(19.71) + (1.82)(11)$$

$$X_2 = 34.41$$

The reduction in X_2 is again 4.63 percent which is the same relation between changes in X_1 and X_2 as shown before the growth. Thus we can say that if the sectors of the economy grow at exactly the same rate as each other, the degree of dependence between them will remain the same.

(b) We will now investigate the effects of uneven sector growth on the relationship. Let us assume the final demand for sector 1 increases by 100 percent and for sector 2 by only 50 percent over the original final demand levels. Now $Y_1 = 40$ and $Y_2 = 15$

$$X_1 = (1.42)(40) + (0.12)(15)$$
$$= 58.6$$
$$X_2 = (0.73)(40) + (1.82)(15)$$
$$= 56.5$$

These changes in final demand produce a 98 percent increase in X_1 and a 72 percent increase in X_2. Now we permit a 10 percent reduction in X_1 and holding Y_2 constant we solve for Y_1 and X_2.

$Y_2 = 15$ $X_1 = 52.74$ (90 percent of 58.6)

$$52.74 = (1.42)(Y_1) + (0.12)(15)$$
$$Y_1 = 35.87$$
$$X_2 = (0.73)(35.87) + (1.82)(15)$$
$$= 53.49$$

This represents a 5.3 percent reduction in X_2 and indicates an increase in the dependence of sector 1 on sector 2. The logic of this change is not difficult to understand. Since here we assumed a relatively greater growth in final demand for sector 1, this caused a greater development in the output of sector 1 than in industry 2 due to the large proportion of output which goes to the final demand of sector 1 and to the relatively low dependence of industry 1 on demand from sector 2. The output of sector 2 also depends on the level of final demand for the products of industry 1 (the coefficient 0.73). Since in our example the final demand for industry 1 grew faster than that of industry 2 the latter has now become relatively more dependent on industry 2 as an outlet for its products. Since under our assumptions Y_1 is not fixed it will vary with the change in X_1 we choose. Thus for the change in output for industry 1 we have assumed here (10 percent) the output of industry 2 is now more strongly affected through this greater dependence, i.e. the change in X_2 for a change in X_1 is increased as we noted in the example from 4.63 percent to 5.3 percent.

In the above argument it has been shown that sector growth arising through uneven changes in final demand sectors can change the relation. There is however more than one way this relation can be changed. Another important influence is technological change. Its effects primarily show up within an input-output system, changing the production processes which in the static model are assumed fixed. Thus the demands of industries for the product of any one industry will change over time as advances in techniques cause substitutions among inputs in processes. In terms of the above two-sector model, it is obvious that where technological progress renders industry 2 less dependent on the products of industry 1 as inputs, any change in output of X_1 ceteris paribus, will cause less change in the output of X_2; and vice versa, for greater dependency on other sectors, increased changes will result.

A third cause of change in the relation over time is the changes in the price structure in the economy. Since the technical and interdependence coefficients of the model are based on money values, the influence of changes in relative prices can become important. Price changes among products which are substitutes as inputs can of course change the value of coefficients. The effects of changes in the price structure of the economy on the relationships in which we are interested are complex and as yet this area remains relatively unexplored.

Perhaps some cautious generalisations could be included here to suggest the possible direction the relations between agriculture and the rest of the economy might take. Assuming that prices change and the terms of trade between agriculture and the rest of the economy move against agriculture and for the moment that no supply reaction occurs, since agricultural products as inputs become relatively cheaper their proportion of the total cost in agricultural processing industries falls, thus reducing the interdependence of these industries somewhat. The relation in which we are interested will therefore tend to decrease. Vice versa if the terms of trade move in favor of agriculture, the relation will become higher. With respect to the relation for agricultural input-supplying industries the reverse holds.

In connection with this study, the consequences of assuming constant prices are not overwhelming. If we were using only 1960 data they would be even less important. The land retirement programs which follow generally envisage prices maintained around the 1959/60 levels held under price support programs. Thus the removal of present government programs and the substitution of land retirement programs principally involve the reduction of market supply volume and the effects of price changes are minor by comparison.

Since we are forced to use 1954 data the consequences are more complicated. To the extent 1954 prices for individual commodities are greater or less than 1960 levels, the absolute income changes in the calculations will respectively over and underestimate those which could be expected using 1960 price levels. The degree of error from this source will be more fully explored for each program.

ANALYSIS OF LAND RETIREMENT PROGRAMS

The previous sections set out the model to be used and the procedure for obtaining a solution using the model. This section deals with the application of the model to two alternative land retirement programs, outlined and evaluated by J. A. Schnittker (59, pp. 21-32).

The Programs Compared

Before dealing with each program and its consequences in detail, the more salient features of these two programs are briefly compared.

Program 1 calls for land retirement which will produce a supply reduction sufficient to wipe out flows of agricultural products to CCC stocks. The program calls for the removal of acreage allotments and a return to the free market. Since supply reduction will only remove flows to the CCC no disturbance in the normal market channels will result. The 1959/60 price levels would be maintained.

The program principally requires land retirement in food grains, feed grains and in cotton. Slight reductions are also necessitated in oil crops and in other crops.

Program 2 can be regarded largely as an extension of Program 1. Similarity exists in that land retirement removes the production surplus which adds to stocks in both feed and food grains and in cotton. The extension arises in that this program requires an additional reduction in feed grain production sufficient to raise feed grain prices about 23 percent above 1960 levels. Therefore in this program the 1960 pattern of marketing is changed. Since feed grain production is lowered and prices are raised, the quantity of livestock production is reduced and consequently livestock processing and related industries are affected. In Program 1 only input-supplying industries are affected while in Program 2 they are more heavily affected and in addition agricultural processing industries are affected.

A difference between the two programs lies with the heavier reductions in feed grains in Program 2. Some substitution of wheat for feed grains occurs since the price of wheat is permitted to fall to feed grain prices.

There are differences in the regional impacts of these programs. Program 1 produces a pattern of retirement similar to acreage allotments in the 1950's. Heavy retirement occurs in the Plains regions. In Program 2 there is a heavy concentration in the Corn Belt and Lake States and there are less but still heavy reductions in the Plains states. Retirements in this program are evenly distributed regionally over the entire country.

To be effective both programs require that resources used in conjunction with the land retired be removed from production and not be permitted to be diverted to the remaining areas. With retirement on a part-farm basis, this requires specific clauses written into the farm program. It is easier to ensure if the retirement program is on a whole farm basis. In this case however other farm enterprises may be affected by the program. This study merely assumes that the diverted resources are not used on the remaining acreages.

Finally it is important to note here that in the analyses of the effects of both these programs, the effects are presented which will occur over a number of years since Schnittker envisages a gradual implementation, for instance between 1961 and 1965.

Program 1

Table 4 shows acreages harvested in 1960 and with retirements envisaged in Program 1 for the crops significantly affected. It can be seen that feed grains especially barley and grain sorghums, and wheat and cotton acreages are principally affected. Some retirements are necessary for flaxseed, rice and for soybeans. Retired land is moved into the Soil Bank while the Conservation Reserve is held at its level. Schnittker's plan to maintain 1959-60 prices in the market by land retirement involves removing acreage allotment controls. These were first imposed in 1953 in order to reduce the market supply of wheat, cotton and corn. Diverted land was used for other crops or was placed in the Conservation Reserve or later

Table 4. Acreages harvested in 1960 and with land retirement under Program 1

Crops	Acreage harvested	
	1960	With land retirement
	million acres	million acres
Corn	82.1	80.4
Oats	27.1	24.8
Barley	13.9	9.0
Grain sorghum	15.3	7.0
Total feed grains	138.4	121.2
Wheat	52.6	44.4
Cotton	15.5	14.4
Rice	1.6	1.4
Soybeans	23.6	23.0
Peanuts	1.4	1.4
Tobacco	1.1	1.1
Flaxseed	3.4	2.6
Hay	69.6	70.0
Sub-total (8 crops)	168.8	157.3
Total (12 crops)	307.2	278.5
Other crops	12.0	10.0
59 crops	319.2	288.5
Soil Bank	28.7	59.4
Grand total	347.9	347.9

in the Soil Bank.

The diversion to other crops raised production considerably, especially in feed grains and oil crops and in fact surplus problems already existing in these other crops were magnified.

Under the land retirement program, the acreages calculated for each crop require:

(1) that these acreages diverted from wheat and cotton be idled to prevent them from returning to production as in 1953, or from remaining in these other crops.

(2) that further acreages which have produced additions to stocks since 1953 be retired. These involve wheat and cotton. The retired acreages would be placed in the Soil Bank while the Conservation Reserve would be maintained at its 1960 level.

It should be noted that the program as such is operationally rather abstracted from reality and from the viewpoint of implementation, many further problems must be solved. It is likely, for instance, that in implementing the program some associated land would have to be taken out as well. This is obviously true if the retirement is on a whole farm basis. However this study is restricted to the stated program and is not concerned with such modifications as may be necessary to make it administratively feasible, important though these may be.

Acreage effects by regions

We now turn from the aggregate effects on acreages harvested to a more minute examination of the retirement program. The implications of Table 1 are now examined by crop and by region.

Acreages harvested for the major crops in Table 4 were obtained for the years 1953 to 1960 (76 and 77). By careful examination of the changes over this period it was generally possible to discern the reductions in acreage by states, induced by crop allotments in wheat and cotton and the direction of the diversions thus caused. It cannot be stated with certainty that the changes assumed here are quantitatively exact, there is no method which can ensure this, but it is felt that in most cases the direction of diversion and in a rough manner, the amounts transferred to other crops or away from crop production are faithfully reproduced.

Table 5 presents the details of regional retirements by crops in accordance with the program. Regional totals in the bottom row show that the heaviest total acreage impacts are in Regions 8, 7, 9 and in 2. In Region 8, the Northern Plains, there are heavy acreage reductions of grain sorghum, barley and wheat and also substantial reductions of flaxseed, oats and corn. For Region 9, the Mountain States, the principal reductions are in barley and in wheat. In the Southern Plains (Region 7) once again grain sorghum and wheat are emphasised with some cotton and barley as well.

In order to grasp how the regional figures in Table 5 were obtained it is necessary to further explain the diversions and the extra retirements noted above. Firstly there is the

Table 5. Retirement of acreage harvested by regions from the 1960 level under Program 1 (thousand acres)

Crop	Region										
	1	2	3	4	5	6	7	8	9	10	U.S. Total
Corn	155	604	330	---	---	---	---	350	65	171	1675
Oats	181	911	258	286	52	40	---	510	62	---	2300
Barley	42	60	---	28	---	---	494	1640	2003	668	4935
Grain sorghum	---	273	---	86	38	---	3816	3522	415	146	8296
Total feed grains	378	1848	588	400	90	40	4310	6022	2545	945	17206
Wheat	195	935	306	163	45	26	1023	3583	1376	548	8200
Rice	---	---	---	---	---	111	53	---	---	36	200
Rye	9	---	---	---	---	---	---	104	---	80	193
Buckwheat	13	---	---	---	---	---	---	---	---	---	13
Total food grains	217	935	306	163	45	137	1076	3687	1376	664	8606
Soybeans	---	150	60	110	60	160	---	60	---	---	600
Flaxseed	---	---	---	---	---	---	---	770	---	---	770
Total oil crops	---	150	60	110	60	160	---	830	---	---	1370
Cotton	---	29	---	63	144	233	489	---	43	65	1066
Regional totals	595	2962	954	736	339	570	5875	10539	3964	1714	28248

retirement of acres diverted from wheat and cotton. By referring to the levels of acreage by crops and States over the period 1953-1960 it proved possible to obtain a reasonably accurate picture of the direction of diversion from both wheat and cotton. The extent of acreage enlargements of other crops is the retirement necessary to prevent any return to these crops. Table 2 includes these retirements by crops and regions. Because of the diversion from wheat, heavy reductions in feed grains are necessary, particularly in barley and grain sorghum. These reductions fall most importantly on the Southern Plains (Region 7), the Mountain States (Region 9) and the Northern Plains (Region 8). Less important reductions in corn acreage are required, centered in the Corn Belt (Region 2) and the Lake States (Region 7) and in the Northern Plains (Region 8). Small reductions in rye are required, mainly in the Northern Plains and the Pacific States. Flaxseed acreage is reduced in the Northern Plains and a minor amount of buckwheat must be removed.

The other major crop diversion was to reduce cotton production. Before the 1953 acreage allotments were imposed about 24 million acres of cotton were harvested. The allotments diverted 8 to 9 million acres away from production. Schnittker estimates that at 1959 prices with no allotments, approximately 5 million acres would return to cotton production and therefore must be retired. Table 5 also includes the consequences of retiring these 5 million acres for other crops. From the records of crop production since 1953 it appears that much of this land went out of production but a substantial proportion was planted to soybeans. In the intervening years, oats production has become relatively less profitable and it is assumed here that the necessary retirement occurs in oats acreage, while soybean acreage is little reduced. Retirement of acreage diverted from cotton to grain sorghum is required in the Southern Plains, Mountain and Pacific States together with a smaller amount of barley in the Pacific States (Region 10).

The other important source of land retirement in this program is the extra land which, since 1953, has added to stocks of wheat and cotton. An additional 1.1 million acres of cotton has to be retired from the 1960 level. This is distributed according to regional production in 1960, falling heavily in the Delta States (Region 6), the Southern Plains (Region 7) and the Southeast (Region 5). Another 8.2 million acres of wheat must also be removed and this is distributed as shown in Table 2. A heavy concentration is apparent in the Plains areas and in the Mountain States.

With this full determination of the acreage implications of the program by crops and regions we can turn to the direct gross output consequences for the producers of these crops.

Gross output implications for agricultural producers

The value of gross output was calculated for all directly affected sectors using 1960 acreages and yields by States (76) and 1954 prices. The acreages to be retired were multiplied by the 1960 average yields and 1954 prices (77) to obtain the gross output value of the retirements by crops in each State. These figures were aggregated to obtain the regional totals by crops and by sectors i.e. for feed grains, food grains, cotton and oil crops. Each was then expressed as a percentage of the 1960 gross output value for that sector by regions. Tables 6 to 9 show the results of these calculations.

Table 6 presents the gross output effects on feed grain output (Sector 12) by Regions ($i = 1, 2, \ldots, 10$). Overall the land retirement program reduces gross output of feed grain producers by 797.1 million dollars or 9.5 percent below 1960 levels. The column for the sum of effects within each region shows Region 8, the Northern Plains to be most heavily affected with a 264.6 million dollar reduction or 18 percent of 1960 feed grain output value. This region is followed by Region 7, the Southern Plains with a reduction of around 200 million dollars which amounts to 40.6 percent of 1960 gross output from feed grains in that region. Despite a low percentage fall from 1960 levels (2.9 percent), Region 2, the Corn Belt shows an important reduction of a little over 100 million

Table 6. Initial effects of retirement on gross output from feed grains by regions in Program 1

Crop	Gross output	Region 1.2	2.2	3.2	4.2	5.2	6.2	7.2	8.2	9.2	10.2	Total
Corn	1960 gross output	272.5	3324.8	839.6	454.2	309.2	88.0	56.1	833.8	66.2	48.9	6293.3
	Gross output reduction	14.4	55.8	23.6	---	---	---	---	20.6	5.1	22.9	142.4
	Percent reduction from 1960	5.3	1.7	2.8	---	---	---	---	2.5	7.7	45.9	2.3
Oats	1960 gross output	53.4	267.1	231.3	15.1	17.1	13.2	32.6	152.2	18.1	15.0	815.1
	Gross output reduction	6.9	29.6	8.6	8.3	1.5	1.5	---	12.3	1.7	---	70.4
	Percent reduction from 1960	12.9	11.1	3.7	55.2	8.5	11.4	---	8.1	9.3	---	8.6
Barley	1960 gross output	14.1	11.1	36.8	11.9	1.4	0.7	23.9	124.4	102.1	126.0	452.4
	Gross output reduction	1.8	2.0	---	1.0	---	---	11.4	43.1	62.0	29.7	151.0
	Percent reduction from 1960	12.7	17.9	---	8.6	---	---	47.5	34.7	60.7	23.6	33.4
Grain sorghum	1960 gross output	---	35.2	---	8.5	2.5	1.7	376.1	324.2	29.5	26.1	803.8

Table 6. (Continued)

Crop	Gross output	Region 1.2	2.2	3.2	4.2	5.2	6.2	7.2	8.2	9.2	10.2	Total
Grain sorghum	Gross output reduction	---	17.6	---	4.6	1.3	---	187.2	188.6	19.3	14.7	433.3
	Percent reduction from 1960	---	49.8	---	54.4	52.1	---	49.8	58.2	65.5	56.2	53.9
Total feed grains	Gross output reduction	23.1	105.0	32.3	13.9	2.8	1.5	198.6	264.6	88.1	67.3	797.1
	Percent reduction from 1960	6.8	2.9	2.9	2.9	0.8	1.4	40.6	18.4	40.8	31.1	9.5

Table 7. Initial effects of retirement on gross output from food grains by regions in Program 1 for 1960 (million dollars)

Crop	Gross output	Region 1.3	2.3	3.3	4.3	5.3	6.3	7.3	8.3	9.3	10.3	Total
Wheat	1960 gross output	60.9	369.7	127.4	49.6	14.1	14.4	444.8	1204.5	404.2	210.7	2900.3
	Gross output reduction	11.7	59.5	18.6	8.6	2.7	2.9	53.4	194.4	65.8	37.2	454.8
	Percent reduction from 1960	19.2	16.1	14.6	17.3	19.1	19.5	12.0	16.1	16.3	17.7	15.7

Table 7. (Continued)

Crop	Gross output	Region 1.3	2.3	3.3	4.3	5.3	6.3	7.3	8.3	9.3	10.3	Total
Rice	1960 gross output	---	---	---	---	---	121.9	64.0	---	---	60.6	246.5
	Gross output reduction	---	---	---	---	---	15.1	8.3	---	---	7.6	31.0
	Percent reduction from 1960	---	---	---	---	---	12.4	12.9	---	---	12.5	12.6
Rye	1960 gross output	2.4	4.1	2.6	1.7	1.0	---	1.5	20.9	2.5	3.2	39.9
	Gross output reduction	0.3	---	---	---	---	---	---	2.7	---	2.1	5.1
	Percent reduction from 1960	12.0	---	---	---	---	---	---	12.8	---	65.6	12.8
Buck-wheat	1960 gross output	0.7	0.1	0.3	0.1	---	---	---	---	---	---	1.2
	Gross output reduction	0.3	---	---	---	---	---	---	---	---	---	0.3
	Percent reduction from 1960	38.2	---	---	---	---	---	---	---	---	---	25.0
Total food grains	Gross output reduction	12.3	59.5	18.6	8.6	2.7	18.0	61.7	197.1	65.8	46.9	491.2

Table 7. (Continued)

Crop	Gross output	1.3	2.3	3.3	4.3	5.3	6.3	7.3	8.3	9.3	10.3	Total
Total food grains	Percent reduction from 1960	19.1	15.2	14.3	16.7	17.8	13.2	12.1	16.1	16.2	17.1	15.4

Table 8. Initial effects of retirement on gross output from cotton by regions

Region	1960 gross output	Gross output reduction	% reduction from 1960
	million dollars	million dollars	
1.6	---	---	---
2.6	90.3	6.3	7.0
3.6	---	---	---
4.6	163.6	11.4	7.0
5.6	332.4	23.3	7.0
6.6	665.8	46.6	7.0
7.6	901.9	62.7	7.0
8.6	---	---	---
9.6	223.0	15.6	7.0
10.6	373.6	26.2	7.0
Total	2750.7	192.1	7.0

dollars. Other important reductions are required in Regions 9, 10 and 1 while in the Appalachian States (Region 4), the Southeast (Region 5) and the Delta States (Region 6) output levels are left relatively unaffected by the program.

The bottom row shows the relative importance of the retirement in each crop on gross output. Reduction of 433.3 million dollars marks grain sorghum output reduction as the most important regional reduction, followed by barley and corn, each less than half as important, then by oats only

Table 9. Initial effects of retirement on gross output from oil crops by regions for 1960

Region	Soybeans			Flaxseed			Total oil crops[a]	
	1960 gross output	Gross output reduction	% reduction from 1960	1960 gross output	Gross output reduction	% reduction from 1960	Gross output reduction	% reduction from 1960
1.8	30.7[b]	---	---	---	---	---	---	---
2.8	863.9	9.4[b]	1.1	0.8[b]	---	---	9.4[b]	1.1
3.8	112.5	2.8	2.5	23.9	---	---	2.8	2.1
4.8	85.6	6.6	7.7	---	---	---	6.6	4.2
5.8	35.9	2.9	8.2	---	---	---	2.9	2.2
6.8	192.7	9.0	4.7	---	---	---	9.0	4.6
7.8	11.0	---	---	3.2	---	---	---	---
8.8	44.9	3.0	5.9	63.2	18.4[b]	29.1	21.4	18.9
9.8	---	---	---	0.8	---	---	---	---
10.8	---	---	---	3.2	---	---	---	---
Total	1382.2	33.7	2.4	163.9	18.4	11.2	52.1	11.9

[a]Total oil crops from which this column is calculated includes the 1960 gross output from peanuts and tung nuts neither of which were appreciably affected by the program.

[b]Millions of dollars.

half as important again. In absolute dollar terms the most important regional output reductions for each crop occur in a pattern parallelling the size of acreage reductions described in Table 5.

Table 7 shows the retirement effects on food grain output by Regions. Wheat retirement (454.8 million dollars) is obviously the most important component with its principal impacts on Regions 8, 9, 7 and 2. Percentage reductions in regional gross output varied between 12 percent (Southern Plains) and 19 percent (North-Eastern States). In absolute terms, regional gross output reductions varied from 2.7 million dollars showing the negligible impact on areas such as the Southeast (Region 5) to 197.1 million dollars in the Northern Plains where the percentage change was a median 16 percent. Other importantly affected regions are the Mountain States, Southern Plains, Pacific States and the Corn Belt. Total absolute reduction amounts to nearly 500 million dollars which is around 15 percent of the 1960 total gross output value in 1954 price terms.

The gross output consequences of the extra acres retired for the cotton industry are shown by Regions in Table 8. The most important reductions are in the Southern Plains (62.7 million dollars), the Delta States (46.6 million dollars) the Southeast (23.3 million dollars) and the Pacific States (26.2 million dollars). The 7 percent overall reduction in acreage reduces gross output by 192.1 million dollars below the 1960 level.

Finally the effects of Program 1 on regional gross output from oil crops are shown in Table 9. A reduction of 52.1 million dollars occurs over the 10 regions which amounts to

11.9 percent of 1960 total gross output. Region 8, the Northern Plains exhibits the highest reduction (21.4 million dollars) due to the concentration of flaxseed retirement there. The value of flaxseed retired amounts to 29.1 percent of 1960 flaxseed output in that region. Soybean retirement in Region 2 (Corn Belt) and 6 (Delta States) also produce substantial reductions. Of the two oil crops involved, soybean retirement produces the most important effects (33.7 million dollars).

Calculation of direct and total effects

We now have the percentage initial reductions in output from 1960 in each of 10 regions for 4 agricultural sectors, giving a total of 40 regional outputs affected by Program 1. These reductions are given in the last row of Tables 6 and 7 and in the last column of Tables 8 and 9. They provide the connecting link with the model. The 40 percentage changes are applied to the 40 outputs in the 1954 model for the corresponding sectors and regions to obtain the absolute amount of these percentage changes in 1954 terms. It is the effects of these changes on related sectors which are measured by the model.

These output level changes are used in two ways to measure the effects on related industries. First, in order to measure the direct effects on other industries, the matrix of technical coefficient is employed and the direct output effects are summed for each industry.

Second, the interdependence matrix is utilized to obtain the total effects of these output changes.

In order to do this the final demand levels are specified, and in Program 1 this is comparatively simple. Regional final demands contain the amounts going to CCC storage and since the reduction of them to zero is the only effect of the program, the 40 final demands of the 40 agricultural sectors initially affected by the programs can be specified by subtracting the sector output changes in 1954 terms from the 1954 final demand levels by regions. The other 63 final demand levels remain the same since markets remain undisturbed and so they are specified at their 1954 level in the model.

Results

Direct effects The use of the technical coefficients and the changes in output in the 40 agricultural sectors required by the land retirement provide the direct effects of the program on related industries. These effects are presented in Table 10.

Among agricultural sectors, Table 10 shows that the direct effects are limited. It should be noted here that the direct effects in Table 10 do not include the initial effects on the 40 sector output levels generated by the program.

Table 10. Direct reducing effects of Program 1 on input-supplying industries for 1954

Sector	Absolute reduction (million dollars)	Percentage of 1954 output
A. Agricultural		
i.2 Feed grains	17.34	0.27
i.3 Food grains	26.53	1.17
i.4 Forage crops	2.95	0.12
i.6 Cotton	1.46	0.04
i.8 Oil crops	3.23	0.29
i.9 Miscellaneous agriculture	57.62	2.84
Total agriculture	109.13	0.27
B. Nonagricultural		
0.18 Fertilizers	36.72	4.12
0.19 Chemical industries	5.34	0.03
0.20 Machinery and services	207.54	0.56
0.21 Petroleum products	39.26	0.32
0.22 All other industries	277.16	0.07
Total nonagriculture	566.02	0.11
Total all industry	675.15	0.06

They show only the immediate or first-round effects of the 40 changes on related industries. In absolute 1954 terms, effects on the miscellaneous agriculture sector are the most substantial. These changes mainly involve reductions in agricultural services to the feed and food grain sectors, e.g., for corn shelling and combining of small grains. There is an over-all reduction of 2.84 percent in these services. Among regions the reductions are fairly evenly distributed except for the Northern and Southern Plains where, as might be expected, the reductions were (about 8 percent) higher. The direct effects on feed and food grain, cotton and oil crops, shown in Table 10, are due to the reduced intrasection requirements of each when their outputs are reduced. Total direct effects are 109 million dollars for agriculture. This amounts to only 0.27 percent of total 1954 agricultural output.

The more important direct effects are the "pull" effects on nonagricultural industries. Since the program does not disturb marketing volume or the pattern of marketing, the direct effects are all on the industries supplying inputs to the affected agricultural sectors.

The fertilizer industry is most affected in percentage terms. It suffers a 4 percent reduction in output, amounting to 1954 terms to 36.7 million dollars. In 1954 absolute terms, the reduction in output in the machinery and services sector of 207.5 million dollars is substantial although as a percentage of sector output, it is minor (6.6 percent). The output reduction in the sector containing all other industries is also sizeable. The high aggregation in this sector clearly leads to a loss of information here. The principal components affected are probably transportation costs, margins for wholesale and retail associated with inputs to agriculture, lime, and repair and operation of capital items. Output reductions in the petroleum products and chemical industries are relatively minor insofar as direct effects are concerned.

In total, the direct effects on nonagricultural sectors are about 566 million dollars or 0.11 percent of 1954 gross output generated outside agriculture. This total change is about 6 times greater than that calculated for agriculture. The all-industry total for direct effects is an imposing 675 million dollars which, however, is only 0.06 percent of total national output for the year 1954.

<u>Total effects</u> The use of final demand levels and the interdependence coefficients permit the sum of the original output deductions caused by the land retirement, the direct effects measured above and the indirect and circular effect on each sector to be measured. The sum of these represents the total effects of the land retirement program under consideration.

Table 11 presents the total effects of Program 1 on all agricultural sectors by regions. The most important changes naturally occur in those sectors initially affected by the land retirement. The subtraction from the percentage reduction shown by sector and region in this table, of the equivalent percentage reductions in output in Tables 6, 7, 8 and 9 show the added direct, indirect and circular effects produced by the intrasector relationships existing in 1954. The comparison shows with almost universal consistency that the direct and indirect effects cause further reductions. The few exceptions may well be due to inaccuracies in the coefficients of the model or to some computational errors.

For feed grains the increases vary from an additional 0.1 percent of output in Region 5 (Southeast) to 2.7 percent in Region 9 (Mountain States). In food grains the increases range from around zero in Region 3 (Lake States) to 10.4 percent in the Southeast with an average of about 1.5 percent. Cotton increase average about 0.1 percent. Total sectoral income changes show expected percentage increases except for feed grains.[1]

---

[1]Feed grains show a slight lower percentage cut for total effects than is shown for initial effects in Table 6. This because when the regional percentage cuts in Table 6 are applied to the 1954 regional pattern of output, which is different from the 1960 pattern, a slightly different cut in total national feed grain production results of 8.5 percent. Actually the 9.0 percent reduction shown for total effects in Table 11 provide somewhat the expected increase in reduction over the 8.5 percent initial effect for 1954.

Table 11. Total reducing effects of Program 1 on related agricultural industries from 1954 levels

Sector	Region 1	2	3	4	5	6	7	8	9	10	Sector total
i.2 Feed grains											
Million dollars	21.2	87.6	87.6	12.8	2.5	2.9	114.9	173.3	69.3	59.2	566.4
Percent of 1954 output	7.2	3.2	2.4	3.4	0.9	2.6	42.4	18.8	43.5	33.2	9.0
i.3 Food grains											
Million dollars	17.7	61.1	12.6	10.2	3.5	16.2	40.2	132.3	52.7	51.0	397.5
Percent of 1954 output	21.9	16.3	14.1	18.7	28.2	14.1	13.5	17.8	17.2	17.9	16.9
i.6 Cotton											
Million dollars	---	6.0	---	18.2	35.1	65.6	70.8	---	20.8	27.0	243.5
Percent of 1954 output	---	7.0	---	7.2	7.0	7.1	7.2	---	7.1	7.1	7.1
i.8 Oil crops											
Million dollars	+0.4	21.7	4.2	4.0	---[a]	1.9	0.6	22.8	1.0	+0.7	55.1
Percent of 1954 output	+3.7	3.5	3.0	4.4	---	4.4	3.3	20.2	36.4	+17.5	5.0
i.9 Miscellaneous agriculture											
Million dollars	2.5	1.4	3.9	5.7	4.3	6.7	13.9	12.3	9.6	5.6	65.9
Percent of 1954 output	0.9	0.5	2.2	2.8	2.2	4.5	8.5	8.6	5.7	2.0	38.5

[a]The effects of Program 1 on sector 5.8 were assumed to be zero. The calculations indicate an increase in output despite a small reduction in output due to the program. It is thought that the original interdependence coefficients are slightly in error so the calculated change is not included. The other small positive changes in the model also appear to be due to inaccuracies in the interdependence matrix of coefficients.

Table 11. (Continued)

Sector	Region 1	2	3	4	5	6	7	8	9	10	Sector total
Others											
Million dollars	1.9	2.7	10.5	1.4	3.9	0.8	3.8	5.6	4.8	3.1	38.5
Percent of 1954 output	0.1	---	0.4	0.1	0.2	0.1	0.3	0.4	0.3	0.1	0.1
Regional total											
Million dollars	42.9	180.5	53.9	52.3	49.3	94.1	244.2	346.3	158.2	145.2	1366.9
Percent of 1954 output	1.1	1.8	1.3	1.4	1.8	4.5	7.8	8.1	6.1	3.6	3.3

Among other interrelated agricultural sectors, miscellaneous agriculture, which supplies services as explained above, show some important reductions due to total effects. Heavy absolute reductions in this sector appear for the Plains regions (Regions 7 and 8) and in the Mountain states (Region 9) while 2 percent reductions are common to other regions except for the Northeast and the Corn Belt (Regions 1 and 2) which are relatively less affected by the program. The other agricultural sectors are little affected even in total by this program.

The last 2 columns of Table 11 show the total regional impacts of Program 1. In percentage and absolute terms the Northern and Southern Plains and the Mountain states are most heavily affected. Substantial reductions in regional agricultural income arise in the Delta states (Region 6) and Pacific states (Region 10) while in percentage terms Region 1 to 5 are only lightly touched by the program.

The grand total for income reduction in agriculture comes to 1.4 billion dollars, some 3.3 percent of the total agricultural income for 1954. This is composed of 1,160 million dollars, the initial effects of the land retirement on the four sectors (feed and food grains, cotton and oil crops); another 109 million dollars is produced by the direct or first-round effects on all agricultural industries, and a further 98 million dollars is produced by the total of the indirect and circular effects on the agricultural sectors.

Table 12 provides details of total effects on nonagricultural industries. These figures are comparable to the direct effects on these industries shown in Table 10. The

Table 12. Total reduction effects of Program 1 on nonagricultural industries from 1954 level

Sector		Absolute reduction (million dollars)	Percentage of 1954 output
0.10	Meat and poultry products	38.0	0.2
0.11	Dairy products	2.9	0.0
0.12	Grain products	1.5	---
0.13	Prepared feeds	5.2	0.2
0.14	Miscellaneous food products	7.6	---
0.15	Vegetable and fruit products	1.0	---
0.16	Tobacco manufacturing	---	---
0.17	Textile products	18.9	0.2
0.18	Fertilizers	44.4	5.0
0.19	Chemical industries	50.6	0.3
0.20	Machinery and services	301.9	0.8
0.21	Petroleum products	56.9	0.5
0.22	All other industries	737.2	0.2
Total nonagricultural industries		1265.5	0.2
Total all industries		2632.4	0.3

most startling difference between the direct and total effects occurs in the chemical industries where output reduction rises from 5 to 51 million dollars. This appears to be due to heavy indirect and circular requirements since the interdependence coefficients are much higher than the technical coefficients. The difference between the percentage changes in 1954 output for direct and total effects which thus measures the heavy indirect effects, is 0.23 percent for this industry. Fertilizers show indirect and circular effects (reductions) of 7.7 million dollars or 0.85 percent, raising total effects to a substantial 5 percent of total income in the industry. The other input-supplying sectors show small percentage changes for total effects as for direct effects, but quite sizeable absolute reductions. The "All other industries" sector, for instance, shows a reduction of 737 million dollars which is 460 million dollars greater than the direct effects. This actually makes the indirect effects greater than the direct effects by 182.9 million dollars, but this is not surprising since the interdependence of non-agricultural sectors is high and the direct effects in non-agricultural industries produce further substantial indirect repercussions in these sectors. In 1954 absolute terms, this highly aggregated sector (All other industries) is the most affected, followed by the machinery and services industry (302 million dollars), and the petroleum industry (57 million dollars) and the fertilizer industry (44 million dollars).

Total effects on nonagricultural sectors include changes in output of agricultural processing industries (0.10 to 0.17). The direct effects are zero for these industries. In absolute 1954 terms, the substantial changes occur in the meat and poultry processing industry where a 38 million dollar reduction is necessary (which is however, only 0.23 percent of 1954 output) and in the textile industry (19 million dollars). These processing industries add 69 million dollars to total effects.

Table 13 summarizes the various effects of Program 1 on agricultural and nonagricultural industries. Total effects on nonagricultural industries amount to 1,266 million dollars which, however, is only 0.2 percent of total nonagricultural income for 1954. Of this, 566 million is the result of direct effects while a further 699.5 million dollars is due to in-

Table 13. Real income and multiplier effects of Program 1 on the economy for 1954

Industry sector	Initial effects, million dollars	Direct effects		Indirect effects, million dollars	Total effects	
		Million dollars	Multiplier		Million dollars	Multiplier
Agriculture	1,160	109	1.09	98	1,367	1.17
Nonagriculture	---	566	0.49	699	1,266	1.09
All industry	1,160	675	1.58	797	2,633	2.27

direct and circular effects on nonagricultural industries, a figure which noticeably exceeds the direct effects. This is apparently explained by the high interdependence in the nonagricultural industries. A comparison with the difference between the direct and the indirect and circular effects in the agriculture sector shows up the lower interdependence in agriculture. There, the indirect effects are a little less than direct effects.

The figures shown in Table 13 can be interpreted in terms of multiplier effects. The within-agriculture multiplier effect of the initial impact of the program (1,160 million dollars) is the ratio of total effect to initial effects within agriculture; this amounts to 1.17, if the operation of this program will generate further income reductions of 17 percent within agriculture.

The nonagricultural multiplier for the program is 1.09. This is an important figure. It implies that the land retirement program generates a roughly equal impact on nonagricultural industries, in a 1:1 relationship approximately. That is, a change of $1 in the initial effect of a program on agriculture generates an effect of roughly $1.10 in nonagricultural industries. Finally the sum of these effects give a total multiplier effect of 2.27 for the economy as a whole.

If the land retirement were implemented all at one point in time, we could regard the sum of the direct effects roughly as a short-run multiplier (1.6) while the sum of the total effects, which probably take longer to become apparent, could be considered as providing a measure of a long-run multiplier (i.e., 2.27). Since this program would be actually implemented gradually, it would be more difficult to discern the effects in this way. The total effects would appear over a much longer period of time and would be confounded with direct effects during this time.

If we assume that the 1954 interindustry relationships hold for 1960, the figures in Tables 6 to 9, showing the initial impact of the program on agriculture in 1960, permit the calculation of the effects on the economy in 1960 terms. Of the 3.5 billion dollar reduction in real national output, 44 percent is due to the initial effects of Program 1, 25 percent is generated by direct effects, and 30 percent arises from indirect effects. Most of both direct and indirect effects occur outside the agricultural sector. These effects are given in Table 14. The 1960 total initial impact of Program 1 is calculated from Tables 6 to 9 to be 1.5 billion dollars, which would produce total real income reduction in the economy of 3.5 billion dollars, of which one-half would be in agriculture and one-half in the nonagricultural sector. If in fact the interdependence within agriculture and between agriculture and the rest of the economy has increased since

Table 14. Real income effects of Program 1 on the economy for 1960

Sector	Initial effects million dollars	Direct effects million dollars	Indirect effects million dollars	Total effects million dollars
Agriculture	1,532	138	122	1,792
Nonagriculture	---	751	919	1,670
All industry	1,532	889	1,041	3,462

1956, we can expect the multipliers calculated here to be too low; the real income effects would be greater than those presented here. It should also be remembered that the 1960 figures use 1954 prices with 1960 quantities.

We have outlined above the impacts of Program 1 on the economy as measured in quantity or real income terms. As outlined by Schnittker, the program would envisage the government paying 60 percent of expected gross income from the land retired in order to make the program attractive to farmers. This would amount to over 900 million dollars or 60 percent of the 1960 initial effects of 1,532 million dollars on agriculture, shown in Table 14. The 60 percent covers unavoidable expenses of production, hence by adding this amount to variable expenses saved, farmers' normal living expenditures should not be disturbed unless there is a movement out of agriculture. The payments and the cost of continuing the Conservation Reserve are the Treasury costs of Program 1.

Total government costs probably amount to 1.5 billion per year. Since prices do not rise, final demands are maintained and the consumers are not affected in any way.

Program 2

The other land retirement proposal developed by Schnittker (59, pp. 28-32) forms the basis for the second program in this study.

The program aims to maintain the price of feed grains slightly above the level which existed in 1959/60 other grains and cotton prices. Regional impacts of retirement are obtained which closely parallel the distribution of production of feed grains, wheat and cotton.

The program can be described in two stages. The details are presented in Table 15. The first stage supposes that all acreage controls are lifted and present commitments under the Soil Bank are allowed to expire. Under these assumptions, harvested acreages of corn and oats rise somewhat while grain sorghum, flaxseed and barley acreages fall. Wheat acreage rises considerably, absorbing some land previously devoted to barley and grain sorghum and other land idled under the Soil Bank program. Cotton acreage also rises under these conditions and other crops such as soybeans, peanuts, tobacco and hay show some slight increase.

The second stage involves a 20 percent retirement of

Table 15. Comparison of acreage patterns for 1960, with no controls, under Program 2 (million acres)

Crop	Actual acreage in 1960	Estimated acreage with no controls or Soil Bank	Acreage under Program 2
Corn	82.1	85.4	68.0
Oats	27.4	28.5	24.0
Barley	13.9	12.0	9.6
Grain sorghum	15.3	12.0	9.6
Wheat	53.0	65.0[a]	53.0[a]
Cotton	15.5	18.0	14.4
Rice	1.6	1.6	1.4
Soybeans	23.6	24.0	24.0
Peanuts	1.4	1.9	1.4
Tobacco	1.1	1.2	1.1
Flaxseed	3.4	3.1	3.1
Hay	69.6	72.0	70.0
Total, 12 crops	307.9	330.8	279.6
Other crops	12.0	16.0	16.0
59 crops	319.9	346.8	295.6
Soil Bank	28.7	---	48.0
Grand total	348.6	346.8	343.6

[a]These figures are revisions to the originals estimated by Schnittker. They were suggested by Schnittker in private communication. 1960.

average quality land from this new level for feed grains, wheat and cotton over all regions, affecting each region according to the acreage level estimated for the situation with no controls or Soil Bank. Program 2 reduces output more than Program 1; it produces a different mix of grains and a different regional distribution of production.

The calculations for this Program which follow have used this procedure on a state, regional and crop basis. The acreage pattern resulting from the new retirement program is then compared with the 1960 pattern to observe the departures necessary for its implementation. As in the first program, the gross output consequences are calculated for the various agricultural sectors for use in the model.

Acreage effects by regions

The method used to obtain the regional acreage figures after retirement can be described in two stages. In the first place the regional distribution of crop acreages was calculated assuming no controls or Soil Bank. As a first approximation the 1960 acreages by States of each feed grain were increased by the estimated Conservation Reserve acres for 1960 as a percentage of total 1954 Census cropland acres (78, 80). Since price and acreage controls are assumed to be lifted some substitution will occur between barley and grain sorghums and wheat. The amount of substitution was calculated in the light of historical patterns since no better method was available. Increases in wheat acreage were judged to occur in Regions 2, 3, 7, 8, 9 and 10 at the expense of barley and grain sorghums. These changes reflect regionally the aggregate changes calculated by Schnittker as accurately as possible. Cotton acreage increases were assumed to occur in a pattern similar to the distribution of production by States in 1960. Hay acreage increases were ignored because of the special difficulties involved in estimating these changes. Since the estimated changes in hay output were small, the error thereby introduced is quite small. It should be noted however that the output effects are to this extent understated.

Table 16 presents the acreage reductions by regions from the 1960 level which are necessitated by Program 2. A total of 29 million acres must be retired. The emphasis falls more heavily on feed grains in this program, which represent 96 percent of the total retirements, as against 65 percent in Program 1. Among the feed grains, corn retirement of 13.8 million acres amounts to about half of the total figure. Reduction of cotton acreage remains the same as in Program 1. No wheat land is retired below 1960 levels in this program. The estimate of the increase in wheat acreage if controls are removed places the harvested acreage level at around 65 million acres. A 20 percent reduction from this level brings total acreage back to its 1960 level. Finally, a small reduction in rice acreage is also necessitated in this program. The important difference between the two programs is the exchange of wheat retirement in the first program for feed grain retirement in the second. This difference has important consequences for the distribution of acreage and output impacts among regions.

Table 16. Retirement of acreage harvested by regions from the 1960 level

Crop	Regions										
	1	2	3	4	5	6	7	8	9	10	U.S. total
Corn	505	6552	1714	1079	874	355	197	2316	103	66	13761
Oats	234	1493	1111	92	79	58	200	965	100	88	4420
Barley	57	106	232	57	4	3	331	1590	1169	792	4341
Grain sorghum	---	255	---	28	11	7	1989	3267	194	49	5800
Total feed grains	796	8406	3057	1256	968	423	2717	8138	1566	995	28322
Wheat	---	---	---	---	---	---	---	---	---	---	---
Rice	---	---	---	---	---	111	53	---	---	36	200
Total food grains	---	---	---	---	---	111	53	---	---	36	200
Soybeans	+9	+256	+48	+29	+14	+69	+21	+4	---	---	+450
Flaxseed	---	---	52	---	---	---	---	238	---	---	290
Total oil crops	+9	+256	4	+29	+14	+69	+21	234	---	---	+160
Cotton	---	29	---	63	144	233	489	---	43	65	1066
Regional totals	787	8179	3061	1290	1098	698	3238	8372	1609	1096	29428

The regional emphasis in this program can be gauged by the last row of Table 16. The Corn Belt (Region 2) and Lake States (Region 3) absorb over 11 million acres of the total retirement while the Southern and Northern Plains (Regions 7 and 8) absorb another 11 1/2 million acres. The rest of the retirement is spread fairly evenly over the regions. A brief comparison with Table 5 in Program 1 reveals the relatively heavy concentration within the Southern and Northern Plains in that Program. In Program 2 the increased importance of feed grains shifts part of the primary impacts away from the wheat producing areas.

The second step involved calculation of the 20 percent retirement of all feed grain acreages required by the Program. These were calculated by States for each crop according to the pattern of production resulting from the first step when controls are removed. Strictly speaking this two-stage procedure should also have been carried out for wheat although total acreage after retirement remains roughly the same as in 1960. This would show up any effects due to the redistribution of wheat acreage by States after controls are lifted. Since this effect was considered to be minor and any attempt to gauge such changes would be highly arbitrary, this calculation was not attempted. It might be stated though that the most likely distributional effects would be for less than proportional increases in wheat in the Corn

Belt and Lake States and more than proportional increases in the Southern and Northern Plains. Thus after retirement of 20 percent of the wheat acreage, output might be lower in the former areas, balanced by higher output in the latter areas.

Retirements of cotton, rice and flaxseed were assumed to be distributed according to the 1960 pattern by States. The slight increase in soybean acreage was assumed to occur in a similar manner for want of a more accurate measure.

Corn retirement is heaviest in the Corn Belt, the Southern Plains and the Lake States. Oats retirement occurs predominantly in the Corn Belt, Lake States and Northern Plains. Barley reductions are concentrated in the Plains area as are grain sorghum reductions. Soybean increases occur principally in the Corn Belt.

Gross output implications for agricultural producers

Tables 17, 18, 19 and 8 provide the details of gross output changes calculated from the acreage figures in Table 16. Since the extent and distribution of cotton retirement is the same in both programs 1 and 2, Table 8 is used for both analyses.

Table 17 presents the effects of Program 2 on gross output from feed grains by regions. Gross output of feed grains shows a total of 1649.5 million dollars for the country as a whole and of this, over a third occurs in the Corn Belt

Table 17. Initial effects of retirement on gross output from feed grains by regions for 1960 (million dollars)

Crop	Gross output	Region										
		1.2	2.2	3.2	4.2	5.2	6.2	7.2	8.2	9.2	10.2	Total
Corn	1960 gross output	272.5	3324.8	839.6	454.2	309.2	88.0	56.1	833.8	66.2	48.9	6293.3
	Gross output reduction	46.8	605.4	122.6	79.6	43.5	14.8	6.8	136.3	8.0	8.8	1072.6
	Percent reduction from 1960	17.2	18.2	14.6	17.6	14.1	16.8	12.2	16.4	12.2	18.1	17.0
Oats	1960 gross output	53.4	267.1	231.3	15.1	17.1	13.2	32.6	152.2	18.1	15.0	815.1
	Gross output reduction	8.9	48.6	37.2	2.7	2.2	2.2	4.0	23.3	2.7	2.6	134.4
	Percent reduction from 1960	16.7	18.2	16.1	17.8	13.0	16.5	12.3	15.3	15.0	17.6	16.5
Barley	1960 gross output	14.1	11.1	36.8	11.9	1.4	0.7	23.9	124.4	102.1	126.0	452.4

Table 17. (Continued)

Crop	Gross output	Region 1.2	2.2	3.2	4.2	5.2	6.2	7.2	8.2	9.2	10.2	Total
Barley	Gross output reduction	2.4	3.5	8.5	2.1	0.2	0.1	7.6	41.8	36.2	35.2	137.6
	Percent reduction from 1960	17.3	31.6	23.1	17.6	10.5	15.0	31.8	33.6	35.5	28.0	30.4
Grain sorghum	1960 gross output	---	35.2	---	8.5	2.5	1.7	376.1	324.2	29.5	26.1	803.8
	Gross output reduction	---	16.4	---	1.5	0.4	0.2	97.6	174.9	9.0	4.9	304.9
	Percent reduction from 1960	---	46.5	---	17.7	15.1	13.7	25.9	54.0	30.6	18.9	37.9
Total feed grains	Gross output reduction	58.1	673.9	168.3	85.9	46.3	17.3	116.0	376.3	55.9	51.5	1649.5
	Percent reduction from 1960	17.1	18.5	15.2	17.6	14.0	16.7	23.7	26.2	25.9	23.9	19.7

Table 18. Initial effects of retirement on gross output from food grains by regions for 1960

Region	Rice			Total food grains[a]	
	1960 gross output[b]	Gross output reduction[b]	% reduction from 1960	Gross output reduction[b]	% reduction from 1960
1.3	---	---	---	---	---
2.3	---	---	---	---	---
3.3	---	---	---	---	---
4.3	---	---	---	---	---
5.3	---	---	---	---	---
6.3	121.9	15.1	12.4	15.1	11.1
7.3	64.0	8.3	12.9	8.3	1.6
8.3	---	---	---	---	---
9.3	---	---	---	---	---
10.3	60.6	7.6	12.5	7.6	2.8
Total	246.5	31.0	12.6	31.0	1.0

[a]Figures in this column for total output of food grains in 1960 include the value of wheat, rye, rice and buckwheat for each region. This program affected only rice acreages so output figures for 1960 were not shown in the table for wheat, rye and buckwheat.

[b]Millions of dollars.

(Region 2) resulting largely from reductions in corn output. Such is the size of the feed grain sector in this region that this amount represents only 18.5 percent of the regional output of feed grains though the proportions of barley and grain sorghum removed are high. Second in importance is the

Table 19. Initial effects of retirement on gross output from oil crops by regions for 1960

Region	Soybeans			Flaxseed			Total oil crops[a]	
	1960 gross output[b]	Gross output increase[b]	% increase from 1960	1960 gross output[b]	Gross output reduction[b]	% reduction from 1960	Gross output change[b]	% change from 1960
1.8	30.7	0.6	1.9	---	---	---	+0.6	+1.9
2.8	863.9	16.0	1.9	0.8	---	---	+16.0	+1.9
3.8	112.5	2.2	2.0	23.9	2.1	8.9	+0.1	+0.1
4.8	85.6	1.7	2.0	---	---	---	+1.7	+1.1
5.8	35.9	0.7	1.9	---	---	---	+0.7	+0.5
6.8	192.7	3.9	2.0	---	---	---	+3.9	+2.1
7.8	11.0	1.2	10.6	3.2	---	---	+1.2	+2.1
8.8	49.9	0.2	0.4	63.2	5.7	9.0	-5.5	-4.9
9.8	---	---	---	0.8	---	---	---	---
10.8	---	---	---	3.2	---	---	---	---
Total	1382.2	26.5	1.9	163.9	7.8	4.8	+18.7	+1.1

[a]Total oil crops from which this column is calculated, includes gross output of tung nuts and peanuts which were unaffected by this program, as well as that of soybeans and flaxseed.

[b]Millions of dollars.

Northern Plains (Region 8) with a little less than 25 percent of the total gross output reduction for the nation. The program reduces output from feed grains by 26.2 percent in this region with a concentration in corn and grain sorghum output. The Lake States and Southern Plains also show important reductions due respectively to impacts on corn and grain sorghum. The impact on other regions is fairly evenly distributed except for the Delta States (Region 6) where the impact is not heavy. The relative importance of corn reductions in the program becomes obvious in the last column of Table 17 where a reduction of 1072.6 million dollars of the total 1649.5 million dollars is shown for corn.

Table 18 presents the gross output consequences of acreage changes in the food grain sector. Only the gross output of rice is affected, with the impacts concentrated in the Delta States (Region 6), Southern Plains (Region 7) and the Pacific States (Region 10). Total gross output reduction from the 1960 level is only 31 million dollars, a mere 1 percent of the national value of gross output in that year. This table emphasizes the minor role of the food grain sector in this retirement program.

Table 19 shows regional gross output changes arising from acreage reductions in oil crops. Gross output from soybeans increases 26.5 million dollars, principally in the Corn Belt (Region 2). Gross output from flaxseed falls 7.8 million dollars, in two regions, the Lake States and the Northern Plains. The net effect is an increase in gross output over 1960 in all regions except the Northern Plains. Total gross output for oil crops increases by 18.7 million dollars, i.e. by 1.1 percent of 1960 total value of oil crop production due to the predominating influence of acreage increases in soybeans.

Calculation of direct and total effects

Direct effects The calculation of the "pull" effects of Program 2, using the change in output in affected sectors and the technical coefficients, provides no problems. Unlike Program 1, however, sector outputs moving to other industries as inputs change, and "push" effects are involved for these industries. The question arises as to what changes in the output of sectors can be expected if one or more inputs are reduced. In this study, a scale effect is assumed, i.e., the same reductions are assumed to occur in all inputs and in the production of the sector using them. Some consideration in the text below is given to this problem.

Total effects As outlined above, Program 2 involves substantial reductions in feed grain production beyond the amounts moving to CCC storage. It also involves a diversion of food grains to feed grain which partially fills this void created in the feed grain market. The reduction beyond the diversion of food grains affects industries using feed grain as an input; namely, the livestock and prepared-feed industries. Thus, unlike Program 1, this land retirement program causes disturbances in the market prices and volume of some agricultural products.

Once again, the 40 percentage output changes (in Tables 17, 18, 19 and 8) are applied to the 40 equivalent outputs in the 1954 model in order to translate them into 1954 terms. For cotton and oil crops, it is possible to assume again that the production changes would only affect regional final demands, and these latter are reduced or increased by the change in regional output. For cotton, Program 2 is the same as in Program 1. For oil crops, where output is in some cases raised, this is to assume that the changes would be channeled to exports and/or to CCC storage. Since the program would not affect regional final demands for forage crops, vegetables and fruit, tobacco and miscellaneous agriculture, these are specified at their 1954 levels.

Specification of regional final demands for livestock, feed and food grains presents more difficulty. Livestock production is reduced by the retirement of feed grain acres in this program. Most livestock production is absorbed by the meat and poultry product and dairy product industries, and only a small proportion goes straight to regional final demand. This mainly consists of consumption on the farm.

It is considered that the elasticity of demand for this on-the-farm consumption would be near zero so that the quantity consumed would remain constant under the conditions of Program 2. Thus, regional livestock final demands are held at 1954 levels.

For feed grains, the problems of simulating the correct regional output reductions by manipulation of final demands are quite substantial.

Feed grain output reductions envisaged under Program 2 can be considered in three categories, each of which has different requirements in terms of the model. First, reductions occur to remove flows to CCC as in Program 1. These can be accomplished by reducing regional final demands for feed grains by the size of output reductions required as in Program 1. Further reductions in feed grain output will affect the amounts moving as inputs to related industries. Program 2 calls for further reductions but also calls for a transfer of food grains normally moving to CCC stocks. This food grain partially replaces the reduced food grain output in the market.

Two problems thus remain for the model. One is to effect or simulate this transfer of food grains to the feed grain market, which is merely a process of substitution. To this extent, the feed grain markets are unchanged. The other is to effect or simulate the net reduction of feed grain output moving to markets buying it as an input. That is to account for the feed grain output reduction which is over and above the amount substituted for by the food grains. This amount is the only quantity which affects other industries.

The second problem of replacing feed grain output with transferred food grain cannot be totally resolved due to the inflexibilities of the input-output model. Substitution is ~~not~~ permitted without changing the structure of the model. Therefore, this feature of the program had to be simulated as closely as possible. Regional final demands for food grains were reduced by the amount of the flows to CCC as in Program 1. This, however, normally reduced regional output of food grains by this amount. However, instead of permitting this, the regional value of these output reductions were subtracted from the regional values of feed grain outputs, and outputs of food grains were assumed constant. In terms of the model, the method assumes the equivalence of the effects on other industries of reducing food grains and feed grains. In fact, the effects on related industries will not be exactly the same, but they are probably close enough to make the error in this assumption a minor one.

The third problem is that of incorporating the effects of the reduction of feed grain to industries using it as an input. Since we are using final demands to achieve the calculated output reductions and since the final demands for the national industries of meat and poultry products and of dairy products are the ones almost exclusively affected, the final demands for these products are changed in such a way that first, total feed grain output would be reduced to the extent required by Program 2, and second, if possible, the reductions would be regionally distributed as desired. The first requirement is fulfilled in the calculations. By actually using the model and various changes in the final demands for these national industries, it is possible to obtain the desired changes in feed grain output. Hence, the levels of final demand for meat and poultry products are specified at this level, which would ensure the correct reduction in feed grain output. Unfortunately, though, the second requirement of correct regional distribution of these reductions can not be fulfilled. The model employs a fixed pattern of demand and supply relations between industries and regions which, in this case, does not correspond to the pattern of output reduction necessitated in Program 2. To this extent, therefore, the calculations of total effects on the economy are not the exact consequences of Program 2. Regional income calculations will not be very accurate, and minor differences will arise in the effects of the program on nonagricultural industries.

The remaining final demands are for nonagricultural industries, and these can be easily specified since they are not noticeably affected by the program.

Results

Direct effects The direct effects of Program 2 can be considered in the two categories of "pull" and "push" effects.

Table 20 presents details of the "pull" effects of the program. Miscellaneous agriculture supplying services is the most heavily affected agricultural sector where an overall 3 percent reduction results, which is a little heavier than in Program 1. Regionally, the Plains States show the heaviest reduction (about 5 percent) while the Pacific States show least effects (1.1 percent). Intrasector requirements are reduced most importantly for feed grains and also for food grains and cotton, while the slight rise in oil crop production necessitates small increases in intrasector purchases. Total direct effects on agriculture amount to about 96 million dollars, or 0.23 percent of 1954 total agricultural gross output.

Direct "pull" effects on nonagricultural industries are about 7 times as large as those on agriculture, but they amount to only 0.08 percent of nonagricultural output in 1954. In absolute terms, the machinery and services industry and all other industry categories are most heavily affected, although again in relation to total output in 1954, the

Table 20. Direct "pull" effects of Program 2 on input-supplying industries for 1954

Sector	Absolute reduction (million dollars)	Percentage of 1954 output
A. Agricultural		
i.2 Feed grains	26.00	0.41
i.3 Food grains	1.46	0.06
i.4 Forage crops	2.10	0.08
i.6 Cotton	1.46	0.04
i.8 Oil crops	+0.59	+0.05
i.9 Miscellaneous agriculture	65.48	3.23
Total agriculture	95.91	0.23
B. Nonagricultural		
0.18 Fertilizers	66.42	7.44
0.19 Chemical industries	5.60	0.03
0.20 Machinery and services	254.10	0.69
0.21 Petroleum products	45.01	0.37
0.22 All other industries	327.40	0.09
Total nonagriculture	698.53	0.08
Total all industry	794.4	0.08

changes are minor. The fertilizer industry suffers a 7.4 percent reduction, a considerable increase over Program 1, due to the increased reductions of feed grains. The chemical industries' output is little affected directly by this program, as in Program 1, while the petroleum industry shows only a small reduction increase over Program 1 (cf Table 10).

Table 21 provides the direct "push" effects, although, as is suggested above, these are only approximations due to the difficulties of accurately predicting these, using the technical coefficients. Two calculations are made for the effects of feed grain reductions to the livestock industry. These are both included in Table 21 and depend on two different assumptions.

The assumption for #1 is that the absolute change in feed grain moving to each livestock sector produces a similar absolute reduction in the livestock output of each sector, i.e., all other inputs remain unchanged. This assumption provides a minimal estimate of the effects on the livestock industry as a whole, of 1.5 percent reduction below 1954 total output.

The second calculation #2 assumes that the percentage change in feed grain inputs to the livestock industry causes a similar percentage change in livestock output, i.e., all inputs are changed by the same percentage change as in feed grains. This produces a scale effect on livestock output.

Table 21. Direct "push" effects of Program 2 for 1954

Sector	Absolute reduction (million dollars)	Percentage of 1954 output
A. Agricultural		
1.1 Livestock	(1) 274.9	(1) 1.5
	(2) 980.3	(2) 5.3
1.4 Forage crops	132.2	5.3
Total agriculture	1,112.5	2.73
B. Nonagricultural		
0.10 Meats and poultry products	889.4	5.3
0.11 Dairy products	413.6	5.3
0.13 Prepared feeds	159.1	5.3
Total nonagriculture	1,462.1	0.16
Total all industry	2,574.6	0.27

In reality, the effect of feed grain changes is probably between the extremes. Since input-output analyses assumes the operation of scale effects, we use these calculations for the discussion. Scale effects on output of livestock produce a 5.3 percent reduction in 1954 output of livestock which consequently results in a 5.3 percent reduction in requirements of forage crops. The percentage regional distribution of the livestock cut is assumed to be even due to difficulties preventing more accurate calculation. Table 22 shows the

Table 22. Combined direct effects of Program 2 for 1954

Sector	Absolute reduction (million dollars)	Percentage of 1954 output
Agriculture	1,208.4	2.96
Nonagriculture	2,160.6	0.23
Total all industry	3,369.0	0.34

total direct effects for agriculture of a 1.2 billion dollar reduction amounting to 3 percent reduction below total 1954 agricultural output.

"Push" effects on nonagricultural industries, assuming the scale effect is sustained from the livestock industry, cause a 5.3 percent reduction in meat and poultry and dairy product industries and the same in the prepared feed industry. It can be seen that "push" effects add substantially to total direct effects. Table 22 shows that combined direct effects rise to 2.2 billion dollars for nonagricultural industries and for all industry to 3.4 billion or 0.34 percent of gross output in the economy as against only 0.06 percent for "pull" effects alone. The absolute reduction caused by the direct effects in nonagricultural industries is only about twice as high as for agriculture due to the livestock reductions, unlike Program 1 where it is five times higher.

<u>Total effects</u> The total effects of Program 2, combining initial, direct, indirect and circular effects, are presented for agricultural industries by regions in Table 23. As discussed earlier, the regional distribution of the effects calculated for livestock and feed grains is not a good measure for Program 2. Livestock output reductions may be underestimated in Regions 1 to 6 and overestimated in Regions 7 to 10. Feed grain output reduction is heavily overestimated in the Plains Regions (7 and 8), in the Mountain States (Region 9) and Pacific States (Region 10); it is heavily underestimated in the Corn Belt (Region 2) and somewhat underestimated in the Lake States (Region 3), Appalachians (Region 4) and the Southeast (Region 5). The same re-emphasis should also occur to some extent for forage crops and for miscellaneous agriculture. Thus, figures in Table 23 are not a good enlargement on initial regional effects calculated in Tables 17, 18, 19 and 8, and particularly in Table 17. Although the figures are not a good representation of Program 2, they still have value as indications of the effects of a land retirement program simply enlarged beyond Program 1.

Although the regional distributions of effects on sectors are probably somewhat inaccurate, the total effects on the sectors as a whole appear to be good approximations. In the calculation of the direct effects of reducing feed grain to livestock, a 5.3 percent reduction of the output of livestock

Table 23. Total reducing effects of Program 2 on agricultural industries from 1954 levels

Sector	Region 1	2	3	4	5	6	7	8	9	10	Sector total
i.1 <u>Livestock</u>											
Million dollars	127.0	354.4	138.9	70.2	50.1	30.3	69.8	122.0	62.3	83.8	1108.8
Percent of 1954 output	5.9	6.5	6.3	5.1	5.6	5.3	5.9	6.4	5.7	5.9	6.0
i.2 <u>Feed grains</u>											
Million dollars	57.3	292.9	90.9	40.5	18.1	23.6	169.3	351.6	131.5	117.6	1293.3
Percent of 1954 output	19.6	10.5	9.6	10.7	6.6	20.6	62.4	38.2	82.4	65.9	20.5
i.4 <u>Forage crops</u>											
Million dollars	12.9	32.9	16.8	12.0	3.2	3.3	8.2	26.5	20.3	14.9	151.0
Percent of 1954 output	5.1	6.9	6.0	5.0	4.2	5.3	7.5	6.7	6.0	5.6	6.1
i.6 <u>Cotton</u>											
Million dollars	---	6.1	---	18.5	35.6	66.5	71.8	---	21.1	27.4	247.0
Percent of 1954 output	---	7.1	---	7.4	7.1	7.2	7.3	---	7.2	7.2	7.2
i.9 <u>Miscellaneous agriculture</u>											

Table 23. (Continued)

Sector	Region 1	2	3	4	5	6	7	8	9	10	Sector total
Million dollars	8.3	9.6	9.2	10.5	7.0	9.0	17.4	5.7	12.7	8.2	97.6
Percent of 1954 output	3.0	3.5	5.3	5.1	3.5	6.2	10.7	4.0	7.5	2.3	4.8
Regional total											
Million dollars	207.4	721.6	257.5	150.0	109.1	144.0	341.5	511.4	250.0	261.6	2954.1
Percent of 1954 output	5.5	4.3	6.1	4.0	4.0	6.9	10.9	11.9	9.6	6.5	6.5

was used. In the approximation of the correct feed grain reductions to livestock by changing final demands for processing livestock industries, a total effect of 6 percent on livestock was produced. The difference of 0.7 percent, which represents the indirect and circular effects, seems quite reasonable. Furthermore, the figure of 20.5 percent for total effects on the feed grain industry appears to be quite accurate. In Table 17, initial effects were calculated to amount to 19.7 percent. Direct effects are calculated at 0.4 percent, leaving 0.5 percent for indirect and circular effects. Finally, the 6.1 percent for total effects on the forage crop industry compares logically with the scale change of 5.3 percent assumed for the direct effects as does 4.8 percent total effects on miscellaneous agriculture with 32 percent for direct effects.

The total effects on the livestock and feed grain sector amount to over 2.4 billion dollars of the 3.0 billion for agriculture as a whole. Cotton reductions are next in importance, followed by forage crops and miscellaneous agriculture. Reductions in other sectors amount to only 56.4 million dollars. The figure of 3.0 billion dollars for the total effects on agriculture as a whole amounts to a substantial 6.5 percent of 1954 gross output, almost double the equivalent figure of 3.3 percent calculated for Program 1. This increase over Program 1 is principally due to the livestock and forage crop reductions in Program 2 and to the heavier reductions in feed grains and in the miscellaneous agriculture sector in this program.

Table 24 probably presents more accurate details of total effects of Program 2 on nonagricultural industries in 1954 terms, than the direct effects presented in Tables 20 and 21. In Table 21, for instance, the rough prediction of a 5.3 percent reduction in output of meat and poultry products and of dairy products is out of line with the more accurate figures of 7.5 percent to 4.1 percent, respectively calculated for total effects. Direct effects for meat and poultry products will probably be nearer 7 percent and for dairy products nearer 4 percent. Also, 5.3 percent for direct effects on prepared feeds is probably a slight exaggeration in view of the 5.1 percent reduction calculated for total effects. In all, total direct effects on nonagricultural industries may be a little underestimated as a result. For other nonagricultural industries, the comparison between direct and total effects shows more consistency.

Total effects on the fertilizer industry amount to an 8 percent reduction for 1954 which is a 3 percent increase over Program 1. Indirect effects for this industry amount to 0.6 percent of 1954 output. Machinery and service suffer a 1.2 percent cut in output for 1954, a one-third increase over Program 1. The "All other industries" sector shows a 1.4

Table 24. Total reduction effects on nonagricultural industries from 1954 level

Sector	Absolute reduction (million dollars)	Percentage of 1954 output
0.10 Meat and poultry products	1,264.6	7.5
0.11 Dairy products	323.3	4.1
0.12 Grain products	9.3	0.3
0.13 Prepared feeds	152.9	5.1
0.14 Miscellaneous food products	36.8	0.2
0.15 Vegetable and fruit products	7.0	0.1
0.16 Tobacco manufacturing	0.6	---
0.17 Textile products	33.1	0.4
0.18 Fertilizers	71.4	8.0
0.19 Chemical industries	108.8	0.6
0.20 Machinery and services	458.8	1.2
0.21 Petroleum products	89.4	0.7
0.22 All other industries	1,382.5	0.4
Total nonagricultural industries	3,938.5	0.4
Total all industries	6,607.8	0.69

billion dollar decrease which is double the reduction in Program 1, but still amounts to only 0.4 percent of 1954 output. Once again, the chemical industry shows much higher indirect than direct effects, i.e., a 103.2 million dollar reduction versus 5.6 million dollars for direct effects. The margin of difference is even more pronounced than in Program 1.

Other nonagricultural industries exhibit small total effects such as the grain products and miscellaneous food product industries. Reductions expressed as percentages of 1954 output show the effects to be relatively minor.

A summary of the various effects of Program 2 on agricultural and nonagricultural industries is given in Table 25 for 1954. Initial effects in 1954 terms amount to 1.5 billion dollars. Within agriculture, these produce direct or short-run effects of 1.2 billion dollars. Thus, a multiplier encompassing all direct effects within agriculture of 1.80 is in operation. Indirect effects add another 252 million dollars to give total effects of 3.0 billion dollars which give a within-agriculture multiplier of 1.98.

As a result of the initial effects of 1.5 billion dollars in agriculture, direct effects of 2.2 billion dollars are generated in nonagricultural industries, suggesting a nonagricultural industry multiplier of 1.45. Indirect effects add a further 1.8 billion dollars to direct effects to

Table 25. Output and multiplier effects of Program 2 on the economy for 1954

Sector	Initial, million dollars	Direct		In-direct, million dollars	Total	
		Million dollars	Multi-plier		Million dollars	Multi-plier
Agri-culture	1,494	1,208	1.80	252	2,954	1.98
Nonagri-culture	---	2,161	1.45	1,778	3,939	2.64
All industry	1,494	3,369	3.3	2,030	6,893	4.6

generate a 3.9 billion dollar output reduction outside agriculture when all effects are accounted for. This implies a nonagricultural multiplier of 2.64 for total effects.

For the economy as a whole, Table 25 shows that the initial effects of a 1.5 billion dollar reduction in agriculture cause, in 1954, a 3.4 billion dollar reduction due to direct effects in the output of the whole economy which implies a multiplier of 3.3. Indirect effects add 2.0 billion dollars to give a total reduction in real national output for the economy of 6.9 billion dollars, which implies a large multiplier of 4.6.

By assuming once again that the 1954 interindustry relationships still hold for 1960, the multipliers calculated in Table 25 can be used to translate the effects of Program 2 into 1960 figures. These figures are presented in Table 26.

Table 26. Output effects of Program 2 on the economy for 1960

Sector	Initial effects (million dollars)	Direct effects (million dollars)	Indirect effects (million dollars)	Total effects (million dollars)
Agriculture	1,854	1,502	315	3,671
Nonagriculture	---	2,688	2,206	4,895
All industry	1,854	4,190	2,521	8,566

From Tables 17, 18, 19 and 8, total initial effects of Program 2 amount to 1.9 billion dollars. The total effects on the economy which result, amount to 8.6 billion dollars, of which 43 percent are generated within agriculture and 57 percent are generated in the nonagricultural sectors. Total effects consist of 22 percent initial effects of the program, 49 percent direct effects and 29 percent indirect effects. About one-third of the direct effects occur within agriculture and two-thirds outside, while, of the indirect effects, only 12 percent is generated within agriculture and 88 percent is generated in the rest of the economy.

If some outflow from CCC stocks was permitted, the market supply of feed grains would tend to be maintained and the effects of Program 2 would be reduced. However the desired price levels would not be achieved under these circumstances and greater acreage retirements would be necessary.

It should be noted that only real gross income changes are measured in these programs. Prices are assumed constant in the model, whereas feed grain, livestock and livestock product prices actually rise in Program 2. If price changes are allowed in the income calculations, the unadjusted income changes would be somewhat lower. In Program 1, this problem is not encountered since prices remain constant at 1959-60 levels.

Cotton reductions are the same as in Program 1, so land retirement cost would remain the same. Grain output is reduced below Program 1 and would raise rental payments to farmers to about 1.2 billion dollars. Thus, contract payments with cotton included rise to about 1.6 billion dollars. Two billion dollars per year is the suggested total costs of the program to the Treasury for some years. Consumers are affected in this program. They pay higher prices for some products and they have a reduced market supply.

EVALUATION OF RESULTS AND METHOD

By the use of this input-output model, regionally disaggregated for agricultural industries, it has been possible to estimate the real gross output effects on the economy of the two land-retirement programs.

The first general limitation on the value of the measurements given above arises due to the use of a 1954 model in an effort to estimate the effects of land retirement under 1960 conditions. This problem allows only highly aggregated estimates of the effects of the programs in 1960 terms (Tables 14 and 26) though quite accurate estimates of the 1960 initial effects of the two programs are used (Tables 6, 7, 8 and 9 and Tables 17, 18, 19 and 8). Despite this, the relationships measured in 1954 terms provide much information on the repercussions to be expected. The problem of using outdated input-output models will probably continue until either data collection for such work becomes regular and systematic, which will cut down the time lag and expense now involved, or the economy will cease to change and grow so fast, whereupon models will be accurate for longer periods. Despite the laments of the proponents of the stagnation thesis, this latter alternative seems unlikely in the short run. Certainly, results would have been more pertinent had a later model been available. More confidence could be placed on the relationships discovered during the investigation.

The most highly aggregated results for Programs 1 and 2 perhaps provide the most interesting comparisons between the two programs and the strongest implications for policy-makers (Table 14 and Table 26).

We can regard Program 1 as a sort of minimal land-retirement program in that it only adjusts supply to market demand and does not attempt to manipulate it to raise prices and income of farmers. Program 2 does this and a little more. Not only are the surpluses moving to CCC removed, but extra reductions are made which raise feed grain prices and, therefore, livestock and livestock product prices. There is, in addition, some substitution between different crops, and there are some differences in the regional impacts of the initial effects of the two land-retirement programs. Broadly speaking though, Program 2 is an extension of Program 1 and so gives an idea of how total effects on the economy change once land retirement extends beyond the point where merely the flows of agricultural products to the CCC are cut off. A comparison of the income calculations for 1960 (Tables 14 and 26) show the multiplier effects of the additional retirements in Program 2 to be high. We can plot initial effects of retirement against total effects on the economy to visualize these more clearly (Fig. 1).

Although it is presumptuous on the basis of two observa-

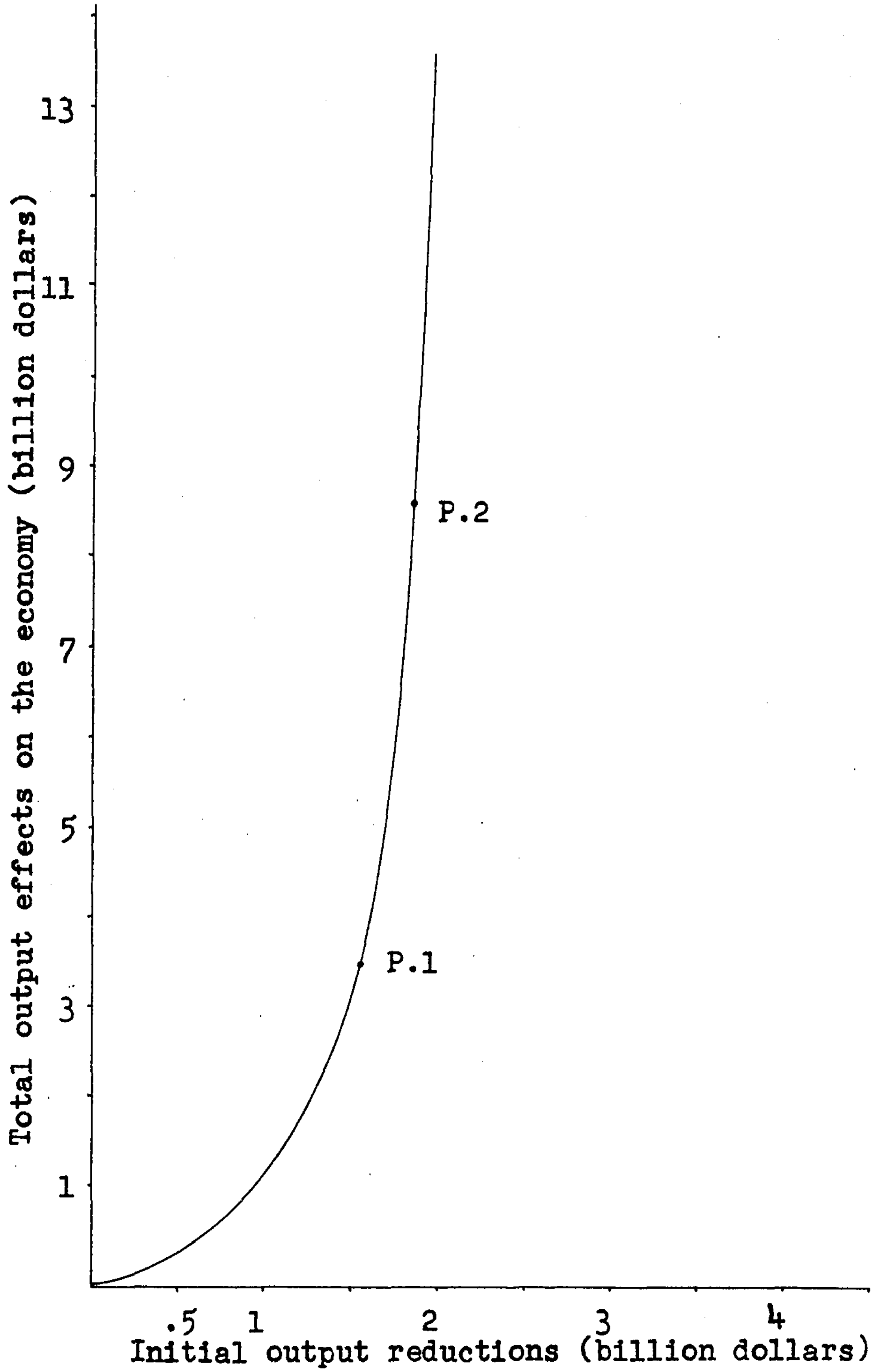

Fig. 1. Total output effects of Programs 1 and 2 on the 1960 economy

tions to conclude much about such a curve, what is obvious is that the slope rises sharply when market disturbances begin to be a consequence of the program. This fact is of value to policy-makers since, if Congress considers proposals such as these programs, it is logical to expect a degree of lobbying pressure which will be in proportion to the effects shown in terms of this curve. The source of the lobbying can be predicted on the basis of the more detailed information on the industries affected and the figures which give the likely extent of the loss.

Policy-makers must be made aware of the magnitude of the repercussions of the type of programs analyzed. In the case of the first program, the initial impact of measures to remove crop flows to CCC of 1 billion dollars in real gross income to farmers causes further reductions in agriculture amounting to 17 percent of the original impact. The rest of the economy suffers repercussions of the same magnitude as the original impact on agriculture.

A program like the second where the initial impact on agriculture is increased by roughly 50 percent over Program 1, has far greater repercussions. The total effects within agriculture are double the initial impact. The total real income consequences outside agriculture are over 2.5 times as great as the initial impact. The total effects on the economy are over 4.5 times the original effects.

The consequences for particular industries are also of considerable importance to the policy-makers. Changes in real income for an industry such as in Program 2 of 8 percent for fertilizer, 1 percent for machinery and services and, within agriculture, of 5 percent for the miscellaneous sector (agricultural services mainly) are serious factors for political deliberations. Furthermore, industry figures hide the implications for individual firms. The regional implications for some industries may well cause crises for locally dependent industries such as fertilizer supplies.

It would be useful to be able to compare similarly constructed input-output tables for a number of years (e.g., tables for every 5 years) to be able to observe the changing interrelationships between agriculture and the rest of the economy. It is probably true that the interrelationships have steadily increased, although agriculture plays an increasingly minor role in the total economy. The relatively faster growth rate in these sectors of the economy tends to reduce the importance of agriculture and, therefore, dwarfs the magnitude of changes caused by programs such as these. The figures of 0.3 percent and 0.7 percent change in the total output of the economy in 1954 indicate this. A counterbalance to this tendency is the growth in the interdependence between agriculture and the rest of the economy. This reasserts the influence that changes in the agricultural sector can have. The size of the multipliers for the total effects of changes in agriculture in Programs 1 and 2 (2.3 and 4.6) tend to bear this out.

The model is capable of providing useful information on the many specific industries affected. Tables 11 and 12 for Program 1 and Tables 23 and 24 for Program 2 show that much information can be obtained for the effects on individual industries directly and indirectly connected with agriculture. Naturally, the more disaggregated the model is, the more this is so. The model used for the most part is highly aggregated in the nonagricultural sector (e.g., the "All other industries" sector), and it was found that important changes occurred within this high aggregation in this sector, therefore resulting in some loss of information. Provided that inversion procedures permit a larger number of sectors, there would be advantages in regional disaggregation of these industries. The fact that many operate nationally anyway may restrict this disaggregation.

The principal difficulty in using this method is in translating calculated initial output effects of such programs into changes in final demand sectors which, when used in the model, will reproduce those output changes. In Program 1, there is no great difficulty in this respect. In Program 2 where there are repercussions in the market, more problems are encountered. If this can be achieved, the method ensures not only that these changes will be reproduced together with their effects on other industries, but also that the direct and indirect effects on these same initially affected sectors will be included. Thus, in Program 2, the specification of changes in final demands and the use of the model enabled the expected 19.7 percent reduction in feed grain output to be obtained together with 0.7 percent of 1954 output reduction which measured the sum of direct and indirect effects on this same sector. Nevertheless, the more comprehensive the program is, the more difficult it will be to reproduce the initial output changes. However, there is considerable information to be gained on the effects of output changes in single industries where this will not be a problem.

The two applications of the model also show that information on the regional effects of programs can be obtained. Program 1 gives accurate figures for these effects, initial, direct and total at least insofar as the limitations of the model permit. The same cannot be said of the results from Program 2 due partly to the particular construction of this model and partly to the nature of the input-output assumptions.

It was pointed out in the discussion of the results of Program 2 that the correct regional pattern of reductions in feed grain output which caused reduced livestock marketings could not be reproduced by changes in any final demand sector, regional or national. This is due to the fact that nonagricultural industries are included in this model on a national basis. Only agricultural industries are identified within regions.

Since there is a fixed relation in the model between regional livestock sectors and nonagricultural livestock product industries and similarly between regional feed grain inputs to regional livestock sectors, there is no way of ensuring that changes in the nonagricultural livestock product sector will produce a desired regional pattern of feed grain output changes. If some of these highly related nonagricultural industries were included on a regional basis, more accurate regional information would be possible. If this is done, the input-output model tends to merge with regional models which could be constructed. It might then be preferable to construct an input-output model for individual regions if this type of information is the most important. It is inevitable that if an input-output model is desired for the whole economy and disaggregation by industries is of primary importance, then information to be gained by any other criterion of classification (e.g., regional) will have to be sacrificed.

Where programs involve some substitution between inputs, a conflict arises with the assumption of fixed input mix in input-output analysis. Such a situation arose in Program 2 where the relative prices of food and feed grains changed and wheat substituted for feed grain as an input for livestock. In this case fortunately, the problem could largely be overcome with only some small loss in accuracy. In other cases, this might be more difficult to accomplish.

The problem serves to introduce a more general conclusion with respect to the type of problem for which the analytical technique is suited. Where a land-retirement program, or indeed any program, principally involves output changes with little price disturbance, this technique is well suited for assessing the consequences for the economy. If the level of all prices changes along with output changes, the same usefulness holds true. However, if relative price changes play an important part of a proposal, the technique will be found more deficient since input substitution is not possible without contravening the assumptions.

The technique provides an opportunity to obtain information on the nature of the effects on other industries. The use of the technical coefficients permits direct effects to be calculated. These are essentially the effects on industries most closely tied with those initially affected. The use of the interdependence coefficients reveals all the repercussions, and they include those initial effects or disturbances whose further repercussions we establish. With knowledge of the extent of these initial effects and the direct effects, we can then obtain the indirect and circular effects which involve those industries more distantly related to the initial source of the disturbance. As we noted in the discussion of the programs, the direct effects are a rough measure of short-run effects of a disturbance, the indirect effects are those which take their course over a longer period. Total effects are, thus, long-run effects of disturbances.

The use of technical coefficients to obtain the direct effects is not without its problems. This was shown in Program 2. The calculation of the direct effects was divided into so-called "pull" effects and "push" effects. "Pull" effects are the effects on industries supplying inputs to those initially disturbed. These calculations present no problems. The "push" effects do raise important difficulties. These effects are the forward repercussions of initial changes. The outputs of initially affected sectors to other industries as inputs are changed.

Two extreme ways of resolving this problem present themselves. One way is to assume that scale effects will occur; e.g., if feed grain output to the livestock industry is reduced 10 percent, a 10 percent reduction in livestock output will result. The other extreme solution is to assume that the absolute reduction in livestock output exactly equals the absolute reduction in feed grain input, i.e., other inputs remain constant. A much lower percentage change in livestock output results here. Under the assumptions of input-output analysis, the scale relation holds. In reality, some change between the two extremes is generally more likely, but what this change will be cannot easily be determined. In Program 2, scale effects were assumed with the recognition that these may well overestimate the effects, especially the direct effects, since these are somewhat short-run. Since there were no "push" effects for Program 1, this was not a problem there. This same problem and possible source of inaccuracy will plague an examination of any program for which there are "push" effects.

Despite the difficulties inherent in the use of the technical coefficients, they are useful tools here in connection with the regional breakdown of agricultural industries. Their combined use provides for further applications of the model.

Since input patterns for a particular sector vary somewhat between regions, it is possible to alter the impact of a land-retirement program on related industries by varying the regional emphasis of the land retirement. For instance, feed grain retirement can be considered in this light. The technical coefficients in the model generally provide a fair indication of the dependence of nonagricultural industries on the output of feed grains by regions. Table 27 provides

Table 27. Direct dependence between feed grain output and nonagricultural industries for 1954

Sector	Region 1	2	3	4	5	6	7	8	9	10
0.18 Fertilizers	.085	.050	.040	.134	.157	.122	.027	.018	.023	.041
0.19 Chemical industries	.001	.001	.002	.001	.002	.003	.002	.002	.006	.013
0.20 Machinery and services	.258	.152	.216	.196	.177	.222	.323	.234	.280	.212
0.21 Petroleum products	.038	.025	.034	.037	.038	.059	.064	.039	.051	.037
.022 All other industries	.131	.248	.185	.245	.207	.295	.292	.258	.299	.429
5-sector total	.514	.476	.476	.613	.581	.701	.707	.550	.658	.732
0.18 + 0.19 + 0.21	.124	.203	.075	.172	.197	.184	.093	.059	.079	.091
1954 output (million dollars)	292.3	2777.2	943.8	378.2	274.5	114.6	271.4	921.1	159.5	178.4

Table 27. (Continued)

Sector	Region									
	1	2	3	4	5	6	7	8	9	10
Program 1 - reductions (million dollars)	19.9	80.5	27.4	11.0	2.2	1.6	110.2	169.5	65.1	55.5
Program 2 - reductions (million dollars)	50.0	513.8	143.8	66.6	38.4	19.1	64.3	241.3	41.3	42.6

these coefficients for the 10 regions and includes some aggregations of these, e.g., for all nonagricultural industries combined and for combined fertilizer, chemical and petroleum product industry coefficients. The 1954 output levels of feed grains by regions are included to indicate the limits of any regional substitution in a program of retirement. Actual output reductions in Programs 1 and 2 are included to show their regional emphasis as against the regional dependence of these nonagricultural industries expressed by the coefficients. It should be noted here that Programs 1 and 2 are not strictly comparable since the latter is a more extensive program; hence, the differences between regional retirement patterns of the two are confounded with this difference in size between the programs. As usual, each coefficient represents the inputs of a nonagricultural industry per dollar of output of feed grain production in a region.

The 5-sector total gives a measure of the total importance of nonagricultural industries as input suppliers for the feed grain sector. A retirement program which would have maximum effects on nonagricultural industries would have reductions concentrated in the Pacific States (Region 10) where the highest coefficient occurs (0.732), then in Region 7 (Southern Plains), Region 6 (Delta States) and in Region 9 (Mountain States). However, regional outputs of feed grains are lowest in these regions, a fact which places a limit on the maximum of the effects for these industries. A retirement program which aims at minimizing these effects should be concentrated in Region 2 (Corn Belt), Region 3 (Lake States), Region 1 (Northeast) and Region 8 (Northern Plains). Program 1 showed important reduction in Regions 7, 9 and 10 of heavy dependence, but also in Regions 2 and 8 where dependence is relatively low. There is obviously scope for rearranging the distribution of retirement if the criterion of dependence is considered important. Reductions could be switched from Regions 7, 9 and 10 to Regions 1, 2 and 3 in order to reduce the effects on nonagricultural industries.

The combined coefficients of the fertilizer, chemical and petroleum product industries show somewhat the reverse pattern. Minimal dependence occurs in Regions 7, 8, 9, 10 and 3. Thus, in Program 1, apart from the reductions in Region 2, the effects are low on these three industries since reductions are highest in these regions. In Program 2, effects on these three industries should be quite heavy due to large feed grain reductions in the Corn Belt (Region 2). However, since the method did not permit regional effects for feed grains in this program to be exactly reproduced, effects on these industries may be a little underestimated.

The machinery and services sector shows high dependence in Regions 1 and 6 to 10 and relatively lower dependence in Regions 2 to 5. Thus, Program 1 tends to maximize effects on this industry while Program 2 shows less concentration on this industry, particularly since high reductions are in Region 2 which has the lowest dependence coefficient. The actual results of Program 2 probably overestimate the true effects since they were more concentrated in Regions 6 to 10.

Programs which minimize effects on the "All other industries" sector would be concentrated in Regions 1, 3 and 4, 2 and 8 in that order. Program 1 tends to maximize the effect on this sector. Actual results for Program 2 probably overestimate the effect since reductions should be lower in Regions 6 to 10 to conform with the desired region change in the program.

Table 28 is a similar table prepared for the direct relations between food grains and nonagricultural industries. The coefficients for the 5-sector total show food grains to have a generally lower dependence on nonagricultural industries than feed grains. Only in Regions 1 to 3 is the reverse true. Thus, government programs stressing feed grain reductions will produce greater changes in nonagricultural output. If we add to this the fact that the value of output reductions in Program 1 were considerably less than those for feed grains, we can conclude that the main proportion of effects produced in Program 1 were caused by feed grain reductions.

The greatest regional dependence of nonagricultural in-

Table 28. Direct dependence between food grain output and nonagricultural industries for 1954

Sector	Region									
	1	2	3	4	5	6	7	8	9	10
0.18 Fertilizer	.091	.079	.062	.095	.093	.040	.016	.011	.005	.026
0.19 Chemical industries	.004	.002	.003	.006	.010	.003	.002	.003	.006	.008
0.20 Machinery and services	.214	.113	.177	.173	.114	.138	.174	.157	.157	.083
0.21 Petroleum products	.045	.024	.038	.043	.052	.036	.037	.029	.031	.017
0.22 All other industries	.168	.304	.241	.288	.207	.168	.236	.264	.271	.251
5-sector total	.523	.520	.521	.605	.475	.384	.467	.463	.471	.385
0.18 + 0.19 + 0.21	.141	.104	.103	.144	.155	.078	.056	.043	.043	.051
1954 output (million dollars)	80.4	373.9	89.8	54.4	12.4	115.4	297.3	742.6	305.6	283.6
Program 1 - reduction (million dollars)	15.4	56.8	12.8	9.1	2.2	15.2	36.0	120.0	49.5	48.5

dustries on food grains arises in Regions 1 to 4 and the lowest in Regions 5 to 10. This is roughly the reverse of the regional dependence with respect to feed grains. To minimize effects in a program of food grain retirement, acreage reductions should therefore be concentrated in Regions 5 to 10. In Program 1, apart from reductions in Region 2, most reductions took place in these regions of relatively low dependency, thus tending to minimize effects on nonagricultural industries.

Programs which minimize effects on fertilizer, chemical and petroleum product industries would be concentrated in Regions 6 to 10. Those which would minimize effects on machinery and services would be emphasized in Regions 1, 3, 7, 4, 8 and 9. The dependency of the "All other industries" sector is least in Regions 1 and 6. Thus, Program 1 somewhat minimizes effects on the combined fertilizer, chemical and petroleum industries; it has a fairly heavy impact on machinery and services and on all other industries.

Finally, there is obviously considerable use in employing the technical coefficients in this way to obtain information on the effects of alternative regional arrangements of an over-all program proposed. The information could be of considerable value to the policy-maker. It should be noted, however, that these measurements of direct effects are only a partial analysis. The results of both Programs 1 and 2 indicate that the further indirect effects on nonagricultural industries can be as large or larger than the direct effects. Thus, the calculation of total effects should be assessed in conjunction with the direct effects.

It should be noted that the input-output multipliers calculated through the model are not on a GNP basis. Due to the construction of the interindustry flow table for input-output analysis, double and triple counting occur in summing the effects of the programs over the economy, e.g. the calculated initial effects on agriculture contain the reductions in dependent industries which we proceed to estimate through the direct and indirect effects and which we add to the initial impacts to obtain total effects. Calculation of GNP reductions should be on a value added basis. It is obvious that on a GNP basis, the multipliers would be much reduced. They can be calculated on this basis by obtaining value added by sectors and by using the percentage changes calculated for each sector in the programs.

The output reductions by sectors could be translated usefully into employment terms. By obtaining employment by sectors and by using the percentage figures for gross output reductions by sectors, the reductions in employment can be estimated in labor units (by man hours or by employees).

As was noted in the introductory discussion of the input-output technique, the rigid nature of the static model does not permit any substitution of resources to take place. It does not incorporate the effects of reabsorption of resources rendered idle by the operation of these two programs. The calculations best fit a program of whole farm retirement where the initial reductions can be most effectively enforced.

In a buoyant economy, considerable reabsorption could be expected. Since labor productivity in agriculture for instance is low, it is quite possible that in a long run sense gross national product could increase if this reabsorption did occur. Labor might be more profitably relocated, to some extent within agriculture but mostly in nonagricultural occupations. In reality this would be somewhat conditioned by the type of labor which is idled by the land retirements, e.g. older farmers may not seek reemployment.

Thus the calculated output effects for the two programs are only the very short-run effects, not allowing for substitution. The long-run effects would be quite different and in some cases even opposite in direction. Another aspect not covered in the model is the investment effect of the output reductions. If any degree of permanency for these programs seemed likely to businessmen, they could be expected to reduce their levels of investment in line with their reductions in sales. This would somewhat counterbalance the source of overestimation in effects described above. In summary, it seems likely that the calculations in this study present a picture of near maximum effects possible from the two programs in the very short run. The aggregated output effects should particularly be considered with some caution. The effects in the long run - and not a very long run - would be very different, requiring different analytical techniques. The results of this thesis can be used as a guide for policy only in a very restricted sense.

SUMMARY

Much consideration is currently being given to the problem of adjusting agricultural production to prevailing levels of demand. Due to general dissatisfaction with the efficacy of the free market in achieving this, many alternative programs requiring government regulation are under consideration. One factor important to these political deliberations and which is common to all these alternatives is the effects they will have on the rest of the economy. This study attempts to quantitatively determine these effects.

The study consists of an examination of the repercussions of two land-retirement programs upon industries that are directly and indirectly related to agriculture, and upon the economy generally. The technique of regional input-output analysis is applied to the problem to obtain these estimates.

More specifically, the initial regional impacts of the land-retirement programs are first calculated for the agricultural products concerned in a fashion which permits the use of the model. The technique is then applied to determine the effects of the two programs on related agricultural industries, on industries supplying agriculture with major inputs, and on industries processing agriculture. Actually, the technique also permits the measurement of any further effects on the agricultural industries initially affected as well.

The model used is one already constructed for the U.S. economy in 1954, which stresses agriculture, and industries closely related to agriculture.

Agriculture is divided into 10 type-of-farming regions. Nine product groupings are identified in each region. Industry is aggregated nationally into seven agricultural processing industries, five agricultural furnishing industries and one highly aggregated sector representing all other industries.

Program 1 selected for analysis envisages land retirement, only sufficient to remove excess production flowing to CCC stocks, in feed grains, food grains and cotton. It calls for the removal of present acreage allotments and concurrently for the implementation of land retirement which will maintain 1959-60 price levels for agricultural products. Crop reductions in this program are particularly heavy in the Northern and Southern Plains.

Program 2 provides for an even acreage retirement in all regions across the country. This produces a regional emphasis different from Program 1. Reductions are heaviest in the Corn Belt and Lake States, but they are also heavy in the Plains States. Program 2 requires a heavier total acreage reduction than the first program which makes it an extension of Program 1. It extends beyond mere reduction of CCC grain flows to zero and involves a reduction in marketed feed grain which raises feed grain prices and the prices of livestock and prepared feed and reduces the quantities sold. The analysis traces the effects through the economy in terms of real income changes.

First, the initial effects of the land-retirement programs on the agricultural sectors involved are calculated for 1960. The percentage changes in sector outputs produced by the programs are then translated into 1954 absolute terms for use in the model. The technical coefficients are used to calculate the direct effects these changes have on related industries. The matrix of interdependence coefficients is used to calculate the total effects of the programs on all industries. Most of the results are expressed in 1954 terms except where some translation back into 1960 terms is possible.

The calculations provide information at several levels of aggregation for the above mentioned effects. Output changes are obtained by industry, by region and in terms of the whole economy.

In the case of Program 1, it is shown that the initial output reduction in agriculture of about 1.5 billion dollars in 1960 terms causes further direct effects within agriculture of about 138 million dollars in reductions or 9 percent of the original impact.

On an industry basis in agriculture, the direct effects occur principally in the original industries affected and in the sector supplying agricultural services. Outside agriculture, the fertilizer industry output is directly reduced by 4 percent in 1954 terms. Other industries suffer considerable reductions in 1954 absolute output terms, e.g., machinery and services fall 208 million dollars, petroleum products by 39 million dollars and the undifferentiated "All other industries" sector by 277 million dollars. However, the reductions expressed as percentages of 1954 output levels are relatively minor, e.g., machinery and services shows the highest with 0.56 percent. The sum of the direct effects on nonagricultural industries amounts to half the initial effects in agriculture caused by the program, i.e., 751 million dollars.

The figures for the total effects include initial, direct and indirect effects. Subtraction of the initial and direct effects leaves a measurement of the indirect effects. Total effects for agriculture show that the direct and indirect effects increase the initial effects by 17 percent. Total effects on nonagricultural industries indicate that an output reduction is generated of approximately the same size as the initial effects of the program in the agricultural sector. A 1:1 relation exists for this program. Thus, indirect effects outside agriculture are as large as the direct effects. For the economy as a whole, total effects are calculated to amount to 2.25 times the initial effects of the program which originated within agriculture. In 1960 terms, this is 3.5 billion dollars as against the original effects of 1.5 billion dollars.

With an industry breakdown, figures indicate that for those sectors originally affected within agriculture, slight increases in reductions occur above the initial effects. Against original reductions of 7.0 percent for the cotton industry, total effects are 7.1 percent; food grains show 17.9 percent for total effects as against 15.4 percent for the initial effects. Among other agricultural sectors, the important total effects are shown on the sector supply agricultural services which suffer a reduction of 3.3 percent (as against 2.8 percent for direct effects).

The calculations provide information on regional total effects of Program 1 for agricultural sectors. These show reductions in line with the distribution of initial effects but they are somewhat increased. The Plains States show reductions of around 8 percent of regional agricultural output in 1954 terms. Other regions suffer reductions varying down to only 1.1 percent in the Northeast.

With the inclusion of indirect effects in total effects, these latter include effects on more nonagricultural industries than is the case for direct effects. Slight absolute and percentage reductions occur for various agricultural processing industries, e.g., for prepared feeds, even though markets are not directly disturbed by the program. Total effects for those directly affected show some further reductions beyond the direct effects. The fertilizer industry suffers a 5 percent reduction (versus 4 percent for direct effects). The chemical industry shows a large increase in reductions due to indirect effects, although the percentage of 1954 output that this represents (0.3 percent) is still small. Nonagricultural industry output is reduced by some 1.3 billion dollars or 0.2 percent of 1954. In contrast, agriculture as a whole suffers a 3.3 percent reduction in 1954 terms.

The same calculations are made for Program 2. The nature of the program and the limitations of the model, however, reduce the information on regional effects of the program. Marked differences are observed from the results of Program 1.

The initial output change in agriculture due to land retirement is 1.9 billion dollars in 1960 terms. This causes further direct effects in agriculture of 1.5 million dollars, i.e., 80 percent of the original impact. On an industry basis, this considerable reduction is due mainly to effects on the livestock industry and, consequently, on the forage crop sector. The sector supplying agricultural services is also reduced directly by more than 3 percent of 1954 output.

Among nonagricultural industries, the direct effects cause a 7.4 percent reduction in the 1954 output of the fertilizer industry. The machinery and services industry is also reduced by 25.4 million dollars which, however, still amounts to only 0.7 percent of 1954 output. The output of the "All other industries" sector is reduced by 327 million dollars (0.09 percent in 1954). The petroleum and chemical industries are also reduced in output to a less important extent. The sum of direct effects on nonagricultural industries is about 2.2 billion dollars which is 145 percent of the initial effects on agriculture.

The total effects for agriculture show that a reduction within this sector of 3.7 billion is produced by the initial change of 1.9 billion dollars. This is almost 200 percent of the original reduction and it is explained by the increased feed grain retirements, the effects on livestock and forage crop requirements and by the effects on the sector supplying services to agriculture. This suggests a 2:1 ratio for the effects of such a program within agriculture alone.

Total effects on nonagricultural industries amount to 4.9 billion dollars in 1960 terms or 264 percent of the original effects in agriculture. Indirect effects are a little less than direct effects, while for agriculture, they are only one-fifth as much. The figure of 264 percent implies a ratio of 2.6:1 for effects outside agriculture.

For the economy as a whole, total effects appear as 8.6 billion dollars in 1960 terms which is 460 percent of the initial impact and implies a relation of 4.6:1 between the initial effects and total effects on the economy.

Information on total effects by industries in the nonagricultural sector indicates that livestock and poultry product industries are reduced by 7.5 percent and the dairy products industry by 4.1 percent; these are in line with the assumptions made. The prepared feeds industry is reduced in 1954 terms by 5.1 percent, the fertilizer industry by 8 percent and the machinery and service industry by 1 percent. Although the "All other industries" sector is reduced in percentage terms only by 0.4 percent, this involves in 1954 absolutes, a reduction of 1.4 billion dollars. All other nonagricultural industries distinguished in the model show reductions but in 1954 percentage terms they are less than 1 percent.

The results have important implications on a firm basis, since we can expect individual firms to be affected to a greater extent than is shown for an industry. Many firms may be forced out of business if they are locally dependent or if they are small scale. Others will be less but still severely affected.

In both programs the absolute real income changes in the economy and by industries are large. These figures have important implications for individual firms within industries affected. Measured against total output, the percentage changes do not appear so great. This is truer for Program 1 than for the second program where more significant percentage effects appear. The measurement of these percentage changes give important perspective to the programs from the wider standpoint of the economy as a whole.

It should be noted that the absolute effects summed over individual industries affected and the multipliers calculated for the effects are not on a GNP basis. Due to the construction of the input-output model, double and triple accounting result in estimating these figures. Multipliers calculated on a GNP basis using value added by sectors would be greatly reduced. Recalculation on this basis is possible with data on value added by sectors. Gross output reductions can also be translated into employment terms using employment by sectors and the percentage reductions in output.

The model and calculations do not take into account the long run effects from reemployment of idled resources, especially labor. If agricultural labor were relocated in agricultural or nonagricultural industries with higher productivity, gross national output could well be increased. On the other hand, the reduced investment which could be expected in affected industries is not included in the calculations.

It is difficult to measure the effects of these considerations. The results of the present study show only the very short-run effects, not allowing for substitution and reallocation of factors, particularly labor. The estimates may be close to the maximum effects which could be expected. They are probably a fairly accurate measure of the effects in the short run, but not at all an accurate measure of the effects in the long run, which probably would be quite different.

BIBLIOGRAPHY

1. Allen, R. G. D. Mathematical economics. London, England, The Macmillan Co., Ltd. 1957.

2. Arrow, Kenneth. Social choice and individual values. Cowles Commission for Research in Economics. Monograph No. 12. New York, N. Y., John Wiley and Sons, Inc. 1951.

3. Bachman, Kenneth. Theories and techniques in aggregative analysis in farm management. Journal of Farm Economics 34: 787-794. 1952.

4. Barna, Tibor, ed. The structural interdependence of the economy. New York, N. Y., John Wiley and Sons, Inc. (ca. 1954).

5. Benedict, Murray B. Farm policies of the United States, 1790-1950. New York, N. Y., The Twentieth Century Fund. 1953.

6. Bishop, R. A. Input-output work as a basis for development planning. Monthly Bulletin of Agricultural Economics and Statistics 5: 790-799. 1956.

7. Cameron, Burgess. The production function in Leontief models. Review of Economic Studies 20: 62-69. 1953.

8. Carter, H. O. Regional input-output analysis of agriculture and industry. Unpublished Ph.D. Thesis. Ames, Iowa, Library of Iowa State University of Science and Technology. 1958.

9. Chenery, Hollis B. Interregional and international input-output analysis. In Barna, Tibor, ed. The structural interdependence of the economy. pp. 339-356. New York, N. Y., John Wiley and Sons, Inc. (ca. 1954).

10. ________, Clark, Paul G. and Pinna, Vera Cao. The structure and growth of the Italian economy. (Mimeographed). Rome, Italy, U. S. Mutual Security Agency. 1953.

11. Clark, Colin. The conditions of economic progress. 3rd ed. London, England, Macmillan and Co., Ltd. 1957.

12. _______. Economic progress and social security. London, England, Macmillan and Co., Ltd. 1946.

13. Dorfman, Robert. The nature and significance of input-output. Review of Economics and Statistics 36: 121-134. 1954.

14. _______, Samuelson, P. A. and Solow, R. M. Linear Programming and Economic Analysis. New York, N. Y., McGraw Hill Book Company, Inc. 1958.

15. Evans, W. Duane. Marketing uses of input-output data. Journal of Marketing 17: 11-22. 1952.

16. _______ and Hoffenberg, Marvin. The interindustry relations study for 1947. Review of Economics and Statistics 34: 97-142. 1952.

17. Fisher, Allan G. B. The economic implications of material progress. International Labor Review 31: 5-18. 1935.

18. Foote, R. J. Analytical tools for studying demand and price structures. U. S. Dept. of Agr. Agriculture Handbook No. 146. 1958.

19. Fox, Karl A. The contribution of farm price support programs to general economic stability. In National Bureau of Economic Research. Report on policies to combat depression. pp. 295-356. Princeton, N. J., Princeton University Press. 1956.

20. _______. Econometric analysis for public policy. Ames, Iowa, The Iowa State College Press. 1958.

21. _______. The measurement of price support costs. Journal of Farm Economics 33: 470-484. 1951.

22. _______. Uses of federal credit in the farm price support programs, 1929-1959. Report prepared for the Commission on Money and Credit. (Mimeographed). 1960.

23. _______ and Norcross, H. C. Some relationships between agriculture and the general economy. Agricultural Economics Research 4: 13-21. 1952.

24. Georgescu-Roegen, N. The aggregate linear production function and its applications to Von Neumann's

economic model. In Koopmans, T. C., ed. Activity analysis of production and allocation. pp. 98-115. New York, N. Y., John Wiley and Sons, Inc. 1951.

25. Grooms, Gerald E. Shipments of feeder livestock and corn among agricultural regions - an application of the transportation model. Unpublished M.S. Thesis. Ames, Iowa, Library of Iowa State University of Science and Technology. 1958.

26. Haavelmo, Trygve. Quantitative research in agricultural economics: the interdependence between agriculture and the rest of the economy. Journal of Farm Economics 27: 910-924. 1947.

27. Heady, E. O. and Candler, W. V. Linear programming methods. Ames, Iowa, Iowa State College Press. 1958.

28. ________ and Carter, H. O. An input-output analysis emphasising regional and commodity sectors of agriculture. Iowa Agr. Exp. Sta. Res. Bul. 469. 1959.

29. Hurwicz, Leonid. Input-output structure and economic structure. American Economic Review 45: 626-636. 1955.

30. Isard, Walter. Interregional and regional input-output analysis: a model of a space economy. Review of Economics and Statistics 33: 318-328. 1951.

31. ________. Regional commodity balances and interregional commodity flows. American Economic Review, Papers and Proceedings 43: 167-180. 1953.

32. ________. Some empirical results and problems of regional input-output analysis. In Leontief, W. W. Studies in the structure of the American economy. pp. 116-185. New York, N. Y., Oxford University Press. 1953.

33. Johansen, Leif A. A multisectoral study of economic growth. Amsterdam, Holland, North-Holland Publishing Company. 1960.

34. Johr, W. A. and Singer, H. W. The role of the economist as official adviser. London, England, George Allen and Unwin Ltd. 1955.

35. Klein, L. R. Economic fluctuations in the United States, 1929-41. New York, N. Y., John Wiley and Sons, Inc. 1950.

36. ________. A textbook of econometrics. New York, N. Y., Row Peterson and Company. 1956.

37. ________ and Goldberger, A. S. An econometric model of the United States, 1929-1952. Amsterdam, Holland, North-Holland Publishing Company. 1955.

38. Koopmans, T. C., ed. Activity analysis of production and allocation. Cowles Commission for Research in Economics. Monograph No. 13. New York, N. Y., John Wiley and Sons, Inc. 1951.

39. Leontief, W. W. The structure of the American economy, 1919-1939. 2nd ed. New York, N. Y., Oxford University Press. 1951.

40. ________ and Members of the Harvard Economic Research Project. Studies in the structure of the American economy. New York, N. Y., Oxford University Press. 1953.

41. Moore, F. T. and Peterson, J. W. Regional analysis: an interindustry model of Utah. Review of Economics and Statistics 37: 368-383. 1955.

42. Moore, Henry L. Economic cycles, their law and cause. New York, N. Y., The Macmillan Company. 1914.

43. Morgenstern, Oskar, ed. Economic activity analysis. New York, N. Y., John Wiley and Sons, Inc. 1954.

44. ________. On the accuracy of economic observation. Princeton, New Jersey, Princeton University Press. 1955.

45. Moses, L. N. Interregional input-output analysis. American Economic Review 45: 803-832. 1955.

46. National Bureau of Economic Research. Input-output analysis: an appraisal. Princeton, New Jersey, Princeton University Press. 1955.

47. ________. Input-output analysis, technical supplement. New York, N. Y., National Bureau of Economic Research. (Multilithed). 1955.

48. National Committee on Agricultural Policy. The farm problem...... What are the choices? Ames, Iowa, Iowa State University Cooperative Extension Service Pamphlets 276 A-L. 1960.

49. Palvia, Chand Mal. An econometric model for development planning (with special reference to India). Institute of Social Studies, The Hague, Holland, North-Holland Publishing Company. 1953.

50. Peterson, G. A. Use of input-output analysis in estimating the interdependence of agriculture and other sectors. Unpublished Ph.D. Thesis. Ames, Iowa, Library of Iowa State University of Science and Technology. 1953.

51. ________ and Heady, E. O. Application of input-output analysis to a simple model emphasising agriculture. Iowa State College Agr. Exp. Sta. Bul. 427. Ames, Iowa. 1955.

52. Polak, J. J. An international economic system. London, England, George Allen and Unwin Ltd. 1954.

53. Quesnay, Francois. Tableau economique. First printed in 1758. Reproduced in facsimile for the British Economic Association. London, England. 1894.

54. Robbins, Lionel. An essay of the nature and significance of economic science. London, England, Macmillan and Company, Ltd. 1952.

55. Röpke, W. Civitas humana: Grundfragen der Gesellschafts - und Wirtschaftsreform. Springer-Verlag, Zurich. 1944.

56. Ryan, J. M. The Leontief system. Southern Economic Journal 19: 481-489. 1953.

57. Samuelson, P. A. Abstract of a theorem concerning substitutability in open Leontief models. In Koopmans, T. C. Activity analysis of production and allocation. pp. 142-146. New York, N. Y., John Wiley and Sons, Inc. 1951.

58. Schnittker, John A. Application of input-output analysis to a regional model stressing agriculture. Unpublished Ph.D. Thesis. Ames, Iowa, Library of Iowa State University of Science and Technology. 1956.

59. ________. Report on economic policies for agriculture in the 1960's. Part 2. Voluntary land retirement. pp. 21-32. Prepared for the Joint Economic Committee, 86th Congress, 2nd Session. Washington, D. C., U. S. Gov't Printing Office. 1960.

60. ________ and Heady, E. O. Application of input-output analysis to a model stressing agriculture. Iowa State College Agr. Exp. Sta. Bul. 454. 1957.

61. Schultz, Henry. Theory and measurement of demand. Chicago, Illinois, University of Chicago Press. 1938.

62a. Schultz, T. W. and Brownlee, O. H. Effects of crop acreage control features of AAA on feed production in 11 midwest states. Iowa Agr. Exp. Sta. Res. Bul. 298. 1947.

62b. Schumpeter, Joseph A. History of economic analysis. New York, N. Y., Oxford University Press. 1954.

63. Scitovsky, Tibor. The state of welfare economics. American Economic Review 51: 303-315. 1951.

64. Shepherd, Geoffrey S. Agricultural price analysis. 4th ed. Ames, Iowa, The Iowa State College Press. 1957.

65. ________. Agricultural price and income policy. 3rd ed. Ames, Iowa, The Iowa State College Press. 1952.

66. ________, Paulsen, Arnold, Kutish, Francis, Kaldor, Don, Heifner, Richard, and Futrell, Gene. Production, price and income estimates and projections for the feed-livestock economy under specified control and market clearing conditions. Iowa Agr. Exp. Sta. Special Report No. 27. 1960.

67. Simon, Herbert A. Models of man. New York, N. Y., John Wiley and Sons, Inc. 1957.

68. Smith, H. M. Uses of Leontief's open input-output model. In Koopmans, T. C. Activity analysis of production and allocation. pp. 132-141. New York, N. Y., John Wiley and Sons, Inc. 1951.

69. Smithies, Arthur. Economic welfare and policy. In Brookings, Lectures on economics and public policy, 1954. pp. 10-24. Washington, D. C., The Brookings Institution. 1955.

70. Tinbergen, Jan. Econometrics. Philadelphia, Pennsylvania, The Blakiston Company. 1951.

71. ________. Economic policy: principles and design. Amsterdam, Holland, North-Holland Publishing Company. 1956.

72. ________. On the theory of economic policy. Amsterdam, Holland, North-Holland Publishing Company. 1952.

73. ________. Business cycles in the United States of America, 1919-1932. Geneva, Switzerland, League of Nations. 1939.

74. Tintner, G. Econometrics. New York, N. Y., John Wiley and Sons, Inc. 1959.

75. ________. Game theory, linear programming and input-output analysis. Iowa State College Agr. Exp. Sta. Stat. Lab. Reprint Series 43. 1957.

76. U. S. Dept. of Agriculture. Crop production - acreage, yield and production of principal crops, by states. Agr. Marketing Service Annual Summary, 1960. Washington, D. C., U. S. Gov't Printing Office. 1960.

77. ________, Agr. Marketing Service. Crops and Markets. Vols. 26-36. 1949-1959.

78. ________. Data Processing Centre Report. Washington, D. C. 1959.

79. ________. A report to the Senate on farm price and income projections under conditions approximating free production and marketing of agricultural commodities. Document 77. 86th Congress. 2nd Session Washington, D. C., U. S. Gov't Printing Office. 1960.

80. U. S. Dept. of Commerce. 1954 Census of agriculture. Washington, D. C., U. S. Gov't Printing Office. 1956.

81. Wald, A. On some systems of mathematical economics. Econometrica 19: 368-404. 1951.

82. Warren, G. F. and Pearson, F. A. Interrelationships of supply and price. New York (Ithaca) Agr. Exp. Sta. Bul. 466. 1928.

83. Waugh, F. V. Inversion of the Leontief matrix by power series. Econometrica 18: 142-154. 1950.

84. Working, E. J. Appraising the demand for American agricultural output during rearmament. Journal of Farm Economics 34: 221. 1952.

ACKNOWLEDGMENTS

The author wishes to express sincere appreciation to Professor G. S. Shepherd for his guidance, tolerance and patience throughout the preparation of this thesis and throughout this whole graduate program. Much appreciation is also extended to Dr. Arnold Paulsen for the useful ideas and perspectives which he contributed to this study. Appreciation is also extended to the other members of the Committee, Profs. Raymond R. Beneke, Howard H. Hines, T. A. Bancroft and C. C. Culbertson for their supervision and guidance.

For the computational procedures and programs developed for various phases of the work and for generous cooperation during the difficult times, thanks are proffered to Mr. Howard Jesperson of the Statistics Department.

Finally the author wishes to express his appreciation to his fellow-students for their many conscious and unconscious contributions in discussion especially to Mr. Yien-I Tu, Mr. Bengt Nekby and to Mr. Antonio Giles.

Needless to say, the author wishes to completely absolve the above from any of the responsibility for errors and omissions which may be attributed to the thesis.