A REGIONAL ECONOMETRIC MODEL FOR POLICY EVALUATION: THE AGRICULTURAL SECTOR OF OKLAHOMA

By

MANUEL RICARDO DEL VALLE

Bachelor of Science
Universidad Peruana Cayetano Heredia
Lima, Peru
1980

Master of Arts
Central State University
Edmond, Oklahoma
1982

Submitted to the Faculty of the
Graduate College of
Oklahoma State University
in partial fulfillment of
the requirements for the Degree of
DOCTOR OF PHILOSOPHY
May, 1989

A REGIONAL ECONOMETRIC MODEL FOR
POLICY EVALUATION: THE
AGRICULTURAL SECTOR
OF OKLAHOMA

Thesis Approved:

Daryll E. Ray
Thesis Adviser

Francis M. Epplin

J. D. Sanders

Edward D. Price III

Norman N. Durham
Dean of the Graduate College

AKNOWLEDGMENTS

I wish to express my appreciation to Dr. Daryll Ray, the major advisor for this study, for his skillful guidance and encouragement. Appreciation is also expressed to the other members of the committee: Dr. Larry Sanders, Dr. Ed Price and Dr. Francis Epplin for their helpful comments.

I am also grateful to Dr. James Osborn, Head of the Department of Agricultural Economics, for the financial assistance provided during this dissertation.

I also wish to thank my wife, Sandra, for her invaluable support, encouragement and sacrifices.

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

LIST OF FIGURES

Figure		Page

Figure Page

CHAPTER I

INTRODUCTION

Overview

For the last five decades public policy in the United States has implicitly favored regulatory measures in agricultural markets. The initial stages of this tendency began in 1862, during the Civil War, when an important change in farm policy was authorized as a result of a coalition of farmers. This emerging social force demanded recognition in the decision making at the national level and its objectives were to improve technology, research and education. Their efforts succeeded and resulted in the Homestead Act which established the guidelines for the creation of the Department of Agriculture, a land grant college system, and other service agencies.

With the onset of the depression, during the late 1920s, pressures to assist the farm sector brought about increased efforts to influence the market system. Authorities favoring a more active role of the government argued that the country could not abandon the farmers who had patriotically responded to the exigencies of war time. The Agricultural Marketing Act of 1929, which was a response to these demands for relief, was designed to encourage collective decisions which would reduce production while leaving the market system intact.

In 1933, during the Roosevelt administration, the Agricultural Adjustment Act of 1933 was enacted as a response to mounting pressures for government relief. With this document, policy makers clearly moved toward an even more active role of government in agricultural markets. Since that time, there has been continuing national debate about the necessity to implement, suspend or alter these government programs.

The advocates of the expansion of these programs have argued that, in the United States, there is a chronic tendency for the agricultural sector to overproduce. This tendency is attributed to the extraordinary ability of agriculture to absorb new technology, the inelastic nature of food demand, and the inability of farm resources to shift easily out of agriculture. Advocates of agricultural programs also point to the instability of the farm sector and its particular vulnerability to drastic economic variations. Furthermore, they claim that since agriculture is the only remaining sector of the economy that is competitive in the classical sense, it is at a disadvantage because of the monopolistic market structures which surround it. The agricultural sector should develop monopolistic market power to present a countervailing force necessary to overcome this disadvantage. Paarlberg (1980), in his book "Farm and Food Policy: Issues of the 1980s", also discusses the commonly held idea that established programs cannot be phased out because their abrupt disappearance would cause serious repercussions in all sectors of the economy.

Opponents of government agricultural programs, on the other hand, argue that the presence of these programs causes United States agricultural products to be non-competitive in the international markets. They point out that the United States often finds itself in the role of residual supplier when other countries design their agricultural prices to be slightly below those of the United States. They further claim that commodity programs are regressive and result in a transfer of wealth from the poor to the rich. When agricultural products are given artificially high prices, poor people who spend a larger share of their income on food are more adversely affected. Furthermore, opponents argue that commodity programs consume sizable government resources, increase taxes, impact on the size of the deficit and become a macroeconomic burden.

The debate generated by the regulatory efforts by the government has also been influenced by the practice of using agricultural products to accomplish international objectives. After World War II, for example, commodity programs were designed to provide incentives for wheat growers to increase production to aid the reconstruction of Europe under the Marshall Plan. Other policies were designed to eliminate large surpluses accumulated because high support prices. For example, during the seven years from 1953 to 1960, technological abundance, high prices and a policy impasse combined to produce enormous surpluses as well as the need for new and more adequate storage facilities. Some of the programs which started during periods of shortages and relative high support prices are politically difficult to phase out, especially during times of large surpluses. Thus, annual government packages are required, which contain additional policies to restrict agricultural supply.

Among the agricultural products of the United States, wheat has been one of the most regulated. Regulation of this crop was fully implemented in the late 1930s within the framework of the "ever normal granary" set forth by Henry Wallace during the Roosevelt administration. The American Farm Bureau Federation was instrumental in shaping agricultural policy and in the implementation of the Act of 1938 which advocated scarcity of wheat to achieve fair prices. The results of these measures were, contrary to expected, a large surplus of wheat by 1942. Another period of surplus followed in 1953 when technological change and high prices produced large surpluses. Periods of wheat scarcity have also existed in the history of this crop; during 1966, wheat stocks were used to meet world food deficits due to the draught in India. Thus, throughout the history of the United States agricultural sector, wheat regulatory measures have been present to achieve perceived national or international needs.

Wheat is grown on more acres than any other cultivated crop in the state of Oklahoma. An average of 7,580,000 acres were planted to wheat from 1983 to 1987, while 506,000 acres were planted to grain sorghum and 387,000 to cotton, the second and third most important crops in Oklahoma. Given these proportions, federal programs that regulate wheat are clearly a fundamental part of the economic history of the state. The acreage harvested to wheat in the state has undergone significant variation in the past decades and this variation stems principally from the presence of federal farm programs.

In the present study, the effects of several proposed wheat commodity programs on the agricultural sector of Oklahoma will be assessed. Since the state is located in a wheat producing region, it is postulated that government programs aimed at regulating the production of wheat will have a significant influence on agricultural variables in the state.

Problem Statement

The agricultural sector in Oklahoma is an important component of the economic activity conducted in the state. Wheat and cattle constitute a large portion of this sector. In 1985, for example, cattle and calf activities comprised 46 percent of cash receipts in the sector, wheat constituted almost 20 percent and government payments--mostly from wheat--totaled 9 percent, as is depicted in Figure 1. Furthermore, the interdependence of these two activities in the economy of the state is enhanced since in the Southern Plains, wheat is frequently used as forage when other options are not economically feasible.

Given the importance of wheat and cattle, the implementation of wheat government programs becomes critical when analyzing the agricultural sector in the state. Since the Farm Bill of 1985, several wheat commodity program reforms have been suggested. It is postulated here that the effects of some features of these measures,

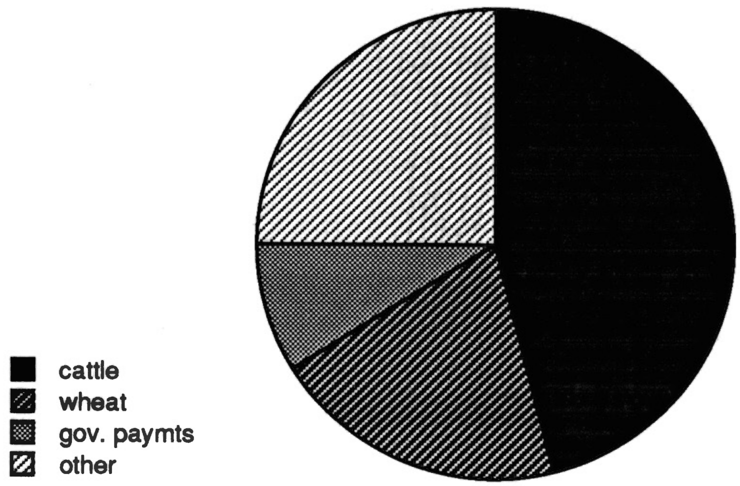

Figure 1. Cash Receipts in the Agricultural Sector of Oklahoma (1985).

on the agricultural sector of Oklahoma are considerable and deserve research attention.

Objective of the Dissertation

The general objective of the present study is to provide policy makers with information regarding the effects of wheat commodity programs on the agriculture sector of Oklahoma. To attain this general goal, the following methodological objectives will be met:

1) To build an econometric model that will include the most relevant variables of the agricultural sector in Oklahoma.

2) To formulate a wheat planted acreage response equation which can be used to assess the effects of wheat commodity programs on the agricultural sector of the state.

3) To establish links between the Oklahoma regional econometric model and large policy evaluation models, to analyze the effects of their projections on Oklahoma endogenous variables.

In addition, using the methodological tools, this study has the following empirical objectives:

1) To assess the effects of the unilateral suspension of commodity programs on the agricultural sector of the state of Oklahoma.

2) To assess the effects of a ten percent reduction in target price on agricultural variables in Oklahoma.

3) To assess the effects of the multilateral suspension of government programs in the United States and its trading partners on Oklahoma agriculture.

Organization of the Study

The present chapter has introduced the subject matter of the study. Chapter II reviews four bodies of literature: large models for policy evaluation, regional models, econometric specification of commodity programs and the rational expectations hypothesis in the supply response literature. The literature review prepares the way for the presentation of the model in Chapter III.

The model is presented in Chapter III, and the equations are discussed theoretically. The acreage response equation and its components, effective support price and expected price, are given important consideration. Chapter IV presents the results and the validation of the model along with its limitations Chapter V contains the results of three simulation exercises, representing recently suggested reforms. Chapter VI contains the conclusions, a summary of the study and presents some suggestions for future research in the area.

CHAPTER II

REVIEW OF LITERATURE

To assess the effects of wheat government commodity programs on agricultural production variables in Oklahoma, four bodies of literature are reviewed in this chapter. First, some of the large agricultural policy econometric models are cited to illustrate the efforts that have been made to carry out policy evaluation at the national level. Second, since policies that affect the state of Oklahoma are given at a national level by central authorities, a review of some regional econometric models is conducted. Third, since the acreage response equation is a pivotal feature of the present model, an overview of the efforts that have been made to specify government programs in the context of econometric models is in order. Fourth, a review is made of the application of the rational expectations hypothesis to agricultural supply response analysis.

Policy Evaluation Models

Since the 1970s, several models have been built to assess the effects of different policies on the agricultural sector of the United States. These models rely on econometric methods and are generally aimed at providing quantitative assessments of the response to the implementation of alternative policy schemes. One of the first models was built by Ray and Heady (1972). The main purpose of their model is to obtain short run and intermediate projections under different policies. The model has a recursive structure and lagged values of endogenous variables are used in successive years. Two-stage least squares and autoregressive least squares estimation techniques are used over a span of a dozen years. This model was the basis for many policy simulation studies at the Center for Agricultural and Rural Development (CARD) at Iowa State University.

The Wharton Agricultural Model was developed four years later by Chen (1976) and was also built for the purposes of short term econometric forecasting, policy evaluation and structural analysis. The model contains four blocks of equations, the livestock and crop block, the crop production block, the income expenditure block and the micro-macro linkage block. This model is privately owned and not accessible to the public.

During the late seventies several models for policy evaluation were developed. Ray and Richardson (1978) report on a model called POLYSIM, which was first constructed in the summer of 1972 and published results were reported in 1973. The main purpose of this model is short-run and intermediate policy evaluation. A Nerlovian approach is used to determine the prices and the model relies heavily on published estimates of demand and supply elasticities. Most equations are determined by these elasticities and baseline data, rather than regression estimations. The effects of the simulated policies are measured in terms of the deviation from a baseline obtained from other sources. Since it was developed, this model has been used to analyze a number of commodity specifications. It was also used by the Economic Research Service (ERS) of the United States Department of Agriculture until the early 1980s.

In May of 1982, the Food and Agricultural Policy Simulator (FAPSIM) was reported by the ERS of the Department of Agriculture. The objectives of the model include the enhancement of intermediate-term economic forecasts and the evaluation of alternative agricultural policies. An important part of the model comprises government policy variables such as loan rates and target prices. Another part includes macroeconomic variables such as population, disposable income and oil prices.

The Food and Agricultural Policy Research Institute (FAPRI) reported another policy model. The FAPRI model includes behavioral relationships for production stocks, exports, imports and consumption of each commodity (Otto, 1985). The livestock sector and the crop sector are linked and reflect the simultaneity of price determination. The cross commodity influence of government policies are analyzed.

Other models constructed during the 1980s include: the NIRAP (Jaske, 1977) for intermediate and long-run projection, the DRI Agricultural Model (DRI, 1977) for short run and intermediate-term policy evaluation and projection, the CHASE (Chase Econometric Associates, 1977) and the AGRIMOD (Ducot and Levis, 1977).

A more recent model, the COMGEM (Penson, et. al., 1984), uses a standard macroeconomic model as a starting point, and traces de effects of these macroeconomic variables on a disaggregated agricultural sector. In 1987, the AGSIM model (Taylor, 1987) was reported. This is an econometric-simulation model of regional crop and national livestock production. The model is built to analyze the impacts of a number of variables such as technological change and farm programs, which affect agriculture.

The above mentioned models assess the impact of a number of policy options on the agricultural sector of the United States. Most of these models deal with the effects of suggested farm programs but they can also be used to analyze the impact of other macroeconomic variables. All these models, with the exception of the AGSIM, analyze the effects of farm programs on the agricultural sector at the national level. In the model that is presented in the next chapter, the effects of farm programs on a particular state, namely Oklahoma, will be assessed.

Regional Models

To assess the effects of a group of policy variables on a particular region, two basic models have been proposed in the literature. One of them, the bottom-to-top approach, is based on the assumption that a significant simultaneous two-directional relationship exists between regional and national variables. This methodology, in which national variables are computed as a summation of regional variables, allows the researcher to conduct consistency checks. Nevertheless, this method becomes impractical since it requires a large amount of inter-regional trade data which are not readily available.

The second basic regional model is the top-to-bottom approach, which has been more widely used in the construction of regional econometric models. The procedure used in top-to-bottom models is based on the assumption that regions are satellites which are passive receivers of external influences. Econometrically, regional endogenous variables are specified in terms of both, national and regional predetermined variables as follows:

$$Y = F(X, Z, B, ¥, e)$$

where Y is a vector of regional dependent variables; X is a vector of predetermined regional variables; Z is a vector of nationally determined variables; B is a vector of parameters associated with the predetermined regional variables; ¥ is a vector of parameters associated with the predetermined national variables; and e is a vector of random disturbances.

Top-to-bottom models are usually used in conjunction with macroeconometric models which provide the national predetermined variables. These macroeconometric models are used by the regional modeler to obtain exogenous regional variables and to build scenarios. This approach clearly has intuitive appeal when the region is small and unable to influence the macroeconomy.

Glickman (1971) built a regional model following the top-to-bottom approach and applied this methodology to estimate an annual econometric model for the Philadelphia Standard Metropolitan Statistical Area. His motivation in conducting the research was to more clearly establish the relationship among the variables between several regions. The author selected two stage least squares to investigate simultaneous relationships. After validating the model using historical data, several simulation experiments and forecasts were performed. The author defended the use of econometric models in analyzing regional variables and showed the superiority of these models, over input-output models. He suggests a combined model for further experimentation.

The exogenous variables in Glickman's model include gross national product, investment levels, average sector wages, and local tax rates. Endogenous variables include the following regional variables: unemployment, average sector wages, non-wage income, total employment and gross product.

Another top-to-bottom regional model was built by Crow (1973) to assess the effects of alternative military expenditure decisions on a large economically open area called the Northeast Corridor. This model was used in tandem with the Wharton Economic Forecasting Associates model to establish, as in Glickman's model, the linkages between regional variables and to investigate the impact of alternative military expenditures in the Corridor.

The core of Crow's model had a group of gross product equations which included the actual supply of residential construction and expected demand for residential construction as major components. He also used a group of equations to model gross product and employment by industry in the region. The specification also included wage and price equations, which were expressed in terms of annual earnings per worker. Complexity was added by allowing property income to be earned outside the region.

Crow's model treated four important sectors: mining, contract construction, manufacturing and agriculture. The latter was not treated in detail; an agricultural gross product equation was used in conjunction with agricultural employment and wage equations.

The agricultural sector in Crow's model is led by the regional consumer price index. The regional CPI determines the wage rate in the agricultural sector of the Corridor, as well as sector and regional employment. The link to the national variables is established by the Corridor's agricultural gross product which is a function of the national wholesale price index.

A similar model was built by Adams, et. al. (1975), to explore the influence of national variables on regional economic variables for the state of Mississippi. The structure of the model utilizes several exogenous variables determined nationally: manufacturing, wage rates and durable manufacturing output. Their influences are traced directly to the state level. The regional endogenous variables include: investment, highway construction, and population.

Farm output and the agricultural sector of Mississippi are defined as exogenous regional variables. Employment in the agricultural sector, which is a function of farm output, is a significant determinant of the transportation sector real output and an important component of the gross state product. No explanatory variables are provided for the farm output variable, it is only tangentially analyzed to compute "macroeconomic" variables of the region.

Several regional models, in which the agricultural sector was not included were built in the mid 1970s. Ballard and Glickman

(1977), for example, built an ambitious regional model for the Delaware valley incorporating the sophistication and reliability of modern computer facilities. Single region models were combined into a multiregional model using an interaction variable to analyze the following sectors and their linkages: manufacturing, construction, transportation, retail trade, insurance, real estate and government.

Hall and Licari (1974) replicated Glickman's model for the city of Los Angeles. The model describes five sectors, manufacturing, wholesale and retail trade, financial services, construction and government. Gross national product, population, and national wage rates are exogenous variables. The model also contains several policy variables: the tax rate and federal revenue sharing. The authors report that the Los Angeles model was a successful application of Glickman's paradigm.

L'Esperance, et. al. (1975), built a regional model for Ohio that departed somewhat from the models described above. The authors set forth a model that incorporates input-output techniques into the econometric regional models. The model is developed by using a six sector input-output tableau that is later attached to an econometric model. The purpose of the paper is to forecast industry employment using the final demands estimated by the econometric model.

Azzam, et. al. (1987), built a state econometric model to analyze the interaction between the livestock and feed sectors in Nebraska and the rest of the United States. They attempted to solve the dilemma of the feedback between regional and national variables by building a symmetric model in which national and regional variables are determined simultaneously. This model establishes the interrelationship between the state and the rest of the nation by assuming that national and regional prices are determined simultaneously by the regional supply-demand balance. They develop and test a two-region, three-commodity, non-spatial equilibrium model. The two regions are Nebraska and the rest of the United States.

Subsequent to the validation of the model, the authors explored the effects of exchange rate fluctuation on the endogenous variables. The first scenario analyzes the impacts from a sustained fifty percent appreciation of the US weighted exchange rate above historical levels. They concluded that exchange rates significantly influence the supply and demand for corn. The second scenario examined the effects of changing the composition of beef exports between fed and non-fed beef.

Otto, et. al. (1985), of Iowa State University, built a regional model for the state of Iowa and conducted an analysis by linking it to the FAPRI national model. The regional model obtained values from the national model to calculate final regional demand. This final demand is later used in an input-output tableau to analyze interindustry flows. The input-output tableau comprised the agricultural sector, agricultural services, construction, manufacturing, transportation, trade, services and government. Three policy options are simulated: the market option, the expanded export base line and an eighty percent parity option.

Ray and Zeller (1978) reported a regional model for Oklahoma. The objective of the model is to project farm income and other agricultural sector measures that could then be integrated into another state econometric model. The Ray/Zeller model contains 54 equations, 15 of which are identities and 39 are behavioral relationships. Cash receipts equations are included for the major crops: wheat, sorghum, peanuts and cotton.

The regional models discussed thus far have primarily concentrated on econometric techniques and the top-to-bottom regional approach. Their main objectives were to estimate and analyze "macroeconomic" regional variables--such as gross regional product, sector regional employment, sector regional government revenues and residential construction--and selected agricultural variables.

A top-to-bottom econometric model is used in the present study to analyze the effects of alternative farm programs on the agricultural sector of Oklahoma. The method is justified because variables that affect state wheat production, namely government commodity programs and market forces, are determined nationally. For example, as illustrated in Figure 2, the U.S. price of wheat and the Oklahoma price of wheat move simultaneously. It is posited that the variables that influence the national price, also influence the regional price of wheat.

Government commodity programs are another illustration of how nationally determined variables affect regional production variables. Some program components, such as target prices, are announced nationally and can clearly be modeled as exogenous. Others such as loan rates or acreage allotments are determined at the state or county level to account for different transportation costs. Nevertheless, these local variables are highly correlated with their

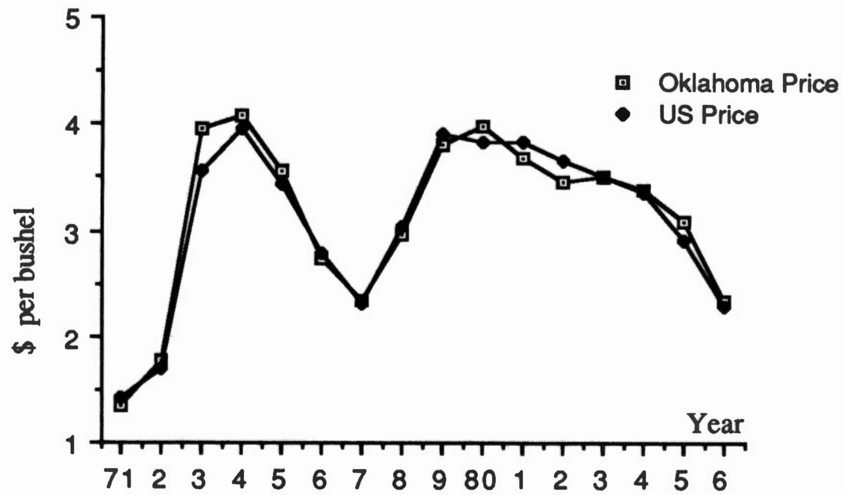

Figure 2. Winter Wheat Prices

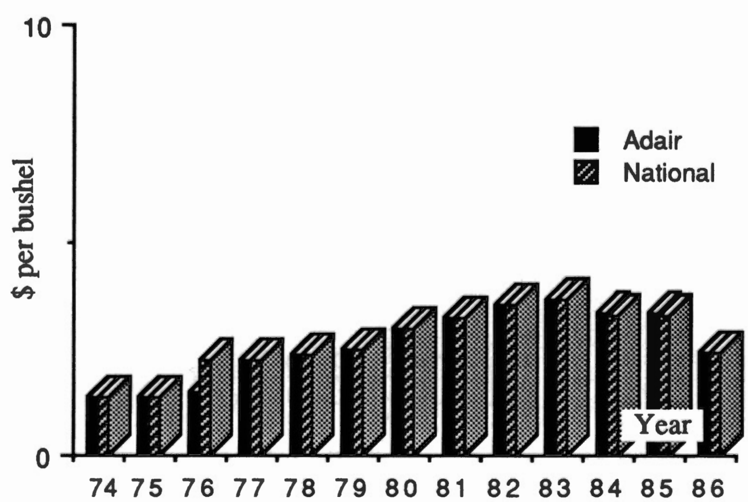

Figure 3. Wheat Loan Rates

national counterparts. For example, the loan rate established for Adair county in Oklahoma is highly correlated with the national loan rate, as it is depicted in Figure 3.

A top-to-bottom approach is also justified by the competitiveness of agricultural activities in the state. Oklahoma agricultural markets exhibit neither monopolistic nor oligopolistic tendencies in the major commodities. The agricultural sector in Oklahoma is therefore a price taker and national influences such as policy variables and market forces should be taken exogenously.

The Specification of Government Programs

Farm commodity programs have been implemented in the United States since the enactment of the Agricultural Adjustment Act of 1933. From 1933 to the early 1960s, these programs aspired to stabilize farm incomes through price supports and supply controls. In 1960, large stocks of agricultural products held by the Commodity Credit Corporation led Congress to change agricultural policy. More attention was directed to farm income support and less to farm income stabilization, while simultaneously it was sought to decrease large stocks. These policies were continued in the 1970s, as export demand grew rapidly. The 1980s saw some changes as commodity programs moved aggressively to reduce production. Each one of these policy changes created their own instruments, some of which have continued irrespective of their original justification.

The instruments used to implement commodity programs can be divided in three broad categories: price support policies, direct payments, and supply controls. Price support measures are designed to prevent the price of farm commodities from falling too rapidly when supply is greater than demand. These price support mechanisms can be implemented through nonrecourse loans or by commodity purchases. Nonrecourse loans are dollar values announced by the Secretary of Agriculture before the planting season. If post-harvest market price is too low farmers have the option of using their crops as full repayment of the loan. This last characteristic makes nonrecourse loans to play the role of floor prices. The other mechanism for implementing price supports is through the purchase of commodities to withdraw surplus from the market and maintain a predetermined price level.

A second option open to agricultural policy makers is direct payments to farmers. The magnitude of these direct payments has recently been determined by a target price which, like the nonrecourse loan rate, is announced yearly by the agricultural authorities. The nonrecourse loan rate, the market price and the target price interact as follows: if the market price is higher than the target price, farmers will redeem their loans and are expected to sell their commodities freely in the market. If the market price is below the target price and above the nonrecourse loan rate, participating farmers will also redeem the loan, sell their product in the market and receive a deficiency payment equal to the difference between the target price and the market price. And lastly, if the market price is below the loan rate, the producer will default on the loan and keep the loan rate value of his crop; in addition, he or she will receive a deficiency payment equal to the difference between the target price and the loan rate.

Another form of direct payments to producers is compensating them for diverting a certain proportion of their base acreage. For example, the wheat program of 1984 contained a Paid Land Diversion program by which wheat growers were paid $2.70 times the normal yield for a maximum of ten percent of idled land. Disaster payments are another form of direct payments which compensate farm incomes adversely affected by natural forces.

The third instrument available to agricultural policy makers is supply control. These measures can be carried out four ways: acreage allotments, marketing quotas, crop land set-asides and acreage diversion payments. Acreage allotments, if implemented, are announced every year as a proportion of national land that will be planted to satisfy domestic and/or international demands. This national allotment is then broken into state allotments and later into county allotments. Marketing quotas are used, in combination with acreage allotments, to restrict the marketing of certain commodities by establishing penalties on excess production. Crop land set-asides are also an important way to control supply. Producers, to be eligible for nonrecourse loans and target price benefits have to idle some proportion of their normal acreage. The fourth means to control supply are paid acreage diversion programs and are sometimes called voluntary acreage diversion programs. Farmers must often participate in unpaid acreage diversion programs to be eligible for participation in paid diversion programs.

Government programs usually consist of a combination of price support measures, direct payments and supply controls. The effects of these government packages have progressively become difficult to interpret since they were implemented in 1933. The influence of these government programs on the agricultural sector is significant and the supply inducing price for the main crops in the United States cannot be estimated without taking these programs into consideration. Several ways to specify government policies in an acreage response have been developed, and in what follows a review of literature on these specifications is conducted.

The Lidman and Bawden Approach

One of the early attempts to estimate the effects of government programs on wheat acreage was conducted by Lidman and Bawden (1974). The authors used U.S. data for the period 1934 to 1968 to analyze the annual variation of acreage planted to wheat. The authors used four explanatory variables in their specification: lagged acreage planted to wheat, lagged market price, acreage allotment and the loan rate. A dummy variable was also included to indicate the years when the allotment was in effect. All coefficients except lagged price were statistically significant. This indicates that market factors were overshadowed by the influence of government programs. In this study, the loan rate has a negative sign implying that an increase in the loan rate would reduce planted acreage to wheat. In Lidman and Bawden's model, the loan rate was introduced through two mechanisms: as an incentive to participation and as a component to price formation. These two roles for the loan rate act in opposite directions. The negative sign indicates that the "participation" effect prevailed. The authors also disaggregated the time series data to investigate groups of years in which other programs were in effect.

The results obtained in this study prompted the authors to conclude that government programs--expressed in this model by the loan rate, current, lagged allotment and the allotment dummy variable--were more influential on acreage planted to wheat than the expected market price.

Garst, et. al. (1975), follows a similar approach to estimate acreage planted to wheat in the United States. As in Lidman and Bawden, the authors specified single policies, each with one regressor. The authors report results for winter-wheat states and spring-wheat states under two different scenarios: with and without the expected market price--specified in this model as the simple lag of market price. This model used wheat allotment, additional diversion, wheat set-aside, lagged price, a no allotment dummy and a relaxed allotment dummy as explanatory variables.

The results show that the signs of the coefficients are consistent with economic theory, wheat allotment is positively related to acreage planted to wheat and is highly significant. The additional diversion variable is moderately significant and carries the correct sign. The set-aside program also has the correct sign but is not significant. The lagged price is highly significant, indicating, contrary to Lidman and Bawden, that last year's price is an important factor in explaining the variation of acreage planted to wheat in the United States. The authors conclude that the set-aside and diversion programs have been effective in reducing planted acres and that the model fits the data well.

In a recent effort to estimate wheat supply elasticities, Burt and Worthington (1988) use a similar methodology to specify government programs in the context of a supply response equation. In the time series used in the study, from 1945 to 1977, the following government programs were suggested as explanatory variables: allotments, not allotments, marketing quotas, acreage reserves (three dummies), certificate payments, diversions and set-asides. This study, uses a total of sixteen regressors in its wheat supply response equation and entails 34 observations. The use of observations before 1965 is questionable for short term forecasting since the coefficients are subject to change over long periods of time.

The specification set forth by Lidman and Bawden, as well as the ones posited by Garst, et. al., and Burt, et. al., are typical cases in which each government program is introduced individually. Each government program requires at least one regressor. As commodity programs become more complex--the trend has been toward combinations of larger numbers of single policies--this approach can rapidly be restricted by the loss of degrees of freedom. Thus, this approach can be useful to analyze single policies that have been in effect for long periods of time--such as the loan rate--but it becomes impractical when analyzing complex and varied packages of government programs.

The Helmberger Approach

The Helmberger approach is an alternative to the specification of farm programs in supply response equations. This alternative acknowledges the possibility that supply functions may change because of government intervention. Thus, a time series may have to be disaggregated into subperiods, each reflecting a different set of policies.

Morzuch, et. al. (1980), when estimating United States wheat acreage supply response under different government programs, used the Helmberger approach. The authors divide the history of wheat programs into two periods: one when the market system was prevalent and the other when government programs were extensive. The equation for the market years (1948-49, 1951-53, 1974) is as follows:

$$WAP = \phi_0 + \phi_1\ ERP + \phi_2\ TREND + e$$

where: WAP represents acreage planted to wheat; ERP represents the expected relative price--the futures price of wheat divided by an index of expected prices for competing crops--TREND is included to account for technological change and e is an error term. The equation for the years of extensive government programs (1965-1973) is specified as:

$$WAP = ¥_0 + ¥_1\ ERP + ¥_2\ TREND + ¥_3\ RUDC + ¥_4\ MAXD + e$$

where: ERP and TREND are as explained above, RUDC is the estimated diversion payment per bushel divided by an index of expected prices for all other crops and MAXD is the upper limit on the permissible diversion.

The authors reported results on thirteen wheat producing states including spring-wheat states. The empirical results for the state of Oklahoma during the "policy regime" show that the coefficient of variation for Oklahoma is relatively low compared to other states. Furthermore, Oklahoma is the only one state where RUDC has counterintuitive results. Diversion payments are directly related to acreage planted in Oklahoma. The expected relative price--ERP--has the expected sign and is significant. Results for all thirteen states indicate that the specification of Morzuck, et. al., performed poorly.

The authors explored another period in the history of government programs when a different set of policies--land diversion--demanded a different specification. This third specification is as follows:

$$WAP = \beta_1 + \beta_2\ ERP + \beta_3\ WAL + \beta_4\ PERRU + \beta_5\ MAXD + u$$

where; WAP, ERP and MAXD were defined as above, WAL is the wheat acreage allotment, and PERRU is a ratio between the bushel payment for land diversion and the loan rate. The results of this second formulation for the state of Oklahoma also show counterintuitive results, namely that the expected price is negatively related to acreage planted. The wheat acreage allotment variable had the expected sign and is significant, while PERRU shows the correct sign and is not significant. The specification, under the second specification also did poorly for the state of Oklahoma while other states showed better coefficients of variation and more consistent and coherent coefficients.

Using a similar procedure, breaking down the time series into subsamples, Lee, et. al. (1985), estimates the supply response for corn and soybeans in Corn Belt states for the 1948-1980 period. The model for the market years (1948-49, 1951-53, 1959-60, 1974-77, 1980) is as follows:

$$AC_{it} = f_i\ (PCX_{it-1}, PSX_{it-1}, T)$$

where AC_{it} is acreage planted to corn (1000 acres) in state i, in year t, PCX_{it-1} and PSX_{it-1} are the state prices of corn and soybeans relative to a variable input price index , and T is a trend variable.

The model for the farm program years is:

$$AC'_{it} = g_i\ (PCX_{it-1}, PSX_{it-1}, FPP_{it}, ADV_{it}, T)$$

where FPP_{it} represents expected feed grain program payments available to producers in dollars per required idled acres. The variable FPP, incorporates estimates of the three main types of participation incentives that were applicable during the periods 1961-73 and 1978-79: a) price support loan incentives, b) payments for required diversion and c) a series of price support, set-asides and deficiency payments. The FPP variable is designed to represent the incentives for the farmer to idle acreages; treating idled acreages as a "crop". Increases in this variable indicate greater incentives for participation which are expected to result in lower corn plantings.

The voluntary diversion acres, ADV, are measured as the maximum allowable level of acreage diversion

The authors used a restricted version of Park's three-stage Aitken model to obtain the empirical results for the farm program regime for Illinois corn. All the signs of the coefficients followed a priori predictions and all are significant.

The Helmberger, et. al., and the Lidman, et. al., approaches postulate alternative ways of specifying government programs in the context of supply response equations for agricultural commodities. Both frameworks reveal their limitations when the number of policy instruments increase and the degrees of freedom decrease. The Houck and Ryan approach that is described below provides a framework to circumvent this problem.

The Houck and Ryan Approach

Houck and Ryan (1972), in an effort to avoid the degrees of freedom problem, provide a theoretical framework to evaluate farm commodity programs in the context of the analysis of the supply of corn in the United States for the period 1948-70. The theoretical framework provided in the article is an important breakthrough in the efforts to investigate the supply response of crop growers to government programs. The method has been used continuously in other articles throughout the mid-1980s in the computation of supply inducing prices for major crops in the United States. Houck and Ryan posed the problem in terms of combining the price and income features of annual programs and their acreage controlling aspects into a few quantitative variables. Houck and Ryan's framework is set forth with the following equation:

$$PF = r\ PA$$

where: PA is the announced support price, PF is the weighted support price and r is an adjustment factor embodying the planting constraint associated with the announced support price. When there are no planting restrictions, r equals one, and the announced support price becomes the effective support price. The more rigorous the planting restrictions the closer r is to zero.

During some years and for some crops, direct payments were offered to farmers to idle land in an effort to reduce crop supply. The concept of weighted diversion payments was constructed following a similar procedure:

$$DP = w\ PR$$

where: DP is the weighted diversion payment, PR is the announced diversion payment, and w the adjustment factor. The coefficient w is equal to one if there is no limit in the acreage eligible for diversion. The smaller the allowed diversion the closer w is to zero.

Following these guidelines, the authors built two variables, weighted support price and weighted diversion price, which were used to obtain corn supply functions. Other explanatory variables included are soybean support loan, acreage planted to sorghum and trend. The results for acreage planted to corn in the United States show that the weighted support price had the correct sign and is statistically significant, indicating that the higher the support price the more acreage planted to wheat. The weighted diversion price is inversely related to planted acreage and highly significant, implying that for the case of corn, the diversion measures accomplished their goals. The coefficient of the competing enterprise, soybeans, has the correct sign and is significant as well as sorghum. Trend is negative.

Other works using the Houck/Ryan approach followed. The one published by Houck et. al. (1976) is a more comprehensive study of the United States crops, in which the concepts of weighted support price and weighted diversion price acquire a more appropriate nomenclature i. e. effective support price and effective diversion payment variables. Both of these are used to estimate the planted acreage to the main crops in the United States. The estimated supply equation for acreage planted to wheat shows that policy variables, represented by the effective price support and voluntary diversion rates, are important in explaining the variations of planted acreage. The lagged market price, representing market forces, is highly significant. The other policy variable, effective diversion payment, has the correct sign but plays a small role in explaining acreage planted to wheat in the United States. Weather, expressed by the range condition variable, was also significant. The validation, conducted with historical data, shows good results but the wheat model did not perform as well. In a cautionary note Houck et. al. make the following statement:

> In analysis of this kind, much of the potential success hinges on the construction, by the researcher, of internally consistent and reasonable variables to reflect

> both price and policy changes. Obviously, this places an additional responsibility on the investigator as compared with more traditional econometric supply response studies. Unfortunately, there is no single method of unambiguous approach that emerged from these studies for constructing effective support price levels and related variables. The general methodology seems appropriate, but the details depend upon the commodity and the times.

This cautionary note, which establishes the limits of the specifications set by Houck, et. al., did not prevent other researchers to fruitfully use the concepts of effective support prices and effective diversion payments that follow these guidelines. Duffy (1985) expanded the series of effective support prices and effective diversion payments from 1974 to 1983 using the same framework, with some adjustments to account for the different set of government policies that were enacted during that period. The mechanics of the computation of these series will be treated in detail in the next chapter.

A practical application of these supply inducing prices is carried out by Duffy, et. al. (1987), to estimate the cotton acreage response for four distinct production regions in the United States. The equation is formulated as follows:

$$PA_{it} = a_i + b_i\ SPC_{it} - c_i\ EPO_{it} + d_i\ PA_{it-1} - e_i\ ADP_{it} + f_i\ T_t + U_{it}$$

where PA_{it} is thousands of planted acres in region i at time t, SPC_{it} is the supply inducing price in region i at time t, PA_{it-1} is thousands of planted acres in region i at time t-1 and EPO_{it} is the supply-inducing price of a competing enterprise i, at time t. The variable ADP_{it} is the effective per acre diversion payment for cotton in dollars at time t; T is a linear trend variable valued at 1 in 1959. The variable ADP, effective diversion price, is directly taken from Houck, et. al. (1976), and Duffy (1985) while SPC, the supply inducing price of corn is taken from Romain (1983).

Romain's specification of the supply inducing price takes as a starting point the assumption that during years when the effective support price is higher than the expected market price, the former should be a good indicator of supply response, while when the expected market price is higher than the effective support price, then a weighting procedure is in order. The weighting procedure is as follows: first, the ratio of expected market price and effective support price is calculated as follows:

ratio = expected market price / effective support price

this ratio will necessarily range between zero and one, because if effective support price is higher than the market price no weighting procedure is applied and the effective support price will become the supply inducing price. The second step is to compute the actual weight which is obtained with the following formula:

weight = 1 / (1 + ratio)

this weight is used, in turn, to compute SPC, the supply inducing price, as follows:

SPC = weight * expected price + (1- weight) * support price where Romain's series is used by Duffy as the SPC variable. The ordinary least squares procedure is utilized to obtain the estimates of the coefficients.

The authors later use a GLS model with one and two restrictions to compute the regression coefficients. The results for the Southern Plains are similar, except that the coefficient for the trend and the expected price of the competing enterprise are not significant. The supply inducing price and the effective diversion price carried the correct sign and was highly significant

In another article, Bailey and Womack (1985) estimate wheat acreage response for the five regions of the United States using the specification by Houck and Ryan. They use a theoretical risk model that relies heavily on Hazel and Scandizzo (1974), to obtain the supply function for wheat. The empirical results, using ordinary least squares, are reported by Bailey and Womack for the five regions of the United States.

The expected price of wheat is significant and carries the correct sign. The effective diversion rate has the correct sign but is not significant. Risk is not significant but carries the correct sign and lagged acreage is statistically significant giving credence to Nerlove's partial adjustment model.

Bailey and Womack's contribution to the efforts to compute the supply inducing price under government programs is the alternative procedure to weigh the importance of the expected price as a percentage of participating producers. In addition, the introduction of risk, following Gallagher's specification, is an interesting component, even though it is not significant in the regression.

The literature on supply inducing prices for major commodities in the United States started with Lidman and Bawden, in which each policy instrument was given a regressor. This methodology was later superseded by Helmberger as a result of the increased number of policy instruments that emerged during the 1970s. The large number of instruments still impeded a smooth econometric treatment because of the constrain posed by the degrees of freedom in the regressions. Some of these programs had been active for only a few years and did not justify a separate regressor. To avoid this problem, Houck and Ryan proposed grouping the large number of policies into two variables that would capture the price support and income support nature of the policy variables.

In later articles, the Houck/Ryan approach is used widely, but the focus shifts to the relationship between the expected market price and the constructed variables. The issue of weighting these two supply inducing forces has also become subject of research. Both, Romain, and Bailey, et. al., offer two different weighting procedures, both of them asymmetrical in the sense that when support price is higher than expected price, the former becomes the supply inducing price and when the expected price is higher than the effective support price, then the latter was still supposed to play a role in the supply inducing price.

Rational Expectations and Supply Response

A review carried out by Askari and Cummings (1977) of approximately 500 studies dealing with supply response specifications, shows that the Nerlovian framework had dominated the research in this area. The nature of agricultural supply functions had a more prominent proclivity to fall under this framework because of the chronology of agricultural activity. At planting time, the decision of which commodity to plant and how much acreage to plant depends critically on the expected price of the commodity in question and on the expected prices of substitutes and complements. Thus, the logical procedure to follow is to include a lagged price explanatory variable in the supply equation. Furthermore, the Nerlovian framework is helpful in explaining the instability and the cyclical nature of agricultural production. If, during the planting season, current price is perceived to be low then acreage planted would decrease, and small harvests the following year would result in higher prices. The stability of the model and the existence of a long-run price equilibrium is dependent on the elasticities of the supply and demand curves.

There are many instances, in the field of economics, where the expectation of future variables plays an important role in the evolution of real variables. For example, in the dynamics of hyperinflation, macroeconomist Cagan stated that the expected value of inflation has repercussions not only on its own value, but on other real variables as well. Expectation of variables are also important in agricultural supply specifications, and it was in the context of a cobweb model that the Rational Expectation Hypothesis (REH) was first set forth by Muth (1971) as follows:

> ..., I should like to suggest that expectations, since they are informed predictions of future events, are essentially

> the same as the predictions of the relevant economic theory. At the risk of confusing this purely descriptive hypothesis with a pronouncement as to what firms ought to do, we call such expectations "rational". It is sometimes argued that the assumption of rationality in economics leads to theories inconsistent with or inadequate to explain, observed phenomena especially changes over time....Our hypothesis is based on exactly the opposite point of view: that dynamic economic models do not assume enough rationality.

Curiously, the article written by Muth did not generate interest for a decade, and was not seriously quoted until the early seventies when theorists such as Lucas, Sargent and Rapping, established a research program that resulted in important revisions of traditional macroeconomics.

Much criticized for its simplicity, the rational expectations hypothesis (REH) states that the behavior of the model is consistent with the beliefs of individual actors about the behavior of the economic system. The subjective expectation of economic agents are, on the average, equal to the true values of the variables in the economy. This seemingly trivial statement generated, during the seventies, several works that resulted in important results such as the "policy ineffectiveness proposition" in which policy variables, when foreseen with no systematic errors by economic agents, do not affect real variables. The money supply is ineffective in altering real income and the REH theorists posited a vertical Phillips curve even in the short run.

In conjunction with the theoretical evolution of the REH, empirical efforts have been conducted to incorporate the hypothesis in econometric models. Equations which contain the specification of an expected variable as an argument are subject to treatment under REH. Expected values of variables are frequently encountered in macroeconomics and in agricultural supply response equations.

Two basic econometric specifications of the REH have been set forth in the literature. First, the error in variables method, where the expected variables are replaced by the realized values of the expected variables plus a random error. Second, the substitution method, which consists in replacing the expected variable with forecasts of the same variable. The desirable properties of these two methods permit the modeling of economic agents as if they did not make systematic errors in their expectations, a crucial requirement to comply with the REH.

In the agricultural supply response literature, Shonkwiler and Emerson (1982), using the substitution method, incorporate the rational expectation hypothesis to estimate the supply of winter tomatos in Florida. The model specification used the substitution method in a supply and demand system of equations. The exogenous variables, expected price and expected consumption, are replaced by autoregressive forecasts of degree one.

Seale and Shonkwiler (1987) also use the substitution method in the context of a supply response model, which incorporates risk. The empirical estimation is conducted with data for watermelons grown in Florida. The model is described with three equations, namely, acreage planted, yield and price. The REH is introduced in the expected price at harvest time and in the anticipated cost of labor. The authors conclude that changes in risk have a significant effect on the annual change in acreage allocated to watermelon production. This study is conducted on an unregulated commodity market and the authors express curiosity at what effect will this specification have, including risk, when analyzing commodities which are heavily regulated by government programs.

Shideed and White (1988) use the error in variables method to incorporate the REH in an agricultural commodity model. The objective of the study is to estimate the supply response of soybeans in Georgia. The theoretical framework follows the model presented by Wickens (1982). The model consists of two equations, one for planted acreage and the other for yield, through which the REH is introduced. The authors use Two Stage Least Squares techniques to estimate consistent and asymptotically efficient coefficients. Ex-post forecasts are performed to validate the model.

White, Shideed, Brain and Glover (1988) also apply the error in variables method to analyze the supply response for double-cropping soybeans and wheat acreages in the South East. The model is described with four equations: planted acreage to wheat, soybean double cropped acreage, soybean single cropped acreage and total soybean acreage planted. A two step two stage least squares (2S2SLS) estimation method, proposed by Cumby et. al. (1983) was used. This technique corrects for serial autocorrelation in simultaneous equations and provides consistent and asymtotically efficient estimators.

The model presented in the next chapter, includes an acreage supply response equation, through which the impact of government programs will be assessed. The benefits of the theoretical imposition of the REH on Oklahoma wheat growers will also be evaluated.

Summary

In this chapter four bodies of literature were reviewed. First, large econometric models designed principally for policy evaluation are presented to expose the different efforts that have been made to assess the effects of different policies on the agricultural sector at the national level.

Second, a review of regional models was conducted to present several ways of linking the variables at the national level to their counterparts in a particular region. Third, the different efforts that have been made to specify government programs in the context of an econometric model were reviewed. Three main approaches dominate the area: the Bawden/Lidman approach, the Helmberger approach and the Houck/Ryan approach. Lastly, a review of the somewhat brief literature on the application of the rational expectations hypothesis to agricultural supply response is conducted.

The model presented in the next chapter combines the four bodies of literature reviewed here. It is a regional econometric model to evaluate government programs which incorporates the partial rational expectations hypothesis as well.

CHAPTER III

THE MODEL

Overview

The objective of the regional model described below is to assess the effects of different wheat commodity programs on agricultural variables in the state of Oklahoma. Wheat commodity programs are comprised of several instruments announced annually which significantly influence planting decisions. The effects of some of these instruments are analyzed using the model described below.

The regional character of the model is made explicit by the clear relationship that exists between certain agricultural variables in Oklahoma and the same variables at the national level. For example, wheat government programs, which affect all states, are exogenous. Likewise, the national price of agricultural commodities is the result of national and international market forces that preclude the influence of an individual state on the market. Therefore, in modeling these relationships, some regional variables are posited to be derived directly from its national counterparts. The numerical values of the variables at the national level are obtained from POLYSIM and FAPRI.

The supply inducing price that is used in this model has to include, on one hand, the policies that are yearly announced by the authorities, and on the other hand, some representation of the market forces. These two components are frequently found in the literature as elements that explain the formation of supply inducing prices. In very few instances, the wheat supply inducing price has been solely dependent on the market mechanism nor on the policy variables.

The present model, described in a block diagram in Figure 4, postulates that the wheat supply inducing price unleashes a chain of causality in several important agricultural variables within the state, which implies that the model described below relies on recursive causal mechanisms. Most recursive models do not call for simultaneous equation techniques, instead, they rely on ordinary least squares or generalized least squares techniques. Values obtained of the endogenous variables in recursive models, enter the next equation as predetermined, thus precluding any simultaneity.

In what follows, each equation of the model is presented and their explanatory variables enumerated.

Wheat Price Equation

The equation for the price of hard winter wheat in the state of Oklahoma is modeled following Glickman's framework where a regional variable is demarcated by its national counterpart. The national variable, in turn, is determined by the interplay of national and international variables, outside the scope of the regional model

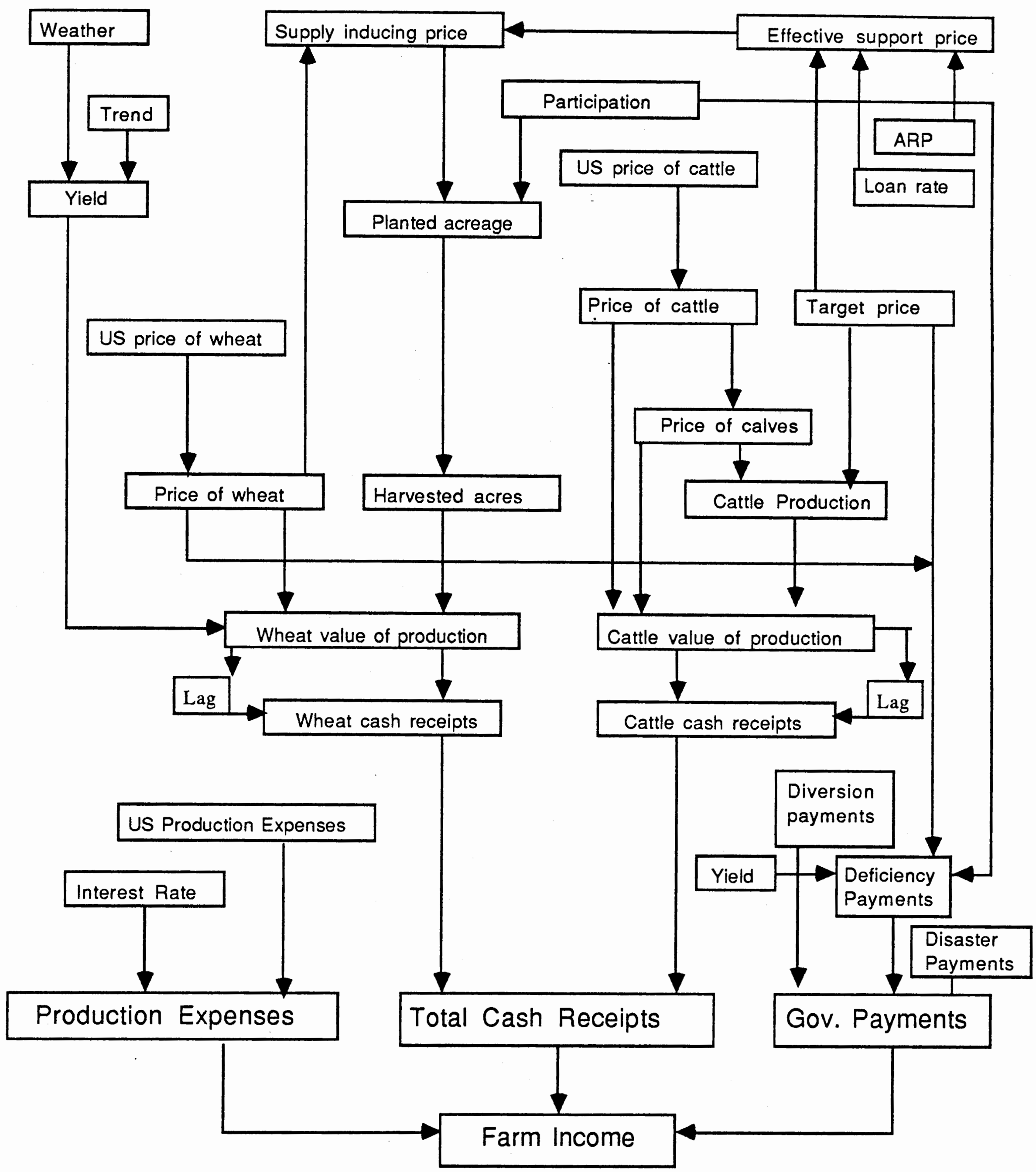

Figure 4. Block Diagram of the Model

that is developed here. Thus, the explanatory variable in the price of wheat in Oklahoma is the price of wheat in the United States as follows:

$$OP_t = f(USP_t)$$

where OP_t is the price of wheat in Oklahoma and USP_t is the price of wheat at the national level.

This equation provides an important linkage to the national scene, and for purposes of estimation, it is through this equation that this regional model is linked to POLYSIM. This specification can also be used to conduct analysis and simulations of macroeconomic variables that affect the national price of wheat.

Wheat Planted Equation

The specification of wheat planted in Oklahoma uses the Houck/Ryan effective support time series, expected price, and a weighting procedure to compute the supply inducing price of wheat in the state.

The weighting procedure used in the present study involves running a regression of the dependent variable, acreages planted, against the two factors, expected price and the Houck/Ryan time series. The coefficients obtained by this regression are then used to establish the weights of the two factors to compute the supply inducing price as follows:

$$SIP = [w \times EFSUDO] + [(1 - w) \times EXPRI]$$

where SIP is supply inducing price, EFSUDO and EXPRI are the effective support price and the expected price of wheat respectively. The coefficient w, is the weighting factor that is obtained by arithmetically transforming the coefficients obtained in the regression as follows: let B_2 and B_3 the coefficients obtained for the effective support price and the expected price respectively and T the sum of both. The coefficient w is obtained by B_2/T and substituted in the equation presented above.

The Effective Support Price. Using the methodology set forth by Houck and Ryan, the following time series for effective support price (EFSUDO) was obtained:

For the year 1972:

{ [78.79 - (19.7 x 0.83)] / 78.79 }x **1.25**+ (19.7 / 78.79) x (**3.02** - **1.25**) = 1.43

where 78.79 is the desired planted acreage (Houck and Sobotnik, 1969) in the absence of wheat commodity programs, 19.7 is the acreage allotment estimated to satisfy national needs, 0.83 is the fraction of the acreage allotment that should be set aside in order for the producer to be eligible to receive the loan rate and deficiency payments, 1.25 is the loan rate, which during this year was applicable to the entire harvest. During 1972 and 1973, wheat marketing certificates in the form of cash equivalent were issued to participants in the program. The certificate payment was the difference between national price and one hundred percent of wheat parity, which is calculated to be 3.02. This mechanism will later evolve to become the target price. The plain numbers represent the coefficient r, the adjustment factor in the Houck and Ryan paradigm, and the bold numbers indicate the announced support prices.

In 1973:

{ [78.79 - (18.7 x 0.86)] / 78.79 } x **1.25** + (18.7 / 78.79) x **(3.39 - 1.25**) = 1.50

The computation of the effective support price for 1973 is similar to the previous year, since both years were subject to the Act of 1971. The acreage allotment however, was lowered from 19.7 to 18.7, wheat parity was increased from 3.02 to 3.39 and the set aside was slightly changed from 0.83 to 0.86.

In 1974:

1.37 + (55 / 78.79) x (**2.05 - 1.37**) = 1.84

During this year wheat commodity programs changed notably, due to the Act of 1973 and the establishment of the target price. The loan rate of 1.37 was applied to all wheat production, while deficiency payments were restricted to seventy percent of planted acreage.

For the year of 1975:

1.37 + (53.5 / 78.79) x **(2.05 - 1.37**) = 1.83

This year was also subject to the Act of 1973.

For 1976:

2.25 + (61.6 / 78.79) x (**2.29 - 2.25**) = 2.28

The computation was the same for this year, except that the loan rate increased to 2.25 as well as the target price to 2.29

For the year 1977:

2.25 + (62.2 / 78.79) x **(2.90 - 2.25**) = 2.76

The target price increased to 2.90.

For 1978:

$$[1 / 1.2] \times \mathbf{2.35} + [1 / 1.2] \times 0.9 \times (\mathbf{3.40} - \mathbf{2.35}) = 2.75$$

The Act of 1977 spearheaded important changes in wheat agricultural policy that lasted until 1980. The Act required that during those years, twenty percent of acreage be left idle to obtain eligibility for loan rates and deficiency payments. Moreover, deficiency payments would be limited to 90 percent of planted acreage.

For the year 1979:

$$[1./ 1.2] \times \mathbf{2.50} + [1./ 1.2] \times 0.9 \times (\mathbf{3.40} - \mathbf{2.50}) = 2.76$$

The loan rate increased from 2.35 to 2.50.

For the year 1980:

$$\mathbf{3.00} + 0.9 \times (\mathbf{3.63} - \mathbf{3.20}) = 3.39$$

The acreage controlling measures were suspended.

For 1981:

$$\mathbf{3.20} + 0.9 \times (\mathbf{3.81} - \mathbf{3.20}) = 3.75$$

The computation of the effective support price for wheat had the same specification as the previous year, except that the loan rate and the target price were raised to 3.20 and 3.81 respectively.

For 1982:

$$[1 / 1.15] \times \mathbf{4.05} = 3.52$$

During this year, 15 percent of the acreage had to be idled for the producer to be eligible for target price and deficiency payment benefits.

For 1983:

$$[1 / 1.15] \times \mathbf{4.30} = 3.74$$

The target price was raised to 4.30.

For 1984:

[1 / 1.3] x **4.38** + 0.1 x (**2.70**) = 3.63

This year a 30 percent acreage reduction requirement was established for eligibility in the program; and during the same year, a program was established, by which, producers had the option of idling 10 percent of their acreage in exchange for a direct payment of 2.70 dollars a bushel, times the yield established in the program.

For 1985:

[1 / 1.3] x **4.38** + 0.1 x (**2.70**) = 3.63

For 1986:

[1 / 1.25] x **4.38** + [0.025 x **1.10**] = 3.53

This year a voluntary acreage reduction program was implemented to producers that idled 2.5 percent of the available acreage. A rate of 1.10 dollars per bushel was established for the Paid Land Diversion program.

For the year 1987:

[1 / 1.275] x **4.38** = 3.43

The construction of this time series for the effective support price, is later used, in the weighting procedure, as an argument in the supply function of Oklahoma wheat. As it becomes clear in the computation shown above, the effective support price is contingent upon specific measures implemented every year and tend to vary significantly from year to year.

<u>Rational Expectations and the Supply Inducing Price.</u> The naive and adaptive expectation models have been widely used in the supply response literature. The naive approach to expectations posits that prices in the next time period are the same as the ones in the present

period, i. e. $E[P_t] = P_{t-1}$. The adaptive expectations approach, in which the expected price is the result of an adjustment process, is econometrically specified by the inclusion of a lagged dependent variable. The alternative hypothesis that has recently been introduced in the supply response literature is that the producers of agricultural commodities form their expectations rationally, which implies that the subjective expectation of economic agents are, on the average, equal to the true values in the economy.

Wickens (1982) presents a general model to illustrate the two existing methods used to specify the rational expectations hypothesis in the context of an econometric model, namely, the substitution and the errors in variables methods. The author demonstrates that the substitution method results in high nonlinearity in the coefficients and that the computational problems usually lead to the abandonment of the rational expectations hypothesis. Wickens refers, in the same paragraph, to an alternative substitution method that can facilitate the computation of the rationally expected variables. This practical procedure consists of replacing the expected variables by the forecast values of their regressions on Z, a vector of variables known to economic agents at the time when expectations are formed. The method is relatively simple if compared to other econometric specifications of the rational expectations hypothesis.

Sargent (1973) claims that the hypothesis that economic agents know the values of all the vector Z, strains credulity. Instead, he states that expectations can be modeled as if economic agents had information only about a subset of Z. This is called the partial or weakly rational expectation hypothesis. McCallum (1976) also refers to the same hypothesis when he states that the possibility that market participants actually utilize only a portion of the relevant information should be considered seriously.

The substitution and the errors in variables methods have been successfully used in small models. As far as large econometric models, Vector Autoregressive Regression (VAR) techniques (Sims 1986) seem to have derived from a need to model the rational expectations hypothesis or at least they are adequate instruments to model it. Since all variables are treated simultaneously and with little theoretical justification, the model itself selects the relevant variables and the appropriate lags, and expectations of market participants can be hypothesized to use all this information in the process. Partial rationality, on the other hand, opens the possibilities of applying the hypothesis in the context of a wider variety of models, including existing agricultural policy models. The partly rational expectation hypothesis specifications permit the modeler to decide, based on economic theory or other exogenous information, which variables are known to economic agents at the time when expectations are formed. In this sense, it is difficult to ignore the similarities between VAR techniques with bayesian priors and the econometric specification of the partly rational expectation hypothesis.

To illustrate the partly rational expectation consider the following model:

$$y_t = B_0 + B_1 y_t^* + B_2 X_t + e_t$$

where y_t is acreage planted to wheat, y_t^* is the expectation at time t-1 of how many acres will be planted at time t, X_t is the support price announced by the authorities before the planting season and e_t is the error component. Implicit in this formulation is the hypothesis that if wheat growers expect an increase in the acreage planted this year, they will theoretically engage in an alternative enterprise.

To eliminate the unobservable variable, y_t^* the rational expectation hypothesis is invoked:

$$y_t^* = E\ (y_t \,/\, P\ )$$

where E is the expected value operator and Π is the set of relevant available information which consists of present and past values of the variables involved:

$$P = (X_t\ , X_{t-1}, \ldots\ X_{t-n};\ \ y_{t-1}, \ldots y_{t-n})$$

where the set of information available to wheat growers at time t consists of the policies that are in effect during planting time and their past values. In addition, they include the trajectory of acreage planted to wheat through time. The true relationships among these variables, which are included in the set of information, then become the true model, and the rational expectation hypothesis claims that these relationships are known to economic agents, at least with no systematic error. The partly rational expectation hypothesis, on the other hand, is stated somewhat differently,

$$y_t^* = E (y_t / p)$$

where p is a subset of P and for illustrative purposes p can be stated as follows:

$$p = (X_t, X_{t-1}, X_{t-2})$$

indicating that wheat growers only form their expectations about planted acreage based on the values of the support prices the three preceding time periods and that past acreage planted is either irrelevant in their planting decisions or that information is not available or that the variables are known with certainty, as is the case of announced policy measures.

The acreage response equation in the present model adheres to the partly rational expectation hypothesis and it is specified as follows:

$$OKAPTB_t = f (OKPRDO^*_t, EFSUDO_t , e_t)$$

where OKAPTB is the acreage planted to wheat in Oklahoma, OKPRDO* is the expected market price of wheat and EFSUDO is the effective support price obtained using the Houck and Ryan paradigm.

The partly rational expectations hypothesis is established as follows:

$$OKPRDO^*_t = E (OKPRDO_t / p)$$

where p , the relevant information for wheat growers, is defined as follows:

$p = (OKPRDO_{t-1}, OKPRDO_{t-2}, \ldots . OKPRDO_{t-7})$

The expected values of $OKPRDO_t$ are obtained by successively fitting Box and Jenkins models to obtain forecasts. The present formulation assumes that the "economic model" is an ARIMA (1,0,1). Since the period covered in the present model is from 1972 to 1987, an ARIMA (1,0,1) is obtained by using price observations from 1964 to 1971, from which the expected price in time period 1972 is forecast. Next, the 1964 price observation is deleted and the actual observation of the 1972 wheat price is introduced to compute a second ARIMA (1,0,1) which is next used to obtain the forecast for the price in 1973. The procedure is repeated to obtain the complete time series of expected prices, from 1972 to 1987. This methodology satisfies the most crucial requirement of the rational expectations hypothesis, namely, that the errors in the forecast are not systematic. To test if the error does not follow tractable patterns, a Wilcoxon Two-sample Rank Sum test was conducted. The null hypothesis--that the partly rational expectation time series does not come from a different population than the actual price--was not rejected. Both time series have the same mean and variance.

Another requirement of the rational expectations hypothesis is also satisfied by this procedure, i.e., that the parameters of the ARIMA (1,0,1) model are time variant, since they change as new actual variables are added to the information set of the producer.

The variable EFSUDO, effective support price, is introduced exogenously in the acreage equation. The implication of this specification is that Oklahoma wheat growers know the value of policy variables at planting time. Table I shows the actual time series for the price of hard red winter wheat in Oklahoma, the time series of expected price under the naive expectations hypothesis and the expected price under the partly rational expectations hypothesis formulated above.

The expected price of Oklahoma wheat growers, under the hypothesis of partly rational expectations is used, in conjunction with the effective support price and the weighting procedure described earlier, to obtain the supply inducing price. Following traditional supply response equations, the own supply inducing price, and the competing enterprise supply inducing price are included in the specification. Thus, the acreage equation is postulated as follows:

$$WA_t = f (SIP_t , SCP_t)$$

where WA_t is the acreage planted to wheat, SIP_t is the supply inducing price of wheat and SCP_t is the supply inducing price of the competing enterprise.

Wheat Harvested Equation

The wheat acreage harvested equation is postulated as follows:

$$WAH_t = f (WA_t , US_t , DP_t)$$

where WAH_t is the acreage harvested to wheat in Oklahoma, WA_t is the acreage planted to wheat in the same state,

TABLE I

WHEAT PRICES UNDER NAIVE AND PARTLY RATIONAL EXPECTATIONS

Year	Actual	Naive	Partly Rational
1972	1.70	1.42	1.49
1973	3.56	1.70	1.54
1974	3.95	3.56	2.97
1975	3.43	3.95	3.01
1976	2.78	3.43	2.76
1977	2.32	2.78	2.63
1978	3.03	2.32	2.60
1979	3.91	3.03	2.53
1980	3.83	3.91	3.43
1981	3.83	3.83	3.53
1982	3.65	3.83	3.46
1983	3.51	3.65	3.54
1984	3.36	3.51	3.45
1985	2.91	3.36	3.46
1986	2.30	2.91	3.43
1987	2.45	2.30	1.76

US_t is the acreage harvested to wheat in the United States and DP_t are diversion payments.

The harvested wheat equation follows the planted acreage equation in a recursive fashion. Unlike at the national level, where acreage harvested to wheat is almost a constant proportion of planted acreage, in Oklahoma this proportion is not constant. The inclusion of diversion payments in the equation suggests that abandonment of planted acreage in Oklahoma occurs as a consequence of the time in which the announcement of diversion payments is sometimes made. Diversion Payments have frequently been made public when winter wheat has already been planted. Using wheat as forage can also be suggested as an explanation for not harvesting planted wheat.

Harvested acreage at the national level is included to account for all the factors that determine the abandonment of planted acreage, and also to establish a link with the national model.

Wheat Yield Equation

The yield equation is postulated as follows:

$$WY = f (WAH , T , WE)$$

where WY is wheat yield for Oklahoma, WAH is wheat planted or, T is trend and WE is weather. Wheat planted or harvested is included as an argument in the yield equation to account for two facts: first, that when less acreage is planted, wheat growers tend to increase the amount per acre of other yield increasing inputs; second, that when land is taken out of production and signed up in government programs, the low yield portion is set aside. A trend variable is also included in the model to account for technological change, and the use of improved and more resistant varieties of wheat. Precipitation and temperature are also included in the yield equation as weather explanatory variables.

Wheat Cash Receipts Equation

The cash receipts equation for Oklahoma wheat is postulated to be a function of the product of wheat production times its price. Thus, the formulation is as follows:

$$WCH_t = f\ (\ WPR_t\ ,\ WPR_{t-1}\ )$$

where:

$$WPR_i = WPO_i \ \text{x} \ WP_i \qquad i = t, t\text{-}1$$

where WCH_t is cash receipts from wheat for Oklahoma, WPO_i is the wheat produced in Oklahoma and WP_i is the price of wheat in Oklahoma. The variable WPR is introduced with its lagged value to account for the fact that wheat cash receipts depend also on the amount that was unsold the previous year.

Cattle Price Equation

The equation for the price of cattle in Oklahoma, as well as the equation for the price of wheat, and the equation of acres harvested to wheat, provides a link to the national model. The price of cattle in Oklahoma is postulated to be a function of its national counterpart. The formulation is as follows:

$$CP_t = f(UCP_t)$$

where CP_t is the price of cattle in Oklahoma and UCP_t is the price of cattle at the national level.

This feature of the model opens the possibility of tracing the changes in the national price of cattle to their effects on the agricultural sector in Oklahoma.

Calves Price Equation

The Oklahoma price of calves equation follows a simple formulation. It is posited here that price of calves is a function of cattle price in Oklahoma. Both variables move contemporaneously. The formulation is as follows:

$$PCV_t = f(CP_t)$$

where PCV_t is the price of calves in Oklahoma, and CP_t is the price of cattle in the same state.

Cattle Production Equation

The following specification was used for the Oklahoma cattle production equation:

$$CPR_t = f(PCV_{t-1}, TP_t)$$

where CPR_t is cattle production in Oklahoma, PCV_{t-1} is the lagged value of the price of calves and, TP_t is the target price of wheat. The direction of causality is posited as follows: since wheat and cattle production are, to a certain extent, competing activities, a low target price of wheat would induce joint producers to increase grazing and thus increase cattle production. It is implicit in this formulation the preference of the price of calves as a supply inducing price for cattle production.

Cattle Cash Receipts Equation

The cattle cash receipts equation is posited to be a function of the value of production of cattle, an identity that will be described below. The difference between the value of production and cash receipts lies in that the latter includes receipts of farm slaughter as well. This equation is postulated as follows:

$$CR_t = f\ (VPR_t)$$

where CR is cash receipts from cattle in Oklahoma and VPR is value of production of cattle in the same state.

Total Cash Receipts Equation

The Oklahoma total cash receipts equation is formulated considering that cattle and wheat production are the two major agricultural activities in Oklahoma. Thus, the total cash receipts equation is a function of cattle cash receipts and wheat cash receipts.

Other agricultural activities are also conducted in the state, which in 1987 comprised 30% of cash receipts, and in the following formulation they are hypothesized to be included in the intercept of the regression. The equation is postulated as follows:

$$TCR_t = f\,(WCH_t\,,\; CR_t\,)$$

where TCR is total cash receipts in Oklahoma, WHR and CR wheat receipts and cattle cash receipts in the state, respectively.

Total Farm Production Expenses

The functional form the cost structure is postulated as follows:

$$EXP = f\,(USEXP, INT\,)$$

where EXP is farm production expenses, USEXP is farm production expenditures in the United States and INT is the interest rate, two macroeconomic variables. The interest rate is include to account for the cost of capital needed to carry out farm operations and USEXP captures other non-regional aspects of farm expenditures.

Identities

The following four identities are presented in the model:

$$WPO = WAH * WY$$

where WPO is wheat produced, WAH is acreage harvested and WY is yield;

$$WPR = WPO * WP$$

where WPR is value of wheat production, WPO is as defined above, and WP is wheat price;

$$GOV = DEF + DIV + DIS$$

where GOV is government payments, DEF is deficiency payments, DIV is diversion payments and DIS is disaster payments;

$$INC0 = TCR + GOV - EXP$$

where INCO is net realized farm income, TCR is total cash receipts, GOV is as defined above and EXP is farm production expenditures.

Summary

The equations presented above constitute a regional model of the agricultural sector in Oklahoma, in which some variables are formulated as a function of its national counterparts.

The model is recursive in nature, therefore simultaneous equation techniques are not required. The values of endogenous variables enter subsequent equations as predetermined without any feedback.

The model contains the following regional endogenous variables: wheat price, planted acreage to wheat, harvested acreage to wheat, cash receipts from wheat, total government payments, cattle price, calf price, cattle production, cash receipts from cattle, total cash receipts, total farm expenditures and net realized farm income.

The planted and harvested acreage equation are given strong emphasis in the model, since it is through these equations that the effects of wheat commodity programs are initially and principally observed. The planted acreage equation contains a formulation of expectation of wheat prices that includes the partial rational expectations hypothesis, but policy variables are shielded from this hypothesis because they are known with certainty at planting time.

The model also contains a cattle submodel which is linked to wheat activities, since in the Southern Plains, wheat is frequently used as forage. This submodel does not intend to represent a complete description of cattle operations in the state, rather, it is built with the intention of assessing the indirect influences of wheat activities.

The final objective of the model is to assess the effects of different suggested wheat commodity programs on farm income in the state.

CHAPTER IV

RESULTS AND VALIDATION

In what follows, the regression results of the equations presented in the previous chapter are reported with the pertinent statistics. Subsequently, ex-post simulation results are presented graphically in order to assess the behavior of the model with respect to historical data. Lastly, results of various validation tests are presented.

Wheat Price Equation

The results of the Oklahoma price equation are as follows:

$$OKPRDO = -0.052 + 1.025^{*}\ USPRDO$$
$$(23.57)$$
$$R^2 = 0.98 \quad D.\ W. = 1.68$$

where OKPRDO is the dollar price of a bushel of winter wheat in Oklahoma and USPRDO is the US price of the same commodity in the same units. In parenthesis are the t values, which in this case shows high statistical significance for the explanatory variable.

Wheat Planted Equation

The equation for acreage planted wheat in Oklahoma is reported as follows:

$$OKAPTB = \underset{(22.5)}{4423.10} + \underset{(14.43)}{926.40} * SIP + \underset{(6.68)}{881.95} * APDUM + \underset{(2.15)}{819.13} * NONPRT$$

$$R^2 = 0.95 \quad D.W. = 2.46$$

where OKAPTB is the number of acres planted to wheat in the state of Oklahoma in thousands of acres, SIP is the supply inducing price obtained by the procedure described in the previous chapter, and APDUM is a dummy variable for the years 1976 and 1977 when government regulations allowed unrestricted wheat grazing. This permissiveness in the use of wheat as forage, increased the acreage planted to wheat during those two years. The variable NONPRT indicates the percentage of wheat growers in Oklahoma who did not participate in the program. The positive sign indicates that acreage planted to wheat increases as the number of farmers who decide not to participate increases, due to the acreage reduction programs included in the policy package.

Effective support prices of competing enterprises did not give statistically significant results in the equation, nor did the lagged prices of other agricultural products in the state, namely, oats, rye, and soybeans. Grain sorghum had the correct negative sign but it was not statistically significant.

Wheat Harvested Equation

The equation for harvested acreage is as follows:

$$OKAHTB = -252.48 + 0.64 * OKAPTB + 0.03 * USAHTA - 1957.74 * EFDIDO$$
$$\qquad\qquad (7.34) \qquad\qquad (4.48) \qquad\qquad (-9.43)$$

$$R^2 = 0.90 \qquad D.\ W. = 2.30$$

where OKAHTB is harvested acreage of wheat in Oklahoma in thousands of acres. The variable OKAPTB is the acreage planted to wheat in Oklahoma in the same units. The variable USAHTA represents the acreage harvested of wheat in the United States. The variable EFDIDO is the effective diversion payment, which is obtained following an analogous methodology as the one proposed for the effective support price.

The regression shows a good fit and the Durbin Watson statistic shows permissible negative autocorrelation. The sign of the acreage planted variable confirms the fact that only a proportion of acreage planted is harvested. The sign of the effective diversion payments is negative as expected, the higher the incentive to abandon planted acreage, especially when diversion payments are announced late, the less harvested acreage. All coefficients are highly significant.

Several ways of introducing diversion payments were empirically tested. First, diversion payments were introduced in the planted acreage equation and the results were not statistically significant. Second, the time series of diversion payments was divided in two: the years in which payments were announced before the planting season and the years in which the payments were announced after the planting season. Each one of the time series was introduced as an explanatory variable in the planted acreage and the harvested acreage equations, respectively. This specification also gave nonoptimal statistical results.

Acreage harvested to wheat at the national level is also introduced as an explanatory variable in this equation. The inclusion of this variable is empirically favorable and it is also used as a link to the national model.

Wheat Yield Equation

The strategy of using stepwise techniques to estimate yield equations is advanced by Ash (1988). These techniques are usually criticized when estimating economic relationships because of their lack of theoretical content; nevertheless, the estimation of a yield equation, whose major arguments are monthly average deviations of precipitation and temperature, can be appropriately carried out with these techniques. Ash used the stepwise option of the stepwise procedure in SAS which is the combination of the forward and backward options. For a number of explanatory variables provided, the forward option starts searching for statistically significant variables, beginning with the first. The backward option begins from the last variable provided, and carries out an analogous procedure but in the opposite direction. To estimate the yield equation of the present model, the option MAX R^2 is used, which is superior to the other stepwise options. When the user provides a size for the desired model, i. e. the number of variables it should contain, then the MAX R^2 option calculates regressions on all possible subsets of the independent variables. The algorithm searches for the "best" nine variable model, the "best" ten variable model, etc., using the R^2 as a selection criterion.

In the present study, the average monthly temperature and precipitation are divided by their historical averages and introduced in the MAX R^2 option. The squares of the same variables, a trend (as years, beginning with 50 and ending in 86), and planted acreage are introduced as well. The results are presented in Table II.

The R^2 is 0.97 and the Durbin Watson is 1.70. Precipitation during the months of August, September, October and November show significant statistical results, indicating the importance of the critical role of the presence of water shortly before planting, during germination, and when the plant is in one of the primary stages of its phenological development. Some of these variables are present as quadratic equations, indicating that only ranges of the deviations are favorable to yield. Deviations from precipitation are also significant during the month of June, right before the peak harvest month of July, when 65 percent of Oklahoma wheat growers harvest (Ruiz, 1988).

Positive deviations from temperature during July are also important and detrimental to yield, since they decrease the moisture needed during the planting season which begins in September. Positive deviations from temperature during the months of January, March and April, also have negative effects on yield. Even during

TABLE II

REGRESSION RESULTS FOR THE YIELD EQUATION

Variable	Coefficient	Std. Error	T-Stat
Year	60.15	12.98	4.63
June Precipitation	0.30	0.04	7.11
August Precipitation	-13.06	3.86	-3.38
September Precipitation	17.86	2.63	6.77
November Precipitation	3.36	0.53	6.37
January Temperature	-11.78	2.57	-4.57
March Temperature	-23.20	5.13	-4.97
April Temperature	-33.37	5.78	-5.77
June $Precipitation^2$	-9.20	1.86	-4.94
August $Precipitation^2$	3.20	1.49	2.14
September $Precipitation^2$	-8.91	1.19	-7.49
October $Precipitation^2$	0.74	0.22	3.33
June $Temperature^2$	13.35	6.37	2.09
August $Temperature^2$	-23.27	7.08	-3.28
November $Temperature^2$	11.24	3.46	3.24

the period of dormancy, drastic temperature changes during the winter months can decrease yield.

The variable representing acreage planted of wheat was rejected after a brief period of iterations in the MAX R^2 option, which indicates that the increased utilization of inputs per acre when acreage planted is reduced does not significantly influence yield.

This yield equation should be used with caution however, since the inclusion of a large number of variables increases multicollinearity problems.

Wheat Cash Receipts Equation

The wheat cash receipts equation for Oklahoma is reported as follows:

$$WHCASH = 724.38 + 0.79 * WPR + 0.18 * WPR(-1)$$
$$(14.18) \qquad (3.42)$$
$$R^2 = 0.96 \qquad D.W. = 1.92$$
$$\rho = -0.64$$
$$(-2.82)$$

where WHCASH is cash receipts from wheat in Oklahoma in thousands of dollars, WPR is the product of wheat produced in Oklahoma times price of wheat. WPR(-1) is the lagged value of the same variable. The rho obtained is -0.64.

The equation reported above accounts for the small discrepancy generated between the calendar year and crop year.

The good fit of the equation reported above indicates that wheat growers in Oklahoma obtain part of their cash receipts from the unsold wheat the previous year.

Cattle Price Equation

The results for the price of cattle equation are as follows:

$$CATPRI = -24.10 + 1.17 * USCATP$$
$$(16.74)$$
$$R^2 = 0.98 \qquad D.W. = 2.65$$
$$\rho = 0.95$$
$$(8.47)$$

where CATPRI is the price of cattle in dollars per hundred pounds and USCATP is the price of cattle in the United States. The rho was found to be 0.95.

The coefficient obtained for the price of cattle in the United States indicates that the price of Oklahoma cattle is positively related to the national price. This equation is also used as a linkage to a national model, and macroeconomic factors that affect the national price can be traced down to the state level.

Calves Price Equation

The results for the calf price in Oklahoma is as follows:

$$CAVPRI = - 15.91 + 1.52 * CATPRI$$
$$(12.23)$$
$$R^2 = 0.96 \qquad D. W. = 1.65$$
$$\rho = 0.69 \quad (3.64)$$

where CAVPRI is the price of calves in Oklahoma in dollars per cwt. Generalized least squares was used because of positive autocorrelation was found in the errors. The rho is reported to be 0.69.

The good fit of the regression shows that, as expected, the price of cattle and the price of calves move simultaneously. The price of calves equation is used because it was found that empirically it gave better statistical results in the cattle production equation presented below.

Cattle Production Equation

The Oklahoma cattle production equation generated the following results:

$$CATPRO = 1993 + \underset{(10.37)}{6.72} * CAVPRI(-1) - \underset{(-4.73)}{68.12} * TARPRI + \underset{(4.14)}{157.82} * VA82$$

$$R^2 = 0.93 \qquad D.W. = 2.39$$

$$\rho = \underset{(3.77)}{0.75}$$

where CATPRO is cattle produced in Oklahoma in millions of pounds. This variable is defined in the Oklahoma Agricultural Statistics as all cattle and calves marketed, farm slaughter and custom slaughter on farms where produced. The variable CAVPRI (-1) is the lagged price of calves in Oklahoma in dollars per cwt. The variable TARPRI is the target price of wheat in dollars per bushel. The variable VA82 is a dummy for the year 1982. During this year poor forage conditions contributed to increased slaughter to improve cash flow. In addition, in 1982 the Statistical Reporting Service stopped reporting data for individual states and other institutions took over the task. This change in data gathering caused an abnormal reported increase in cattle production.

The choice of the supply inducing of cattle production relied more on an empirical approach. Other prices were attempted, i. e. price of cattle, lagged price of cattle and current price of calves. The lagged price of calves gave the most desirable statistical results.

The variable TARPRI, the target price of wheat, is an important variable in the model. It is a policy variable that establishes the link between the wheat and the cattle submodel. The negative sign obtained in the regression supports the fact that wheat and cattle are interdependent enterprises. Wheat can be sold directly in the market or it can be used as an input to cattle production. The significant negative coefficient of the target price of wheat reflects the tendency of joint producers to a more intensive use of wheat as forage when the target price is set too low.

Value of Cattle Production Equation

The equation is reported as follows:

$$CAVAPR = -\ 811.82\ ^{*} + \underset{(4.50)}{0.53}\ ^{*}\ CATPRO + \underset{(11.23)}{12.83}\ ^{*}\ CAVPRI$$

$$R^2 = 0.97 \qquad D.\,W. = 1.78$$

$$\rho = \underset{(3.77)}{0.75}$$

where CAVAPR is the value of cattle and calf production in millions of dollars, CATPRO is all cattle and calf production in millions of pounds and CAVPRI is the price in dollars per cwt of calves. The coefficient rho was found to be 0.75.

This relationship was originally expressed as an identity but resulted in systematic underpredictions of the actual values. It was decided to use a functional form because some of the value of production of cattle originates from the small percentage of calves sold, which have a higher price than cattle.

Cattle Cash Receipts Equation

The cattle cash receipts equation was obtained as follows:

$$CACASH = 187.01 + 1.10 * CAVAPR + 170.20 * VA82$$

$$(18.26) \qquad (2.47)$$

$$R^2 = 0.97 \qquad D.\ W. = 1.76$$

where CACASH is cattle cash receipts in the state of Oklahoma in thousands of dollars and CAVAPR is the value of production of cattle. This latter variable is obtained as the product of cattle produced times the price of cattle.

The variable CAVAPR includes slaughter for use on farm where produced and interfarm sales within the state, while CACASH are receipts from marketings and from sales of farm slaughter.

Total Cash Receipts Equation

The results of the total cash receipts equation is reported as follows:

$$TOCASH = 1110.47 + 1.176 * WHCASH + 1.048 * CACASH$$
$$(11.81) \qquad (16.10)$$
$$R^2 = 0.99 \qquad D.W. = 1.29$$
$$\rho = 0.90$$
$$(15.14)$$

where TOCASH is total cash receipts for the state of Oklahoma in thousands of dollars; it includes farm marketings, non-money income and other farm income. The variables WHCASH and CACASH are wheat and cattle cash receipts, respectively. A first order autocorrelation technique was used to correct for non-spherical disturbances with a rho of 0.90.

The results show the importance of cattle and wheat production activities in the state of Oklahoma, both of them explain almost all the variation in total cash receipts in the state. Other agricultural activities in the state are included in the intercept, and clearly, they do not have a significant influence in the variation of cash receipts in Oklahoma.

Total Farm Production Expenses Equation

The results of the regression are as follows:

$$TOCOST = 347.37 + 0.015 * USCOST + 35.79 * INTERE$$
$$\qquad\qquad (12.99) \qquad\qquad (3.38)$$
$$+ 167.34 * DUM77$$
$$(1.55)$$
$$R^2 = 0.98 \qquad D.W. = 2.16$$

where TOCOST is total farm expenditures in the state of Oklahoma in millions of dollars, USCOST is the total farm expenditures in the US and INTERE is the average annual prime rate charged by banks, and DUM77 is a dummy variable for the year 1977, when severe cold winter froze out pastures and prices of hay increased drastically.

The presence of these two macroeconomic variables in the cost equation shows the influence of the national economic environment on farm income in the state.

Validation

Figures 5 through 19 depict the predicted and the actual values for the years 1972 through 1987 of the following endogenous variables: price of wheat in Oklahoma, acreage planted to wheat, acreage harvested, yield, production, value of production of wheat, cash receipts from wheat, price of cattle, price of calves, cattle production, value of cattle production, cash receipts from cattle, total cash receipts in the farm sector of Oklahoma, total farm expenditures and net realized farm income.

In a recursive model such as the one used in this study, two approaches exist to carry out the validation, both using historical

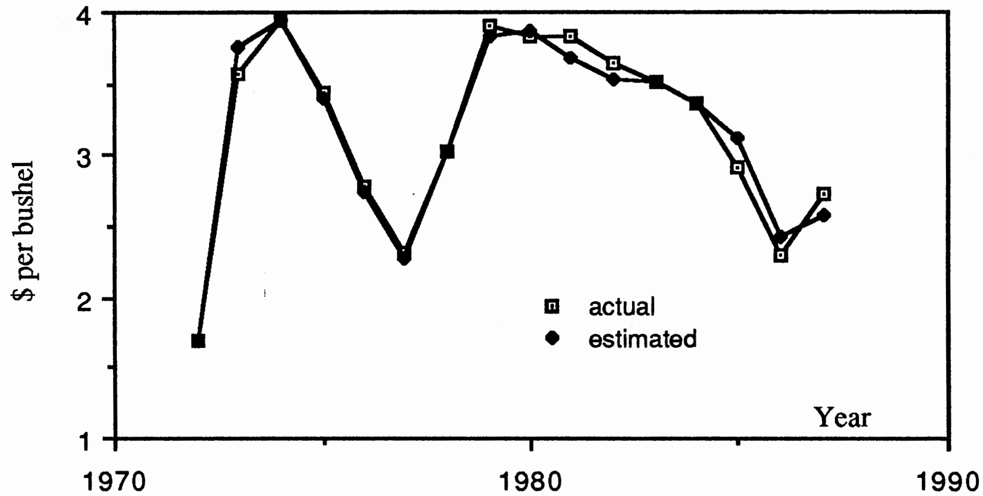

Figure 5. Price of Wheat in Oklahoma

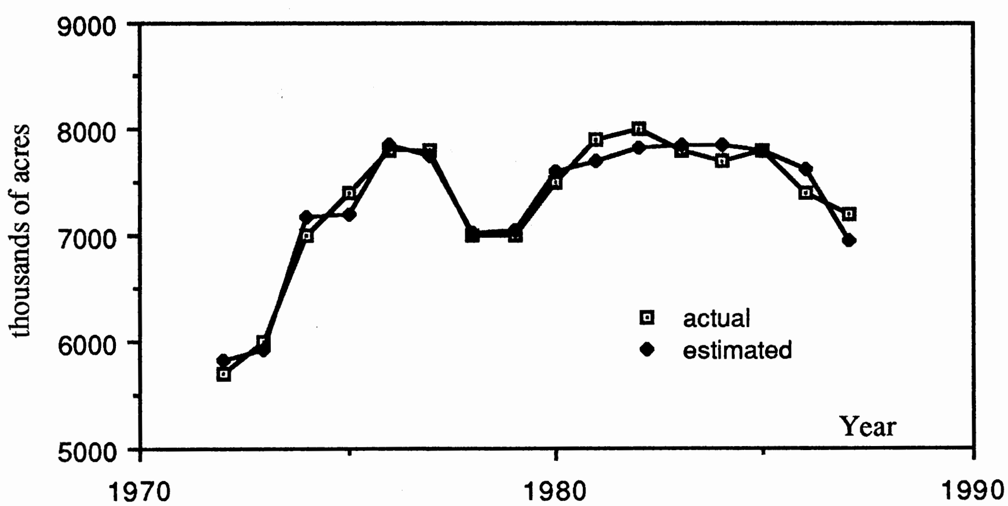

Figure 6. Acreage Planted to Wheat in Oklahoma

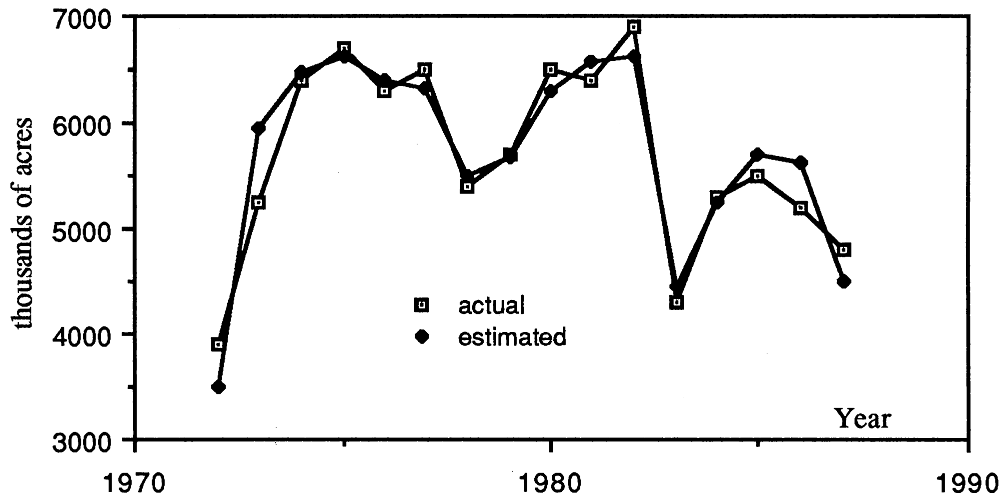

Figure 7. Acreage Harvested to Wheat in Oklahoma

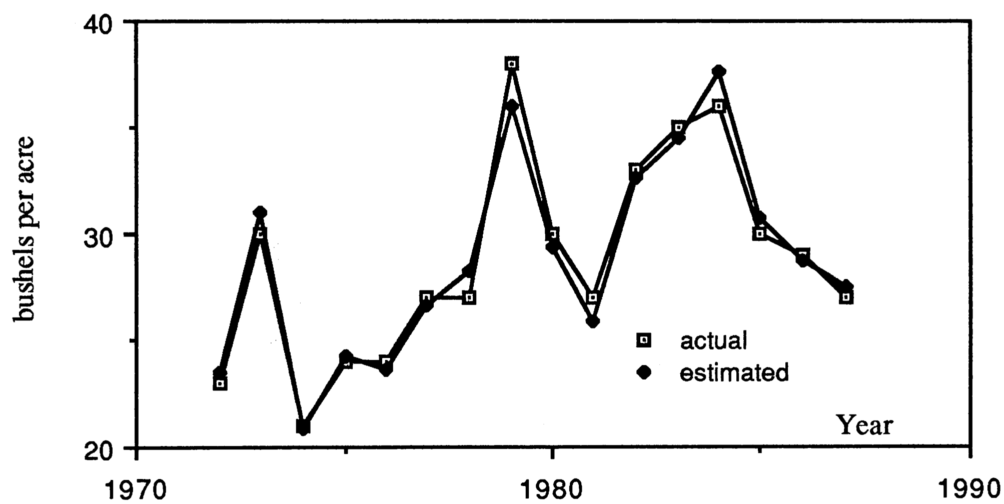

Figure 8. Wheat Yield in Oklahoma

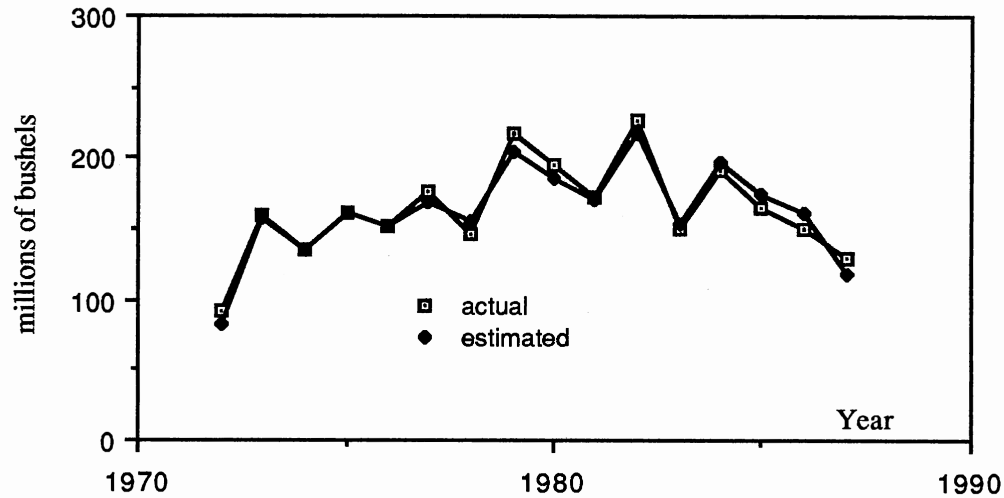

Figure 9. Wheat Produced in Oklahoma

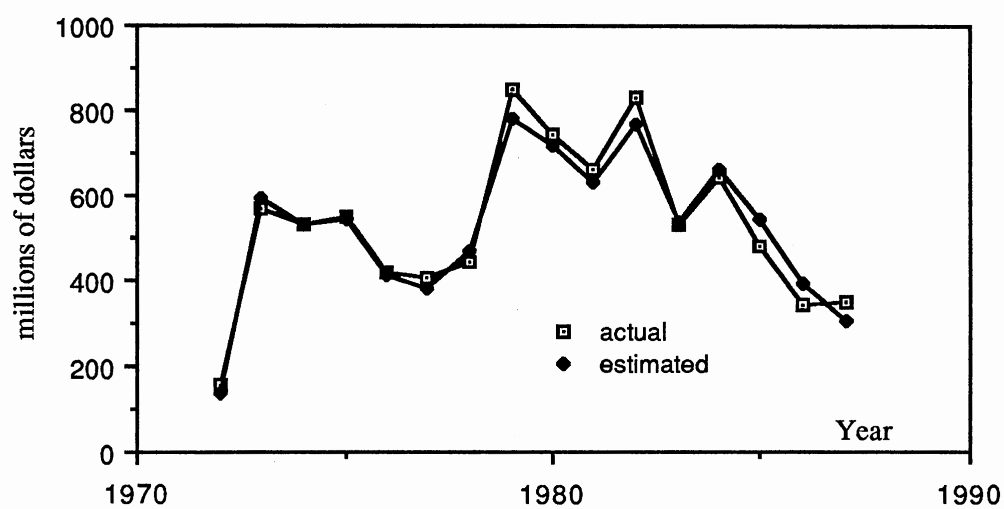

Figure 10. Value of Wheat Production in Oklahoma

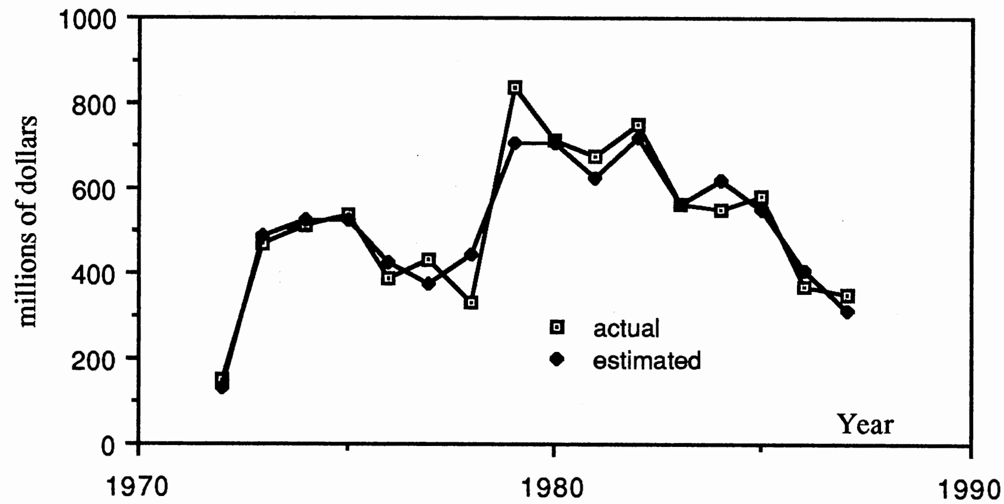

Figure 11. Cash Receipts from Wheat in Oklahoma

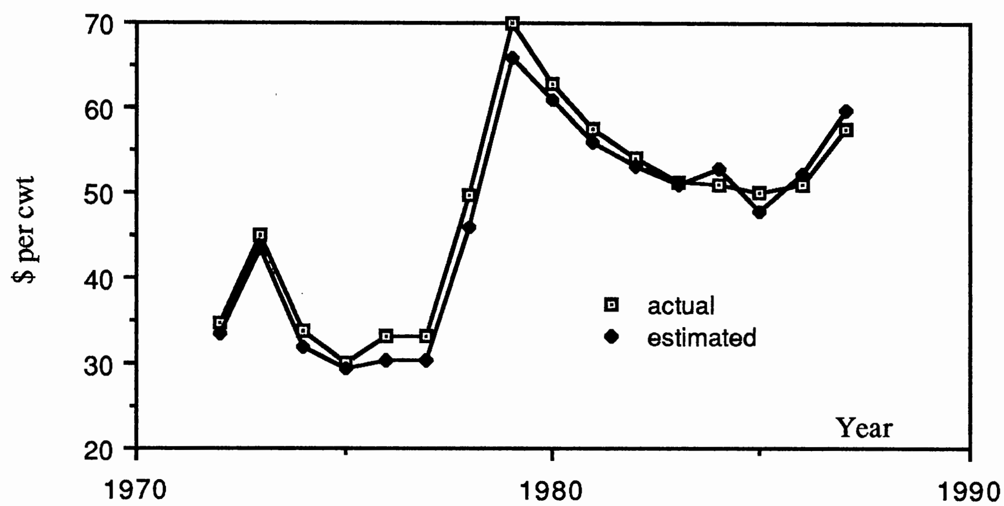

Figure 12. Price of Cattle in Oklahoma

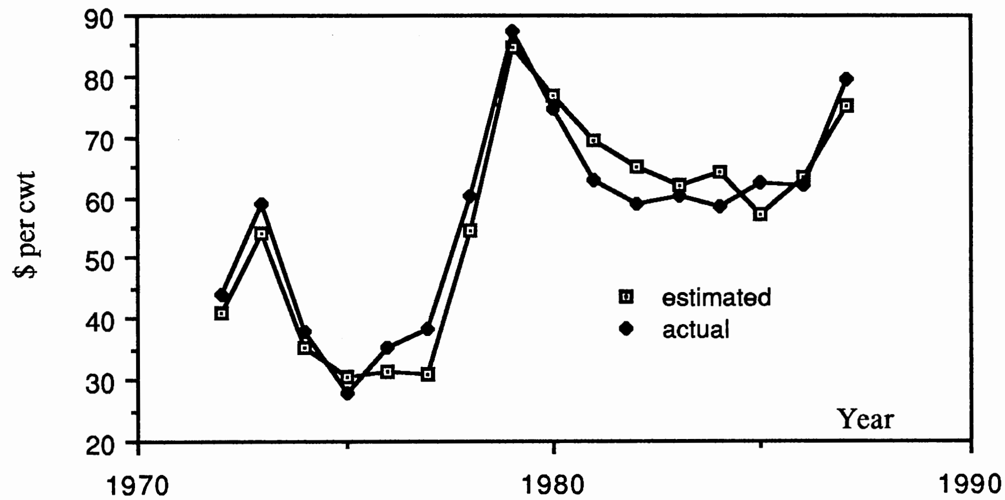

Figure 13. Price of Calves in Oklahoma

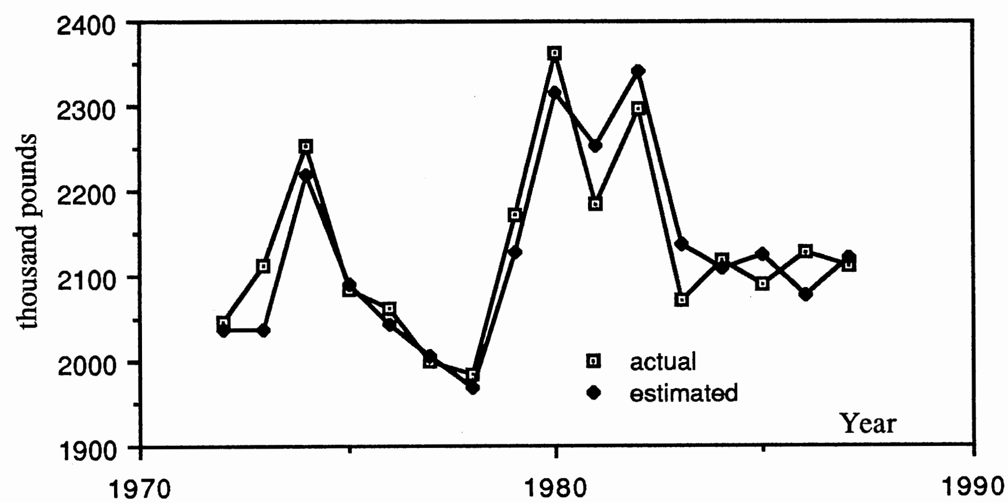

Figure 14. Cattle Produced in Oklahoma

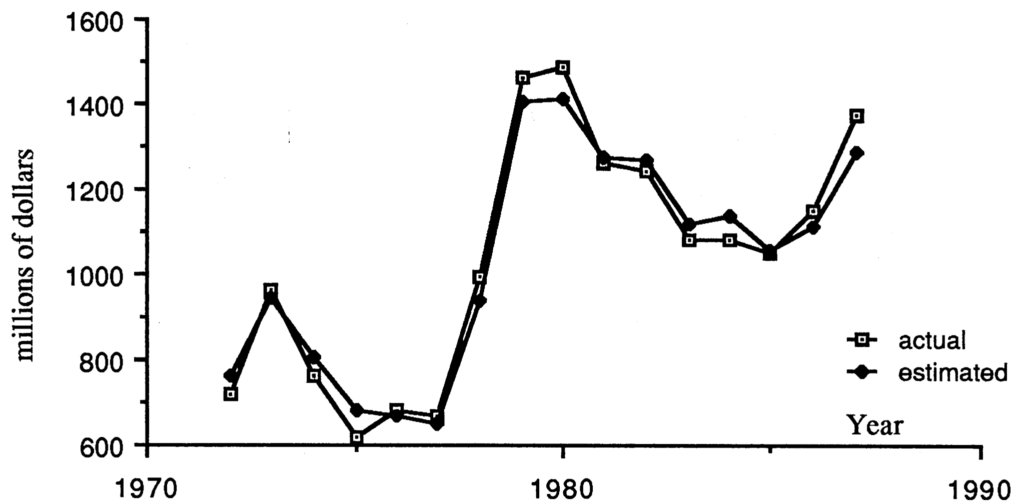

Figure 15. Value of Cattle Production in Oklahoma

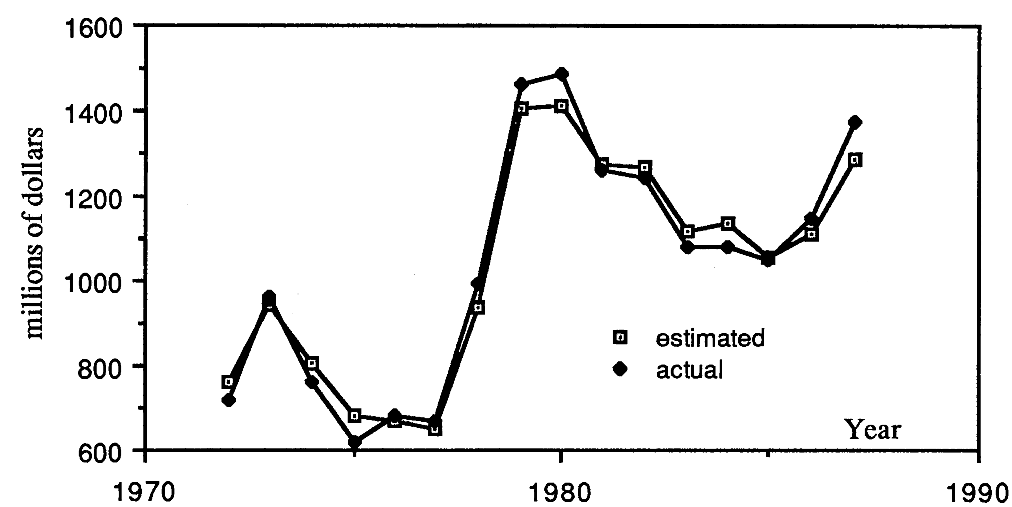

Figure 16. Cash Receipts from Cattle in Oklahoma

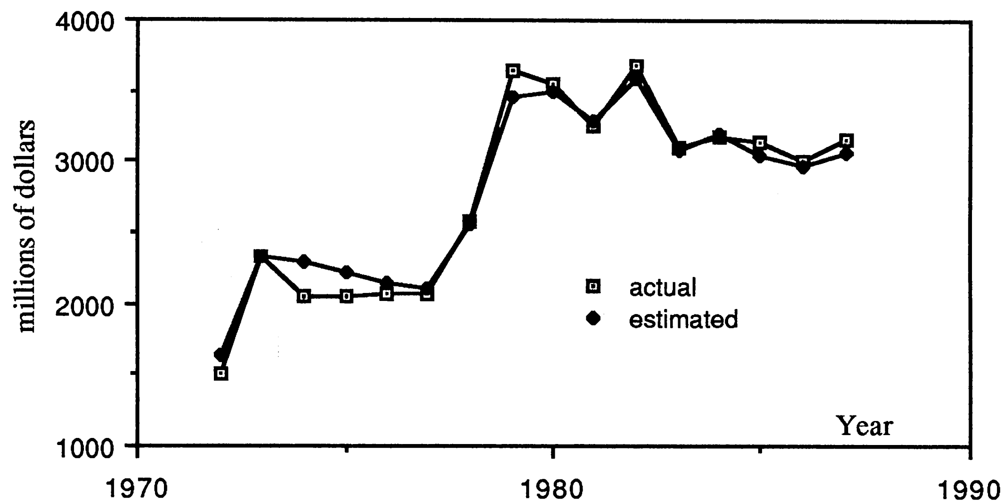

Figure 17. Total Cash Receipts in the Farm Sector of Oklahoma

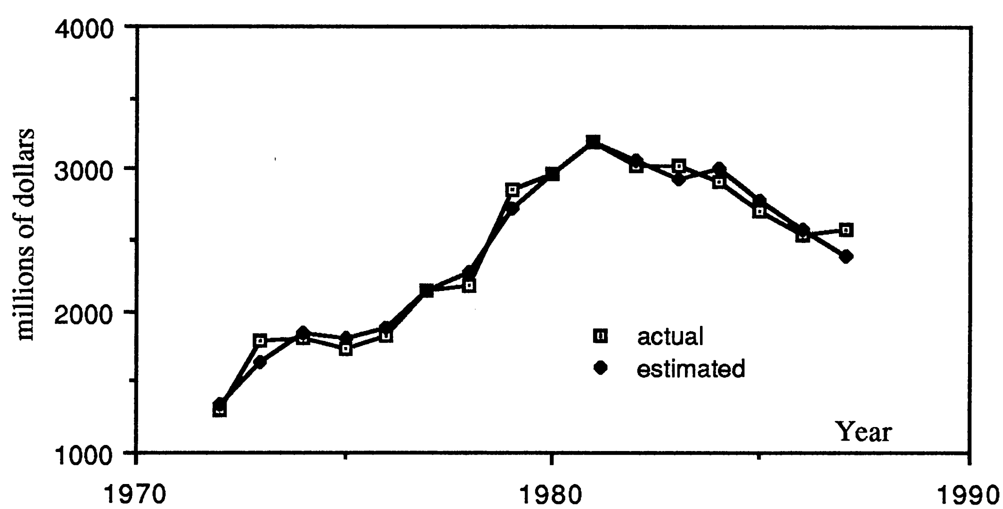

Figure 18. Farm Production Expenses in Oklahoma

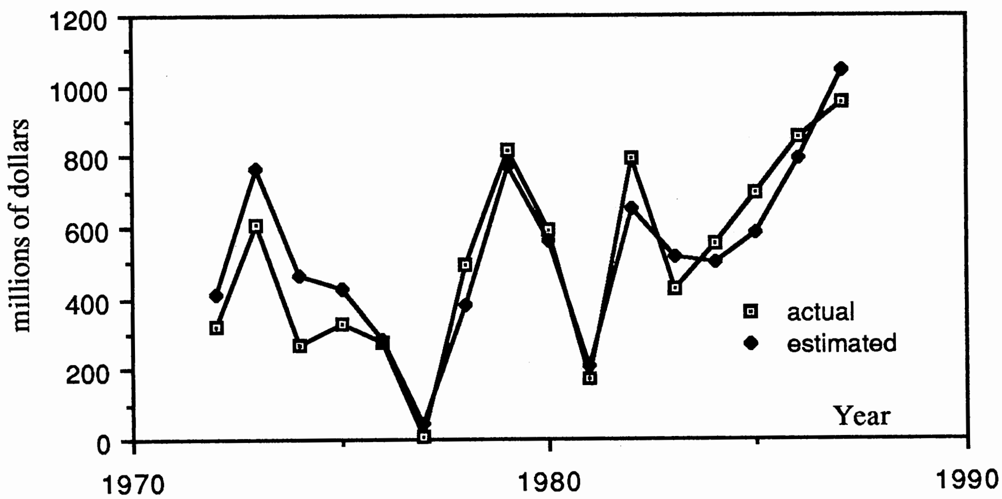

Figure 19. Net Realized Farm Income

data. The first approach involves obtaining the estimated values of the historical data using each regression and plotting the actual vis a vis the estimated values. The second approach, which is used in the present study, is more rigorous and consists in using the estimated values of one regression as the explanatory variables in the regression that follows. This validation alternative has the tendency to accumulate errors in subsequent equations.

In the structure postulated by the present model, the second validation approach presents additional difficulties when applied to net realized farm income, since this variable is calculated as the result of the summation of three large magnitudes of endogenous variables, namely, total cash receipts, total farm production expenditures, and government payments (the latter predetermined in this model). For example, net realized farm income in Oklahoma was 951 million dollars in 1987, total cash receipts was 3,157 million dollars, farm production expenses 2,568 million, and government payments 362 million. A ten percent error in the estimation of cash receipts, keeping the rest of factors constant, would be reflected in the net realized farm income variable as a 37% error. Top to bottom econometric recursive models, whose target variable is farm income, are likely to show vulnerability in this respect.

Nevertheless, the figures show that the estimated values follow the actual ones reasonably well.

Validation Statistics

Five validation statistics, namely, mean simulation error, mean simulation percent error, root mean square error, root mean square percent error and the U Theil Inequality Coefficient are computed for each one of the endogenous variables and they are presented in Table III.

The mean simulation error and the root mean square error are both sensitive to the units used in the model. Their usefulness usually requires some familiarity with the variable in question and the units with which it is usually measured. Thus, for example, when a mean simulation error for acreage planted is reported to be 52.62 thousand acres, the interpretation requires familiarity with how many acres are customarily planted. The other statistics reported avoid this problem by expressing the difference between the actual and estimated values in terms of percentages or unit free values.

Low values are observed for all variables when using the mean simulation percent error and the U Theil. However, when applying root mean square percent error, net realized farm income is reported a value of 0.95, which indicates a serious error. This result illustrates the inadequacy of this statistic when the variable in question gravitates around zero, even in one observation. The reason for this bias against variables close to zero stems from the fact that actual values are denominators in the computation of the statistic.

This issue is further illustrated during the year of 1977, when net realized farm income fell to unprecedented levels, i. e. to 9.9 million dollars. When this year is deleted from the analysis the root

TABLE III

VALIDATION STATISTICS

	MSE	MS%E	RSE	RS%E	U-Theil
Price of Wheat	0.00001	0.0010	0.1015	0.033	0.0156
Acreage Planted	-0.0005	0.0004	140.5	0.019	0.0095
Acreage Harvested	-56.620	-0.0109	249.7	0.051	0.0217
Wheat Produced	-1632.6	-0.0103	7944.1	0.052	0.0239
Value of Wheat Producion	-5791.5	-0.0083	36850	0.076	0.0331
Cash Receipts from Wheat	-5.3150	0.0013	54600.9	0.119	0.0509
Price of Cattle	-1.2440	-0.2936	2.117	0.048	0.0218
Price of Calves	-0.7950	-0.0183	4.45	0.088	0.0378
Cattle Production	-3.5740	-0.0015	39.85	0.018	0.0093
Value of Cattle Production	0.41100	0.0050	42.61	0.045	0.0200
Cash Receipts from Cattle	1.81000	0.0085	94.54	0.080	0.0349
Total Cash Receipts	15.4000	0.0154	104.93	0.041	0.0185
Farm Expenditures	11.8400	0.0064	76.99	0.035	0.0155
Net Realized Farm Income	9.79000	0.3100	99.23	0.950	0.0926

mean square percent error decreases from 0.95 to 0.25, while the U Theil Inequality Coefficient, which does not share this bias, only improves marginally.

The validation statistics give good results. The highest value of the U Theil is 0.09 for net realized farm income and the next highest value is 0.05 for cash receipts from wheat. The mean simulation error gives reasonable good results with the majority of variables under 0.02.

Limitations of the Model

The limitation of almost any econometric model can be cast in terms of its completeness. To capture exhaustively all variables and their relationships, even when only one sector of the economy is involved, is unrealistic. To evaluate completeness, the objective with which the model was built is an appropriate criterion, but even in this case, variables and relationships which can show important features of economic phenomena can always be suggested.

In the model presented above, suggestions can be made to improve and expand it. First, the cattle sub-sector can be fruitfully expanded by de-annualizing the model and provide more detail in the cattle sector and its relationship to wheat production.

Second, other crop production and other livestock production variables should be taken in consideration even though wheat and cattle are strongly predominant in the state.

As far as the acreage response equation, expectation formation, a frontier issue in macroeconomics and other fields of economics, can always be criticized as being inflicted by adhockery. However, the Nerlovian specification of expectations, which thus far has been widely used in agricultural models, can also be criticized with the same argument. Rational expectation theorists repeatedly point out that their primary motivation for the search of alternative expectation specifications has been that conventional treatments are arbitrary.

Another limitation of the present model is that the Houck/Ryan econometric specification of government programs can not encapsulate all features of a policy package. Numerous subtleties have to be left out, i. e. changing grazing policies, different timing in the announcement of policies, the computation of the program yield, and the limitation in the payments to an individual producer.

CHAPTER V

SIMULATIONS

In the present chapter, future effects of alternative policy options are assessed with the aid of the model described in the previous chapters. Projections are carried out from 1988 to 1996. Three policy scenarios are outlined, namely, unilateral suspension of farm programs, a ten percent reduction in target prices and the multilateral suspension of farm programs. Subsequently, these scenarios are contrasted with the baseline.

Baseline

To conduct analytically consistent simulation exercises, a baseline is needed, against which the different policy options can be compared. Baselines are usually projections of present conditions and they reflect the status quo. In the present study the baseline has the following characteristics:

1) Since some exogenous variables in the present regional model are obtained from the National Agricultural Policy Simulator (POLYSIM) and the FAPRI, the macroeconomic environment described in these models apply to the Oklahoma model.

2) As far as the baseline values of acreage reduction programs and target prices, they follow the general guidelines of the

1985 Farm Bill as it is depicted in Table IV. Acreage reduction remains at present levels during 1988, decreases to 15 percent[1] in 1989, remains at 10 percent during 1990 and 1991 and decreases to 5 percent for the rest of the projection period.

3) As Table IV shows, the target price decreases from present levels of 4.38 to 3.52 at the end of the projection period.

4) Yield is assumed under normal weather. Weather regressors in the yield equation are expressed as ratios of temperature and historical average, as well as precipitation and its monthly historical average. Under normal weather, the Xs in the regression become ones and to obtain the forecast of yield, only trend is projected and the coefficients of the weather variables and the intercept are added.

5) Farm production expenditures are projected but set constant for the different policy scenarios. The future values are obtained using projections of the interest rate and US farm production expenditures from the FAPRI model.

6) Participation rates in Oklahoma are traditionally higher than national participation rates and this proportion is preserved when obtaining their future values. Thus, Oklahoma participation rates for 1988 and 1996 are calculated as a linear transformation of national participation rates, which are obtained from the FAPRI model.

---

[1] While this study was in progress, wheat commodity programs were announced for 1989, and the acreage reduction program was reported to be 10 percent.

TABLE IV

BASELINE POLICY VARIABLES

Year	ARP	Target Price	Loan Rate
1987	27.5	4.38	2.28
1988	7.5	4.23	2.21
1989	15	4.10	2.06
1990	10	4.00	2.10
1991	10	3.92	2.10
1992	5	3.84	2.22
1993	5	3.76	2.27
1994	5	3.69	2.29
1995	5	3.62	2.30
1996	5	3.52	3.34

7) In addition, the baseline assumes no diversion payments, no decoupling measures and no unrestricted grazing in the policy package.

8) The effects of the 1987-1988 drought are not taken in consideration.

The Scenarios

With the aid of the model described above, the following three policy options are explored. First, the unilateral suspension of farm programs is analyzed, where acreage reduction programs and target prices are eliminated in the U.S. before the winter wheat planting season in 1988. Exogenous variable data for this scenario are obtained from POLYSIM.

The second policy option which will be analyzed is a ten percent target price reduction. Under this scenario, wheat target price is decreased ten percent below its baseline value, beginning in 1988. Exogenous variable data are also obtained from POLYSIM.

The third policy option discussed in this study is the multilateral suspension of farm programs. In addition to all assumptions used when unilateral suspension is applied, this scenario includes the elimination of farm programs in countries which are U.S. trading partners and domestic wheat prices are determined by world prices. Exogenous variable data are obtained from the FAPRI model, since this model can be run in conjunction with a well developed set of country specific demand relationships.

Government payments was obtained for the projection period by multiplying these five factors: acreage reduction payments, participation rate, desired acreage (established at 8,000 thousand), yield (used as a proxy for program yield), and the difference between target and market price.

Results

Unilateral Suspension Scenario

The results from the simulation of the unilateral suspension scenario are presented in Table V. The projection period is divided in two sets of years, one from 1988 to 1992 which, hereafter, will be called the first period, and the other from 1992 to 1996 which, hereafter, will be called the second period. Averages of the endogenous variables are obtained and reported for each of the periods. Data presented this way depicts more concisely the trend of the variables during the projection period.

The unilateral suspension option, contrasted with the baseline, shows a drastic decline in the price of wheat during the first period, while the second period shows a moderate -9 percentage change from the baseline.

Acreage planted shows a marginal decrease of 1.5 percent in the first period, when compared with the baseline, and a more significant difference during the second period. Despite the drastic reduction in the price of wheat, acreage planted remains relatively

TABLE V

RESULTS FROM UNILATERAL SUSPENSION

Item	1988-1992 (avg.)			1992-1996		
	Baseline	Unil. Susp.	Δ%	Baseline	Unil. Susp.	Δ%
Price of Wheat $ per bushel	3.02	2.17	-28	3.26	2.95	-9
Acreage Planted th. of acres	7353	7242	-1.5	7635	7587	-6
Acreage Harvested th. of acres	5961	5881	-1.3	6213	6134	-1.3
Wheat Production mil. bush.	196	193	-1.3	212	209	-1.2
Value of Prod. mil. $	593	423	-28	695	622	-10
Cash Receipts mil. $	564	402	-29	667	595	-11
Price of Cattle $ per cwt	56.90	51.20	-10	53.88	46.58	-14
Price of Calves $ per cwt	70.59	61.91	-12	65.98	54.90	-16
Cattle Production mil. pounds	2215	2299	3.7	2168	2140	-1.2
Value of Prod. mil. $	1277	1210	-5.1	1193	1036	-13
Cash Receipts mil. $	1594	1521	-4.5	1502	1328	-11
Total Cash Receipts mill $	3401	3134	-7.8	3468	3201	-7.6
Net R. Farm Income mil. $	887	509	-42	593	323	-45

stable during the first period and declines somewhat during the second period.

Harvested acreage to wheat does not differ significantly from the baseline. In general terms, it can be stated that the suspension of wheat commodity programs does not substantially change the level of harvested acreage in Oklahoma. These somewhat counterintuitive results are accounted by the fact that the suspension of all wheat commodity programs implies the simultaneous elimination of supply restricting and supply inducing measures included in a policy package. In addition, the specialization of the state in the production of wheat production makes the flow of resources into alternative crops more difficult.

Production of wheat in the state, when farm programs are suspended, is also subject to the explanation presented above, since its levels are marginally different from the baseline. It should be mentioned here, however, that the yield equation postulated in the present study does not include the price of wheat as an argument, and it is possible that its inclusion might have caused a reduction in wheat production, especially during the first period.

The value of wheat production and cash receipts from wheat show a significant departure from baseline of -28 per cent, and -29 respectively, during the first period. This difference shows the important impact of the decrease in the price of wheat on revenue variables during the first period. This difference significantly declines during the second period but remains at high levels.

The prices of cattle and calves are low in the unilateral suspension scenario when compared to the baseline in the first period, and even lower in the second period.

During the first period, cattle production is higher when wheat programs are eliminated than when present programs are unchanged. More intensive use of wheat as forage accounts for this result, even in an environment of low cattle and calves prices. It is suggested that the rate of conversion from wheat to cattle would have been higher, had prices of cattle and calves remained unchanged. Nevertheless, this difference reversed signs during the second period. Value of cattle and calves production and cash receipts from cattle and calves are moderately lower than the baseline during the first period, but significantly lower during the second period.

Total cash receipts are moderately lower during the two periods but the full impact of the suspension of farm programs is felt in net realized farm income. A moderate negative value for percentage change in the total cash receipts is magnified in farm income, especially when government payments have been suspended. Net realized income, if farm programs are suspended decreases 42 percent during the first period, when compared to the baseline and 45 percent during the second period.

In summary, the results show that the unilateral suspension of wheat commodity programs depresses the price of wheat keeping the volume of production unchanged, depresses the prices of cattle and calves, decreases total cash receipts and drastically decreases net realized farm income.

Ten Percent Target Price Reduction

As it is depicted in Table VI, when the target price is reduced ten percent below its baseline value, the price of wheat is slightly lower than the baseline and acreage planted to wheat remains very close the baseline values during both periods.

Acreage harvested to wheat in this scenario is marginally lower than the baseline and the production of wheat is also somewhat lower in both periods.

The wheat revenue variables, i. e. value of wheat production and cash receipts from wheat, show a moderate decrease during both periods with respect to the baseline. This difference does not take in account government payments that would accrue to wheat growers who idle acreage under the acreage reduction programs.

The results show that when the target price is reduced ten percent, the cattle sector remains practically unchanged. The expected effects of an increase in cattle production as a result of a decrease in the target price of wheat are offset by the decrease in cattle prices. Total cash receipts from cattle are also moderately lower than the baseline.

The moderately lower total cash receipts result in a significant decrease in net realized farm income, -12 percent during the first period and -20 during the second period. This reduction is partially caused by a decrease in government payments, which are reduced significantly, especially during the second period.

TABLE VI

RESULTS FORM 10% TARGET PRICE REDUCTION

	1988-1992 (avg.)			1992-1996		
Item	Baseline	TP Reduc.	Δ%	Baseline	TP Reduc.	Δ%
Price of Wheat $ per bushel	3.02	2.93	-2.9	3.26	3.19	-2
Acreage Planted th. of acres	7353	7241	-1.5	7635	7442	-2.5
Acreage Harvested th. of acres	5961	5805	-2.6	6213	5999	-3.4
Wheat Production mil. bush.	196	191	-2.4	212	205	-3.3
Value of Prod. mil. $	593	561	-5.3	695	657	-5.4
Cash Receipts mil. $	564	533	-5.4	667	631	-5.3
Price of Cattle $ per cwt	56.90	56.25	-1.1	53.88	52.98	-1.6
Price of Calves $ per cwt	70.59	69.61	-1.4	65.98	64.62	-2
Cattle Production mil. pounds	2215	2238	1	2168	2184	0.7
Value of Prod. mil. $	1277	1276	0	1193	1184	-0.7
Cash Receipts mil. $	1594	1593	0	1502	1491	-0.6
Total Cash Receipts mil. $	3401	3355	-1.3	3468	3391	-2.1
Net R. Farm Income mil. $	887	780	-12	593	474	-20
Gov. Payments mil. $	197	129	-34	91.8	38.4	-58

The ten percent target price reduction scenario has a marginal negative impact in the production of wheat and a moderate negative impact on wheat cash receipts. It has no effect on the cattle sector, but it has an important negative impact on net realized farm income.

The benefit of the implementation of this policy option corresponds to tax payers, through the significant reduction of government payments, principally during the second period.

Multilateral Suspension

As it is shown in Table VII, the multilateral suspension of wheat government programs in the U.S. and its trading partners, results in a higher price for wheat than the baseline, especially in the second period.

High prices and suspended acreage reduction programs, result in a large number of acres planted to wheat, almost 8 million during the first period and 8 million and a half during the second period. Likewise, harvested acreage is significantly higher than the baseline in both periods.

Production of wheat is 6.4 percent higher than the baseline during the first period and 9.3 percent higher during the second period. The wheat revenue variables, value of production and cash receipts, are significantly higher that the baseline. Policy conditions are optimal under this scenario, acreage reduction measures are suspended and wheat price is high because of the increase in exports.

The prices of cattle and calves are marginally higher than the baseline during the first period and significantly higher during the

TABLE VII

RESULTS FROM THE MULTILATERAL SUSPENSION

Item	1988-1992 (avg.) Baseline	Mul Susp.	Δ%	1992-1996 Baseline	Mult Susp.	Δ%
Price of Wheat $ per bushel	3.02	3.22	6.5	3.26	3.70	13
Acreage Planted th. of acres	7353	7968	8.3	7635	8533	11
Acreage Harvested th. of acres	5961	6353	6.5	6213	6791	9.3
Wheat Production mil. bush.	196	208	6.4	212	232	9.5
Value of Prod. mil. $	593	675	13	695	861	23
Cash Receipts mil. $	564	637	13	667	826	23
Price of Cattle $ per cwt	56.90	58.20	2.2	53.88	59.11	9.7
Price of Calves $ per cwt	70.59	72.56	2.8	65.98	73.94	12
Cattle Production mil. pounds	2215	2277	2.8	2168	2208	1.8
Value of Prod. mil. $	1277	1336	4.6	1193	1316	10
Cash Receipts mil. $	1594	1658	4	1502	1637	9
Total Cash Receipts mil. $	3401	3555	4.7	3468	3797	9.4
Net R. Farm Income mil. $	887	827	-6.7	593	805	36

second period due to the increase in cattle exports. Cattle production is not much higher than the baseline because the incentives for wheat conversion to beef are removed when exports increase.

The revenue variables for the cattle and calf sector are marginally higher that the baseline during the first period and moderately higher during the second period. Total cash receipts in both periods are moderately higher than the baseline.

During the first period, net realized farm income is lower than the baseline because of the absence of government payments during the adjustment period. During the second period, net realized income increases significantly and supersedes baseline levels.

In summary, the multilateral policy option stimulates the wheat sector in Oklahoma, bringing production and cash receipts to optimal levels. The policy is marginally beneficial to the cattle sector and significantly beneficial to net realized farm income especially during the second period.

<u>Cross Sectional Results of the Three Policy Options</u>

The projections of the endogenous variables, price of wheat, acreage planted to wheat, acreage harvested, wheat produced, value of wheat produced, cash received from wheat, price of cattle, price of calves, production of cattle, value of cattle production, cash receipts from cattle, total cash receipts in the state, net realized farm income and government payments are depicted in Figures 20 to 33.

The price of wheat in Oklahoma, as it is shown in Figure 20, decreases drastically under the free market option to 1.53 dollars

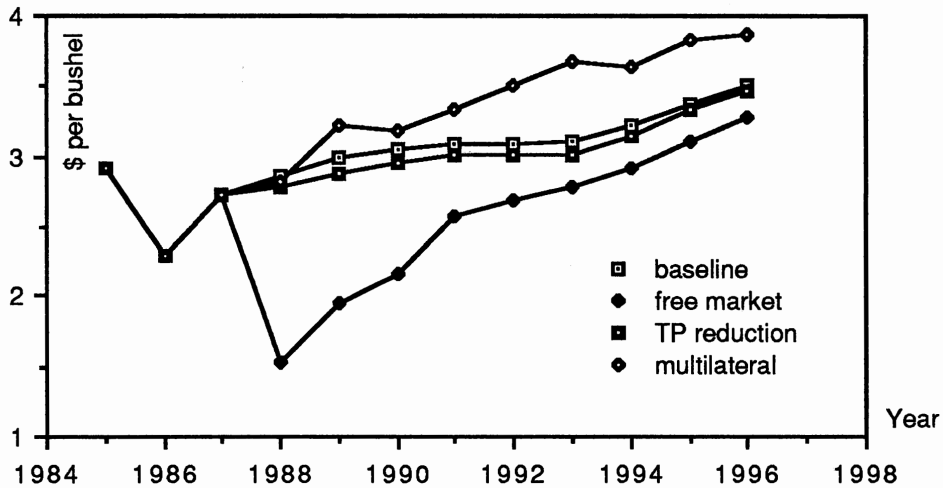

Figure 20. Price of Wheat Under Three Policy Options

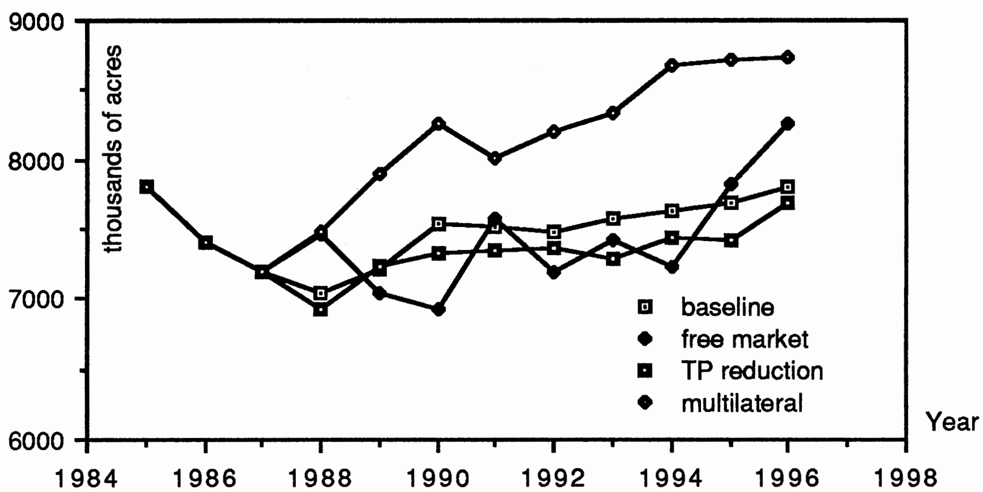

Figure 21. Wheat Planted Acreage Under Three Policy Options

per bushel in 1988 and increases slowly to reach almost baseline levels. The target price reduction policy deviates from the baseline only very little and under the multilateral suspension option the price of wheat increases to levels of 3.82 and 3.86 in 1995 and 1996 respectively.

Planted acreage to wheat, shown in Figure 21, remains relatively at the same levels under the baseline, increasing slightly and steadily from 7.01 million acres to 7.80 in 1996. Under the multilateral suspension option, acreage planted to wheat increases to levels of 8.7 million acres in 1996. The target price reduction scenario results in stable low levels of planted acreage throughout the projection period, except towards 1995, when it increases almost to baseline levels. The unilateral suspension of farm programs by the United States, results in an initial increase of planted acreage in 1988 to 7.5 million acres due to the elimination of acreage reduction programs. The levels are noticeably unstable during the projection period, supporting the hypothesis that when farm programs are suspended, more instability is reflected in this variable.

Yield is assumed to be deterministic for the projection period. Thus, the instability present in the planted acreage equation is caused by the fact that when all programs are suspended, wheat producers have to rely more on their price expectations. Interestingly, the ARIMA (1,0,1) model used to generate expected values of the price of wheat, gives results that resemble the ones which would be obtained by a Cobweb model, depicting a quasi sinusoidal path.

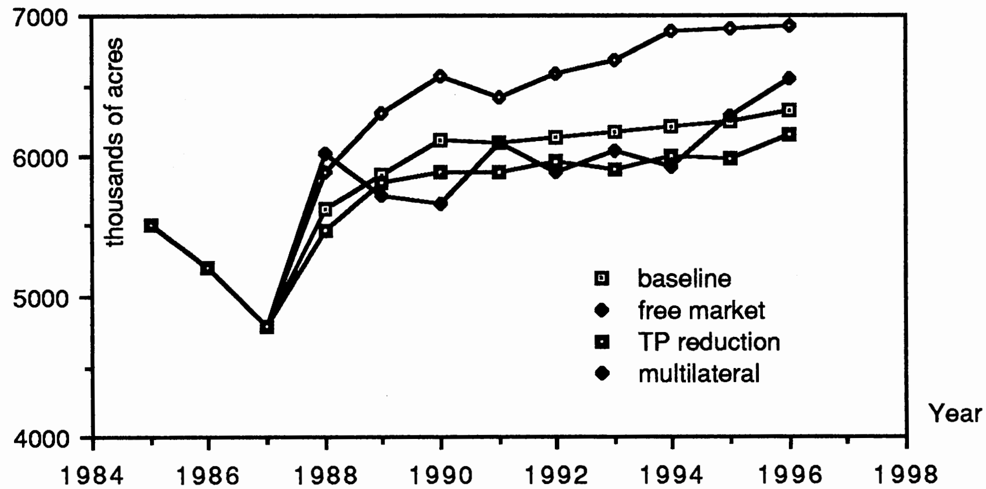

Figure 22. Wheat Harvested Acreage Under Three Policy Options

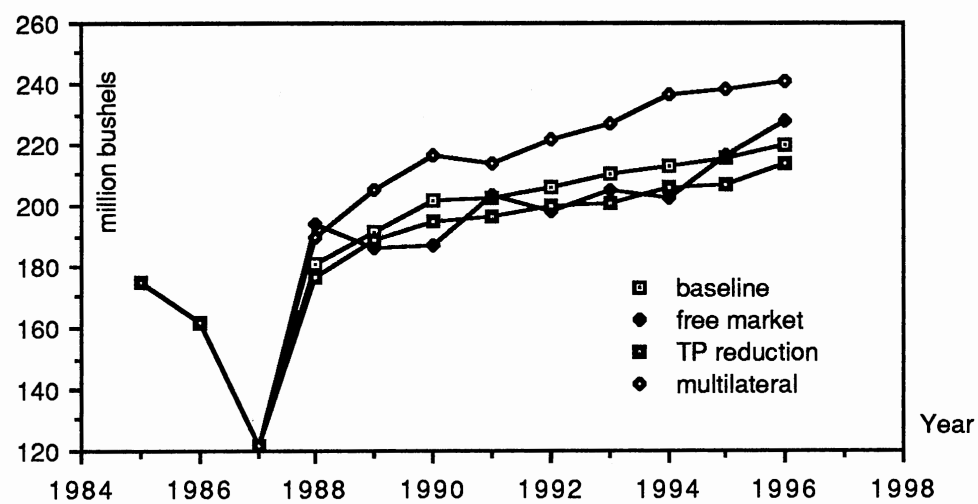

Figure 23. Wheat Produced Under Three Policy Options

Area harvested to wheat in Oklahoma, shown in Figure 22, follows a smoothed version of planted acreage, indicating the strong relationship between acreage planted and acreage harvested. The superiority of the multilateral option--using production as a criterion--is reflected in these results.

A similar pattern is followed by quantity produced of wheat under the three policy scenarios, after an actual drastic decrease in 1987, as shown in Figure 23. It can be noted that the unilateral suspension option shows higher levels of production than the baseline towards the end of the projection period.

The value of wheat production and cash receipts, shown in Figures 24 and 25, follow similar patterns, except that the former is proportionately higher than the latter, reflecting the fact that some wheat is used for other purposes such as grazing. In both cases however, the unilateral suspension scenario is associated with very low levels of value of wheat production and cash receipts during the initial years. The values recover quickly and reach levels generated by the target price reduction, and both become become significantly close to baseline levels. As expected, the multilateral option outperforms the other two scenarios and the baseline. It reaches levels of close 900 million dollars in cash receipts from wheat for 1996.

The price of cattle in Oklahoma under the three options and the baseline undergoes a decrease from 1989 to 1993, as shown in Figure 26, and begins increasing until the end of the forecast period. Under the unilateral suspension the price of cattle decreases almost

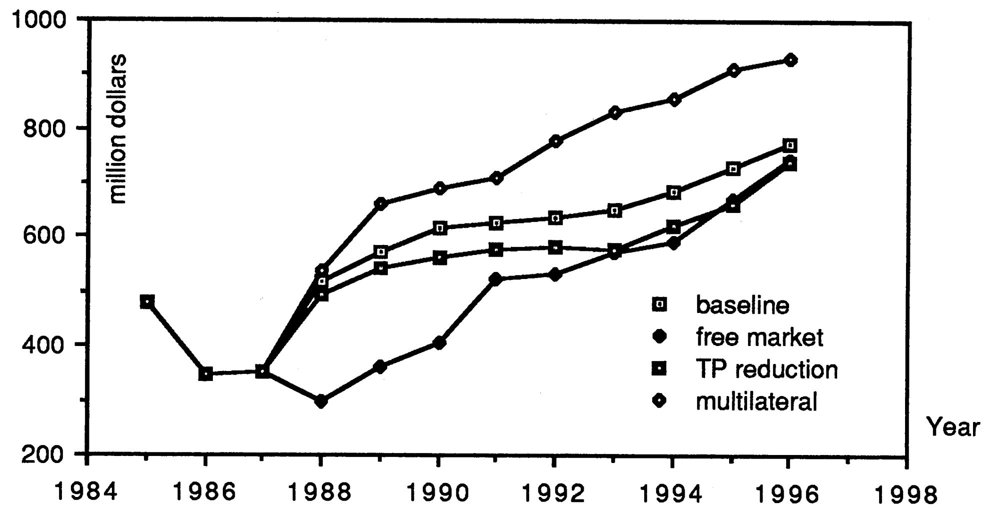

Figure 24. Value of Wheat Production Under Three Policy Options

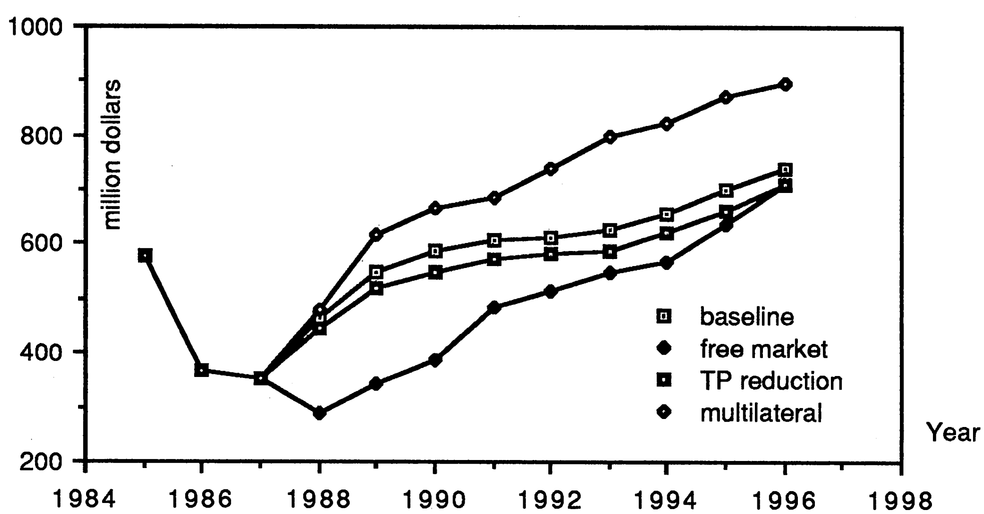

Figure 25. Wheat Cash Receipts Under Three Policy Options

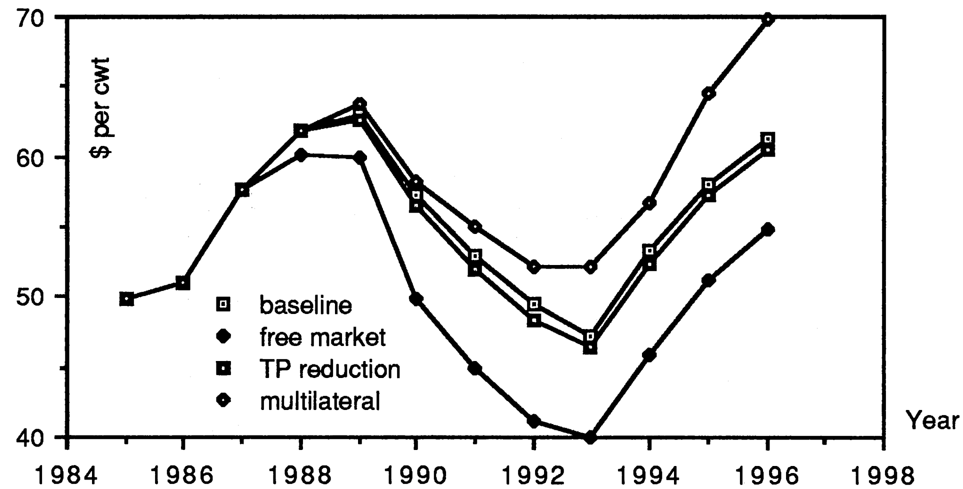

Figure 26. Cattle Price Under Three Policy Options

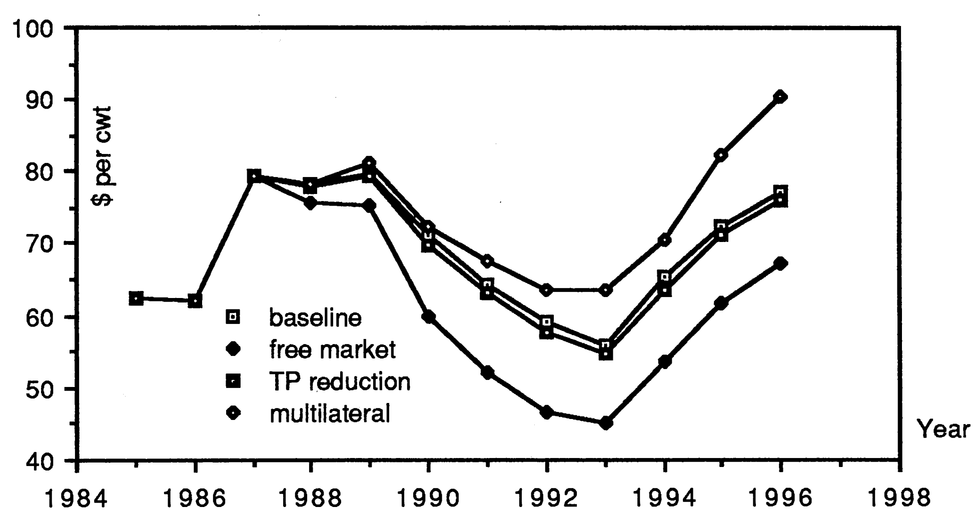

Figure 27. Calf Price Under Three Policy Options

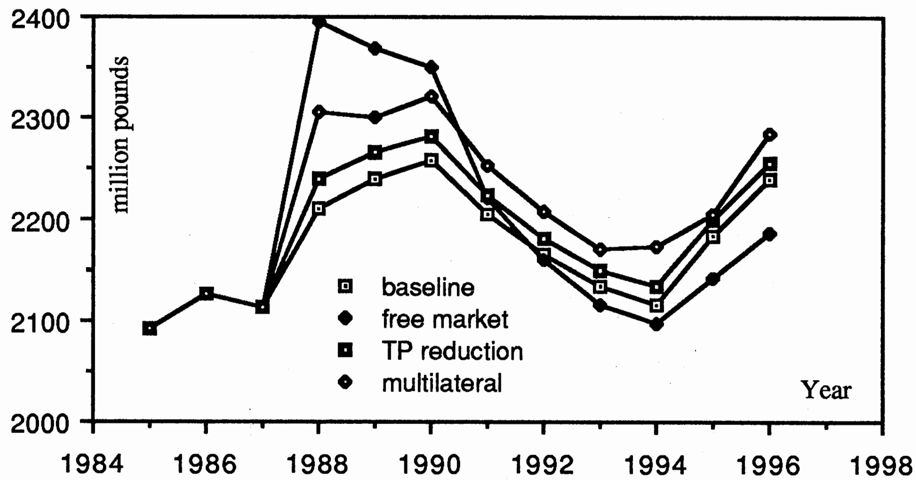

Figure 28. Cattle Production Under Three Policy Options

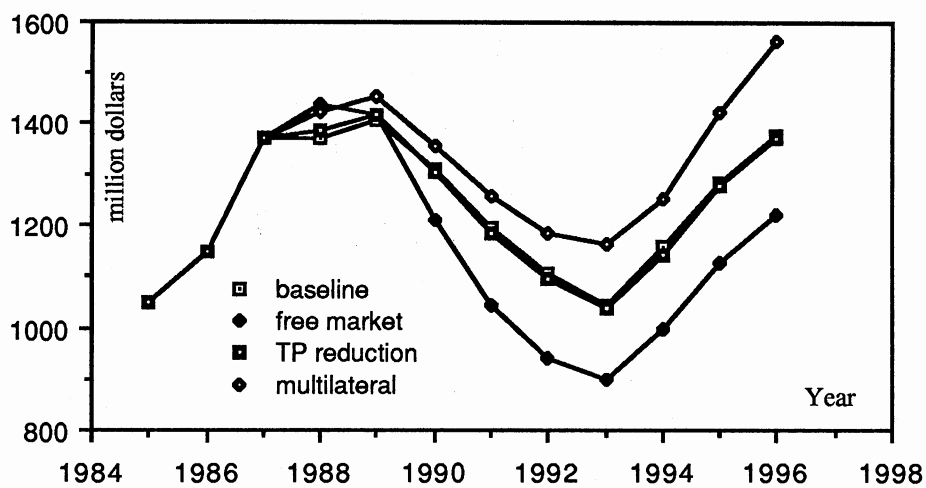

Figure 29. Cattle Value of Production: Three Policy Options

until $40 per cwt. The price of calves in Oklahoma, in Figure 27, follows a similar path.

Under the free market scenario, production of cattle (Figure 28) increases to 2,394 million pounds, a higher level than the other two policy options and the baseline. This result reflects the dual production character of Oklahoma wheat producers of switching from wheat to cattle when the price of the grain undergoes a significant decrease. The levels of production do not remain high however, and they decline to 2,097 million pounds in 1994, lower than the other two scenarios and the baseline.

The value of cattle production, shown in Figure 29, is significantly influenced by the decrease in cattle and calf prices and follow a similar shape. The multilateral option again outperforms the other scenarios and the projection for the baseline and target price reduction are noticeably close.

Under the unilateral suspension scenario, cash receipts from cattle (Figure 30) decrease significantly to 1,338 million dollars in 1993, as opposed to 1,501 for the baseline; 1,519 for the target price reduction;1,519 for the target price reduction option and 1,574 for the multilateral suspension of farm programs.

Total cash receipts under the three policy scenarios is depicted in Figure 31. All three curves and the baseline follow an oscillating path, with a moderate peak in 1989 and a moderate decrease in 1992. The four curves show the expected outcome, the multilateral option outperforming the other two options and the baseline. The unilateral suspension is consistently below the baseline.

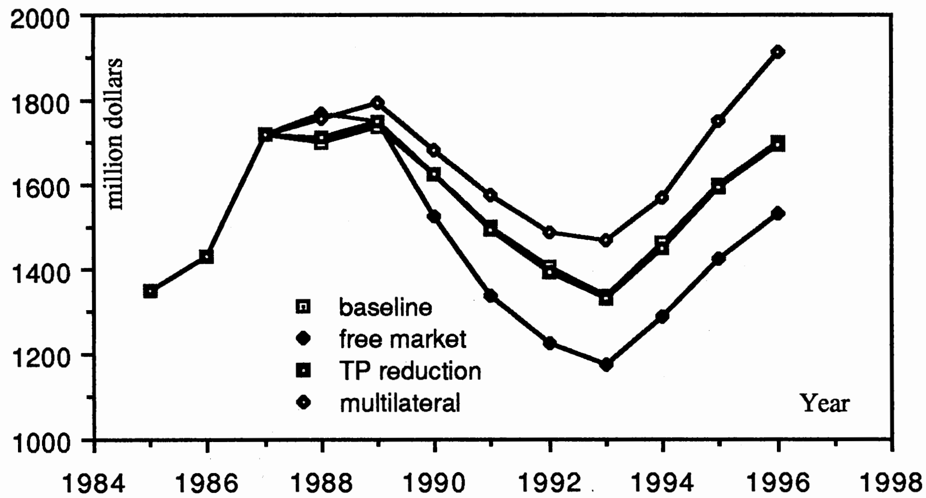

Figure 30. Cattle Cash Receipts Under Three Policy Options

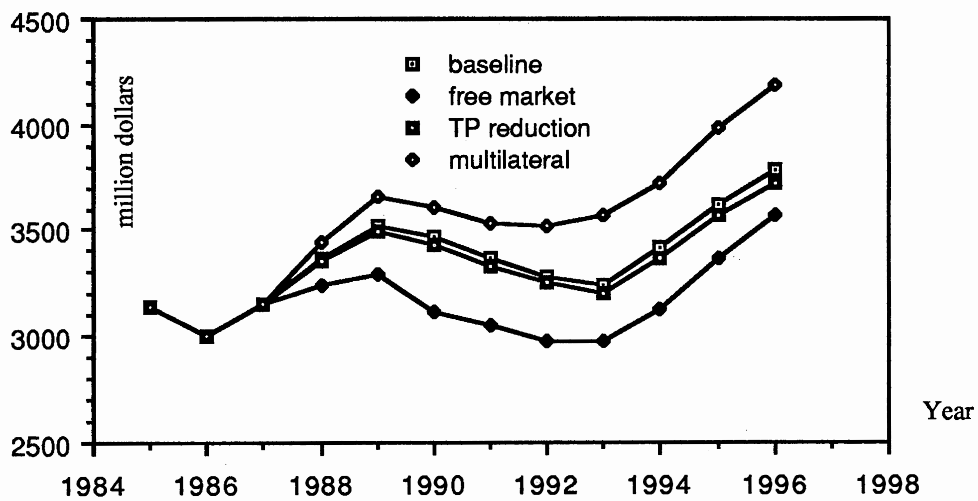

Figure 31. Total Cash Receipts Under Three Policy Options

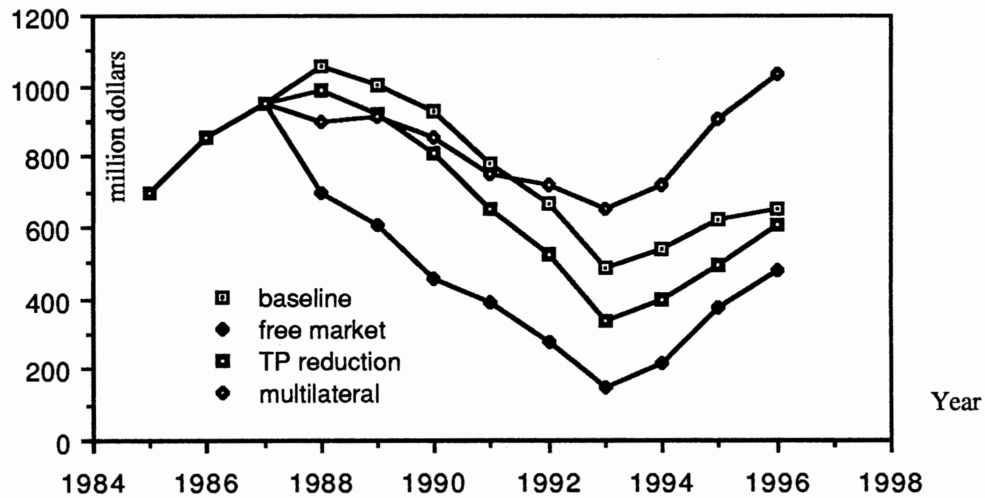

Figure 32. Net Realized Farm Income: Three Policy Options

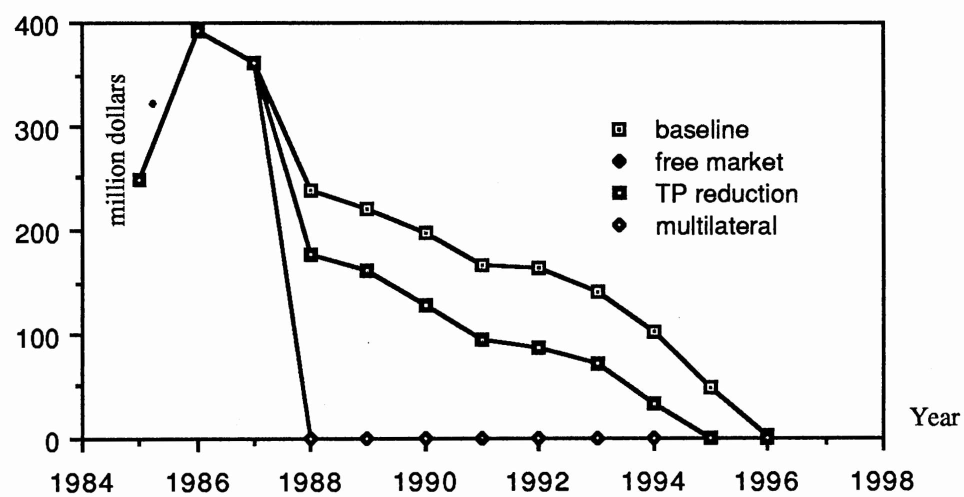

Figure 33. Government Payments: Three Policy Options

Figure 32, which depicts net realized farm income, shows interesting results. While the multilateral suspension scenario and the unilateral suspension show a decrease in farm income immediately after the implementation of the policy, the former maintains a relative high level over 600 million dollars, while the free market option decreases to 152 million in 1992. The three options plus the baseline reach lowest levels of the projection period in 1933, when the baseline, target price reduction and unilateral suspension decrease to 487, 314 and 152 (m of $), respectively.

Government payments, shown in Figure 33, decrease to zero in 1988 for the unilateral suspension and the multilateral options. The target price scenario decreases to zero in 1991, and the baseline in 1996, when the market price exceeds the target price.

The simulation exercises performed in this chapter give credence to the advantages derived from the implementation of the multilateral suspension of farm programs. Both, cash receipts from cattle and wheat show significant increases when this policy is implemented. The results also show that the target price reduction option, by itself, is not too different from the baseline, except in farm income, where the negative effects of the former are observed against the baseline. Drastic changes in the endogenous variables are observed when programs are suspended unilaterally, acreage planted to wheat becomes more unstable, cash receipts initially decrease significantly but recover moderately soon after. Cattle produced is increased for a few years in this scenario, but cash receipts are the lowest compared to the other options.

CHAPTER VI

CONCLUSIONS

Wheat production is one of the two most important agricultural activities in the state of Oklahoma. The interdependence of wheat and cattle production in the economy of the state is enhanced since in the Southern Plains, wheat is frequently used as forage. Consequently, wheat commodity programs have an important role in the agricultural sector of the state and they have become a complex set of regulations in recent decades. The broad objective of the present study is to provide a quantitative assessment of the effects of wheat commodity programs on the agriculture of Oklahoma.

The methodological goal of the present study is to build a regional econometric with which to analyze the effects of wheat commodity programs on the agricultural sector of the state. The empirical objective is to assess the impacts of recently suggested wheat policy reforms on farm income and other relevant variables.

Procedure

A regional recursive econometric model is used in the present study to attain the objectives described above. The model consists of twelve equations and four identities.

The price of wheat in Oklahoma is postulated as a function of its counterpart at the national level, to establish a linkage to a large policy evaluation model. The acreage response equation is found to be a function of the supply inducing price, participation rates and unrestricted grazing.

In the present model, acreage harvested to wheat is a function of acreage planted, effective diversion payments and harvested acreage at the national level. Wheat production, wheat value of production and cash receipts from wheat are also formulated.

The price of cattle in Oklahoma is posited to be a function of the price of cattle in the United States. Cattle production is a function of the lagged price of calves and the target price of wheat. The value of cattle and calf production and cash receipts are also formulated.

Total cash receipts are postulated to be a function of cash receipts from wheat and cash receipts from cattle and calf production. A total farm expenditures equation is also set forth with interest rate and farm expenditures at the national level as its arguments.

Five statistics are used to validate the model, namely, mean simulation error, mean simulation percentage error, root mean simulation error, root mean simulation percentage error and the U Theil Inequality Coefficient. All validation tests give good results. In addition, graphic validation is presented, in which the actual and the estimated values of the endogenous variables are depicted.

Acreage planted to wheat is paid special attention in this study. The Houck/Ryan approach is selected to specify government programs as supply inducing prices. In this formulation of the acreage planted equation, the partly rational expectations hypothesis is introduced through a Box and Jenkins model. The partly rational expectation hypothesis claims that only a subset of all information available is used by the economic agent in question.

Results From Simulations

To conduct the simulation exercises, a baseline was constructed for the projection period (1988-1996). The baseline incorporates macroeconomic and policy environments that reflect the implementation of relevant features of the Farm bill of 1985.

Subsequently, projections are obtained for three policy scenarios, namely, unilateral suspension of all programs, ten percent target price reduction and the multilateral suspension of farm programs. The unlilateral suspension refers to the elimination of target prices, loan rates, and diversion payments in the U.S.. The ten percent target price reduction--below its baseline value--is suggested as an instrument to phase out government programs gradually. The multilateral suspension refers to the elimination of government intervention in agricultural markets in the United States and its trading partners.

The unilateral suspension of programs brings about a moderate decrease in agricultural activity and a significant decrease in net realized farm income. These results partly reflect the projection from other large agricultural econometric models, which consistently predict a significant decrease in the price of crops after the unilateral suspension of crop commodity programs.

The projections obtained when the target price reduction option is implemented do not differ significantly from the baseline with two exceptions. First, government payments decrease more rapidly when target price reduction is implemented, compared to the baseline. Second, net realized farm income is higher when the policy is implemented than when present policies are unchanged.

The results of the projections for the multilateral suspension scenario support basic international trade theory, i. e. that the elimination of farm programs in the United States and its trading partners increases farm income in Oklahoma. It also enhances agricultural activity due to increased levels of international trade. In addition, since government payments are eliminated, multilateral suspension also removes fiscal pressures.

Suggestions for Future Research

The successful treatment of a research topic should generate more questions than answers and the present model shows several directions in which its completeness can be more fully achieved. Cattle activity, for example, is treated somewhat simplistically in the present study and more extensions should be added to reflect cattle production more realistically.

Another source of research questions is the effects of macroeconomic variables on the state. Prices of cattle and wheat in the present model are obtained from large policy models that deal with the national effects of policy implementation. These two prices are vulnerable to macroeconomic influences such as money supply, exchange rate, inflation and interest rates. The linkages of these variables to the agricultural sector of Oklahoma are of interest to policy makers who want to explore these functional relationships

The approach and procedures used in this study can be applied to other regulated crops, i. e grain sorghum, peanuts, cotton, etc. In addition, the same framework can be used to analyze the agricultural sectors of other regions and other states.

Expectations in supply response models point in the direction of fruitful applied research. Many other specifications of expectations, following the partly rational expectation hypothesis can be tested empirically, taking into consideration the theoretical issues involved in the inclusion or exclusion of variables in the information set of the producer.

REFERENCES

Adams, F. G., C. Brooking and N. J. Glickman. 1975. "On the Specification and Simulation of a Regional Econometric Model: A Model of Mississippi." The Review of Economics and Statistics. 57:286-298.

Arzac, Enrique R. and Maurice Wilkinson. 1979. "A Quarterly Econometric Model of the US Livestock and Feed Grain Markets and Some of Its Policy Implications." American Journal of Agricultural Economics. 61:297-308.

ASCS Commodity Fact Sheets. 1972-1987. USDA, Agricultural Stabilization and Conservation Service. Wheat Summary.

Ash, Mark S. and William Lin. May 1986. "Wheat Yield Response: Policy Implications and Projections." Wheat Situation and Outlook Report WS 275.

Ash, Mark. August 1988. "Predicting Yields of Wheat by Class." Wheat Situation and Outlook Report WS-282.

Azzam, Azzeddine M., John F. Yanagida and Dean Linsenmeyer. 1987. "A Linked Model of the Livestock-Feed Sectors in Nebraska and the Rest of the United States." North Central Journal of Agricultural Economics. 9:247-258.

Ballard, Kenneth and Norman J. Glickman. 1977. "A Multiregional Econometric Forecasting System: A Model for the Delaware Valley. Journal of Regional Science. 17:161-172.

Bailey, K. W. and A. W. Womack. 1985. "Wheat Acreage Response: A Regional Econometric Investigation." Southern Journal of Agricultural Economics. 17:171-180.

Burt, Oscar and Virginia E. Worthington. 1988. "Wheat Acreage Supply Response in the United States." Western Journal of Agricultural Economics. 13:100-111.

Chambers, Robert G. and Richard E. Just. 1981. "Effects of Exchange Rates Changes on U.S. Agriculture: A Dynamic Analysis." American Journal of Agricultural Economics. 63:33-46.

Chase Econometrics Associates, Inc.. 1977. Chase Agricultural Model, Bala-Cynwyd, Pennsylvania .

Chen, Dean T. 1976. "The Wharton Agricultural Model: Structure, Specification and Some Simulation Results." American Journal of Agricultural Economics. 59:106-16.

Congressional Budget Office. May 1980. Agricultural Price Support Programs: a Handbook. Staff Working Paper. U.S. Congress, Washington, D.C..

Crow, R. T. 1973. "A Nationally Linked Regional Econometric Model." Journal of Regional Science. 13:187-204.

Cumby, R. E, J. Huizinga and M. Obstfeld. 1983. "Two-Step Two-Stage Least Squares Estimation in Models with Rational Expectations." Journal of Econometrics. 21:333-335.

DRI Agricultural Service. October 1976. The 1977 Version of the DRI Agricultural Model. Working Paper No. 5. DRI Data Resources Inc.. Lexington, Massachusetts..

Ducot, Elizabeth and Alexander Levis. January 1977. "Brief Description of AGRIMOD." Systems Control Inc..

Duffy, Patricia. December 1985. "An Analysis of Alternative Farm Policies for Cotton." Unpublished Ph.D. Dissertation. Department of Agricultural Economics, Texas A & M, College Station, Texas.

Duffy, Patricia A., James Richardson and Michael K. Wohlgenant. 1987. "Regional Cotton Acreage Response." Southern Journal of Agricultural Economics. 19:99-109.

Eckstein, Zvi. 1984. "A Rational Expectations Model of Agricultural Supply." Journal of Political Economy. 92:1-19.

Farmer, Charles M. September 1987. "Corn and Wheat: Situation and Outlook for 1987-88." Prepared for the Southern Regional Outlook Conference. Atlanta, Georgia.

Fereidoon Shahrokh and Walter C. Labys. 1985. "A Commodity Regional Model of West Virginia." Journal of Regional Science. 25:383-410.

Fishkind, Henry H. 1977. "The Regional Impact of Monetary Policy: An Economic Study of Indiana." Journal of Regional Science. 17:77-88.

Food and Agricultural Policy Research Insitute. February 1987. "The Commodity Supply Management Program." FAPRI Staff Report 2-87.

Food and Agricultural Policy Research Institute. July 1987. "Managing the Food Security Act of 1985: the Current Strategy and Two Alternatives." FAPRI Staff Report 3-87.

Gallagher, Paul. 1978. "The Effectiveness of Price Support Policy: Some Evidence for US Corn Acreage Response." Agricultural Economic Research. 30: 8-14.

Garst, Gail D., and Thomas A. Miller. 1975. "Impact of the Set-Aside Programs on the US Wheat Acreages." Agricultural Economics Research. 27:30-37.

Glickman, Norman J. 1971. "An Econometric Forecasting Model for the Philadelphia Region." Journal of Regional Science. 11:15-32.

Goodwin, Thomas and Steven Sheffrin. 1982. "Testing the Rational Expectation Hypothesis in an Agricultural Market." Review of Economics and Statistics. 64:658-67.

Hadwiger, Don F. Federal Wheat Commodity Programs. 1982. The Iowa State University Press. Ames, Iowa.

Halcrow, Harold. 1984. Agricultural Policy Analysis. McGraw Hill Book Company.

Hall, Owen and Joseph Licari. 1974. "Building Small Region Econometric Models: Extension of Glickman's Structure to Los Angeles." Journal of Regional Science. 14:337-353.

Hazell P. and P. Scandizzo. 1974. "Competitive Demand Structures Under risk in Agricultural Linear Programming Models." American Journal of Agricultural Economics. 56:235-244.

Hoffman, Dennis L., and Peter Schmidt. 1981. "Testing the Restrictions Implied by the Rational Expectations Hypothesis." Journal of Econometrics. 15:265-287.

Hoffman, Robert G.. August 1973. "Wheat Regional Supply Analysis." Wheat Situation and Outlook Report.

Houck, James P. and Abraham Subotnik. 1969. "The U.S. Supply of Soybeans: Regional Acreage Functions." Agricultural Economics Research. 21:99-108.

Houck, James P. and Mary E. Ryan. 1972. "Supply Analysis for Corn in the US: The Impact of Changing Government Programs." American Journal of Agricultural Economics. 54:184-191.

Houck, James P., and Paul W. Gallagher. 1976. "The Price Responsiveness of US Corn Yields." American Journal of Agricultural Economics. 58:731-734.

Houck, James P., Martin E. Abel, Mary E. Ryan, Paul W. Gallagher, Robert G. Hoffman and J. B. Penn. August 1976. "Analyzing the Impact of Government Programs on Crop Acreage." USDA-ERS and the University of Minnesota Agricultural Experiment Station. Technical Bulletin 1548.

Jaske, Michael R.. June 1977. System Documentation of the Annual Version of NIRAP. Data Service Center. Economic Research Service. Washington D. C..

Johnson, D. Gale. 1985. Agricultural Policy and Trade. The Triangle Papers. Published by New York University Press. New York and London.

Just, Richard E., and Gordon C. Rausser. 1981. "Commodity Price Forecasting with Large Scale Econometric Models and the Futures Market." American Journal of Agricultural Economics. 63:197-208.

Kitchen, John, Suchada Langley, Ralph Monaco and J. Michael Price. May 1987. "Effects of Monetary and Fiscal Policy on Agriculture." USDA-ERS. Agricultural Information Bulletin 517.

Klein, Lawrence and Norman J. Glickman. 1977. "Econometric Model Building at Regional Level." Regional Science and Urban Economics. 7: 3-23.

L'Esperance, W. L., A. E. King and R. H. Sines. 1977. "Conjoining and Ohio Input-Output Model with an Econometric Model of Ohio." Regional Science Perspectives. 7:55-77.

Lee, David R. and Peter G. Helmberber. 1985. "Estimating Supply Response in the Presence of Farm Programs". American Journal of Agricultural Economics. 67:193-203.

Lee, David R. and Peter Helmberger. December 1982. "Structural Change in Acreage Supply Response: An Econometric Analysis of US Feed Grain Programs, 1948-1980." Department of Agricultural Economics. Cornell University Agricultural Experiment Station. A. E. Res. 82-47.

Lidman, Russel, Lee D. Badwen. 1974. "The Impact of Government Programs on Wheat Acreage." Land Economics. 50:327-335.

Livezey, Janet. November 1983. "Factors Affecting US Wheat Feed Use." Wheat Outlook and Situation Report. WS - 266. USDA - ERS.

McCalla, Alex F. and Timothy E. Josling. 1985. Agricultural Policy and World Markets. McMillan Publishing Company. New York.

McCallum, B. T. 1976. "Rational Expectations and the Estimation of Econometric Models: an Alternative Procedure." International Economic Review. 17:484-490.

Morzuch, B. J., R. D. Weaver and P. G. Helmberger. 1980. "Wheat Acreage Supply Response under Changing Government Farm Programs." American Journal of Agricultural Economics. 62:29-37.

Muth, J. F. 1971. "Rational Expectations and the Theory of Price Movements." Econometrica. 29:315-335.

Nelson, C. R. 1975. "Rational Expectations and the Estimation of Econometric Models." International Economic Review. 16:555-567.

Otto Daniel, Michael D. Helmar and William H. Meyers. April 1985. Impacts of Alternative Agricultural Policies on Iowa Agriculture. CTAP Staff Report No 9.

Otto, Daniel M., Michael D. Helmar and William H. Meyers. 1985. CTAP Staff Report 9. FAPRI.

Paarlberg, Don. 1980. Farm and Food Policy: Issues of the 1980s. University of Nebraska Press. Lincoln and London.

Penson, John B., Dean W. Hughes and Robert T. J. Romain. December 1984. "An Overview of COMGEM: A Macroeconomic Model Emphasizing Agriculture." Staff Paper Series. The Texas Agricultural Experiment Station, Texas A & M, College Station, Texas.

Pindyck, Robert and Daniel F. Rubinfeld. 1981. Econometric Models and Economic Forecasts. Second Edition. International Student Edition. McGraw Hill International Book Company.

Ray, Daryll E. and Earl O. Heady. 1972. "Government Farm Programs and Commodity Interaction: A Simulation Analysis" American Journal of Agricultural Economics. 15:577-590.

Ray, Daryll and Theo Moriak. 1976. "POLYSIM: A National Agricultural Policy Simulator". The Journal of Agricultural Economic Research. 28:14-21.

Ray, Daryll E. and James W. Richardson. December 1978. "Detailed Description of POLYSIM." Technical Bulletin T-151, Agricultural Experiment Station. Oklahoma State University.

Ray, Daryll E. and Richard Zeller. 1978. "An Econometric Model of Oklahoma Agriculture". Mimeo. Oklahoma State University.

Ray, Daryll E. 1988. "Description and Two Applications of POLYSIM". AAEA Modeling Workshop. Annual Meeting, Knoxville, Tennessee.

Reed, Michael R. and Steven K. Riggins. 1981. "A Disaggregated Analysis of Corn Acreage Response in Kentucky." American Journal of Agricultural Economics. 63:708-711.

Richardson, James W. and Daryll Ray. July 1979. "An Application of Optimal Control Techniques to Agricultural Policy Analysis." Agricultural Experiment Station. Oklahoma State University. Technical Bulletin T-154.

Riepe, Jean Rosscup, David L Watt and William W. Wilson. 1987. "Differenciated Demand for Wheats in International Competition." AAEA meetings, Michigan State University.

Romain, R. F. December 1983. "A Commodity Specific Simulation Model for US Agriculture." Unpublished Ph.D. Dissertation. Department of Agricultural Economics, Texas A&M, College Station, Texas..

Rude, Le Roy. Commodity Program Update. Food and Agricultural Policy Branch, NED, ERS, USDA.

Ruiz, Norma. Department of Agronomy. Oklahoma State University. Personal communication.

Ryan, Mary E. and Martin E. Abel. December 1972. "Supply Response of US Sorghum Acreage to Government Programs." Staff Paper P72-30. Department of Agricultural and Applied Economics. University of Minnesota.

Sargent, Thomas. 1973. Rational Expectations, the Real Rate of Interest, and the Natural Rate of Unemployment. Brookings Papers of Economic Activity. pp 429-472.

Seale, James and J. S. Shonkwiller. 1987. "Rationality, Price Risk and Response." Southern Journal of Agricultural Economics. pp. 111-118.

Sheffrin, Steven M. 1983. Rational Expectations. Cambridge Surveys of Economic Literature. Cambridge University Press.

Shideed, Kamil H. and Fred C. White. January 1988. "Supply Response Analysis for Double-Cropping Soybeans and Wheat Acreages in the Southeast." Division of Agricultural Economics. College of Agriculture, University of Georgia. Faculty series 88-14.

Shideed, Kamil H., Fred C. White and Stephen J. Bramman. 1987. "Alternative Procedures for the Formation of Price Expectations in Supply Response Analysis: An Application to US Corn Acreage." Manuscript prepared for the American Agricultural Economics Association. Michigan State University.

Shideed, Kamil H., Stephen J. Brunnen and Robert S. Glover. 1988. "Econometric Estimation of Soybean Supply Response under the Rational Expectations Hypothesis." Georgia Agricultural Experiment Station.

Shonkwiler, J. Scott and Robert D. Emerson. 1982. "Imports and the Supply of Winter Tomatos: An Application of Rational Expectations." American Journal of Agricultural Economics. 64:634-641.

Shumway, C Richard. 1983. "Supply, Demand and Technology in a Multiproduct Industry: Texas Field Crops." American Journal of Agricultural Economics. 65:154-161.

Sims, Christopher. Winter 1986. "Are Forecasting Models Usable for Policy Analysis?. Quarterly Review. Federal Reserve Bank of Minneapolis :1-16.

Taylor, C. Robert. August 1987. "AGSIM: Deterministic and Stochastic Simulation Model and Benchmark Results for Version 87.3". Manuscript, University of Illinois, Urbana, Champaign.

Tryfos, P. 1974. "Canadian Supply Functions for Livestock and Meat." American Journal of Agricultural Economics. 56:107-13.

Tweeten, L. G. and C. L. Quance. 1969. "Positivistic Measures of Aggregate Supply Elasticities: Some New Approaches." American Journal of Agricultural Economics. 51:342-52.

Tweeten, Luther. Editor. December 1982. Oklahoma Agriculture 2000. General Summary. Division of Agriculture. Oklahoma State University.

United States Department of Agriculture, Economic Research Service. Wheat Situation and Outlook Report. Several Issues.

United States Department of Agriculture, Economic Research Service. September 1984. "Wheat: Background for 1985 Farm Legislation." Agriculture Information Bulletin 467.

Vijay K. Mathur and Sheldon Stein. 1980. "Regional Impact of Monetary and Fiscal Policy: An Investigation into the Reduced Form Approach." Journal of Regional Science. 20:343-351.

Wallis, Kenneth F. 1980. "Econometric Implications of the Rational Expectation Hypothesis." Econometrica. 48:49-73.

Weiss, Michael D., Mac W. Whittington and Lloyd D. Teigen. 1987. National Economics Division, ERS, USDA. Statistical Bulletin 737.

Westcott, Paul C. and David B. Hull. 1985. "A Quarterly Forecasting Model for US Agriculture." USDA-ERS Technical Bulletin 1700.

White, Fred, Kamil Shideed, Stephen J. Brannen and Robert S. Glover. 1986. "The Contribution of Farm Programs to Structural Changes of Corn Supply Response in Georgia". Division of Agricultural Economics Faculty Series FS88-09. College of Agriculture. University of Georgia.

Wickens, M. R. 1982. "The Efficient Estimation of Econometric Models with Rational Expectations." Review of Economic Studies. 99:55-67

APPENDIX

SUMMARY OF THE MODEL

Equations

$$OKPRDO = -0.052 + \underset{(3.45)}{1.025} * USPRDO$$

$R^2 = 0.98$ D. W.= 1.68

$$OKAPTB = \underset{(22.5)}{4423.10} + \underset{(14.43)}{926.40} * SIP + \underset{(6.68)}{881.95} * APDUM$$
$$\underset{(2.15)}{819.13} * NONPRT$$

$R^2 = 0.95$ D.W. = 2.46

$$OKAHTB = - 252.48 + \underset{(7.34)}{0.64} * OKAPTB + \underset{(4.48)}{0.03} * USAHTA$$
$$\underset{(-\ 9.43)}{-1957.74} * EFDIDO$$

$R^2 = 0.90$ D. W. = 2.30

$$OKYIBU = 60.15 + \underset{(7.13)}{0.29} * YEAR + \underset{(4.30)}{19.09} * JUNP - \underset{(-3.38)}{13.11} * LAUGP$$
$$+ \underset{(6.79)}{17.86} * LSEPP + \underset{(6.37)}{3.38} * LNOVP - \underset{(-4.59)}{11.79} * JANT$$
$$- \underset{(-5.74)}{23.66} * MART - \underset{(-5.77)}{33.36} * APRT - \underset{(-4.94)}{9.20} * JUNP2$$
$$+\underset{(2.14)}{3.22} * LAUGP2 - \underset{(-7.48)}{8.91} * LSEPP2 + \underset{(3.33)}{0.74} * LOCTP2$$
$$+\underset{(2.11)}{13.35} * JUNT2 - \underset{(-3.28)}{23.29} * LAUGT2 + \underset{(-3.24)}{11.24} * LNOVT2$$

$R^2 = 0.97$ D. W. = 1.70

$$WHCASH = 724.38 + \underset{(14.18)}{0.79} * WPR + \underset{(3.42)}{0.18} * WPR (-1)$$

$R^2 = 0.96$ D. W. = 1.92

$$CATPRI = -24.10 + \underset{(16.74)}{1.17} * USCATP$$

$R^2 = 0.98$ D.W. = 2.65

$$CAVPRI = -15.91 + \underset{(12.23)}{1.52} * CATPRI$$

$R^2 = 0.96$ D. W. = 1.65

$$CATPRO = 1993 + \underset{(10.37)}{6.72} * CAVPRI(-1) - \underset{(-4.73)}{68.12} * TARPRI + \underset{(4.14)}{157.82} * VA82$$

$R^2 = 0.93$ D.W. = 2.39

$$CAVAPR = -811.82 * + \underset{(4.50)}{0.53} * CATPRO + \underset{(11.23)}{12.83} * CAVPRI$$

$R^2 = 0.97$ D. W.= 1.78

$$CACASH = 187.01 + \underset{(18.26)}{1.10} * CAVAPR + \underset{(68.96)}{170.20} * VA82$$

$R^2 = 0.97$ D. W. = 1.76

$$TOCASH = 1110 + \underset{(11.81)}{1.176} * WHCASH + \underset{(16.10)}{1.048} * CACASH$$

$R^2 = 0.99$ D. W. = 1.29

$$TOCOST = 347.37 + \underset{(12.99)}{0.015} * USCOST + \underset{(3.38)}{35.79} * INTERE + \underset{(1.55)}{167.34} * DUM77$$

$R^2 = 0.98$ D.W. = 2.16

Identities

OKPRTB = OKAHTB * OKYIBU

WPR = OKPPTB*OKPRDO

GOVPAY= DEF + DIV + DIS

INCO = TOCASH + GOVPAY + TOCOST

Variables

APDUM = Dummy variable for 1976 and 1977.
APRT = April deviation from average temperature.(Fahrenheit).
CACASH = Cash receipts from Cattle.(million dollars).
CATPRI = Price of cattle (dollars per cwt).
CATPRO = Cattle produced (million pounds).
CAVAPR = Value of cattle production (million dollars).
CAVPRI = Price of Calves (dollars per cwt)
DEF = Deficiency Payments (million dollars).
DIS = Disaster Payments.(million dollars).
DIV = Diversion Payments (million dollars).
DUM77.= Dummy for 1977.
EFDIDO = Effective diversion payments (dollars per bushel)
GOVPAY = Govenment Payments (million dollars)
INCO = Net realized farm income (million dollars).
INTERE = Average annual prime rate charded by banks.
JANT = January deviation from average temperature (Fahrenheit).
JUNP = June deviation from average precipitation (inches).
JUNP2 = Square of JUNP.
JUNT2 = Square of deviation from average June temperature (Fahrenheit).
LAUGP = Lagged deviation from average August Precipitation.
LAUGP2 = Square of LAUGP.
LAUGT2 = Square Lagged deviation from average August Temperature.
LNOVP = Lagged deviation from average November Precipitation (inches).
LNOVT2.= Squared lagged deviation from average November Temperature.
LOCTP2 = Squared lagged deviation from average October Precipitation.
LSEPP = Lagged deviation from average September Precipitation.
LSEPP2 = Lagged deviation from average September Precipitation.
MART = Deviation from average March Temperature.
NONPRT = Rate of non-participation of Oklahoma wheat growers.
OKAHTB = Acreage harvested to wheat (million acres).
OKAPTB = Acreage planted to wheat (million acres).

OKPRDO = Price of wheat in Oklahoma (dollars per bushel).
OKPRTB = Wheat produced in Oklaoma (thousands of bushels)
OKYIBU = Wheat yield in Oklahoma (bushels per acre).
SIP = Wheat supply inducing price (dollars per bushel).
TARPRI = Targer price for wheat (dollars per bushel).
TOCASH = Total cash receipts (million dollars).
TOCOST = Total farm expenditures (million dollars).
USAHTA = U.S. harvested acreage to wheat (million bushels).
USCATP = U.S. cattle price (dollars per cwt).
USCOST = U.S. farm expenditures (million dollars).
USPRDO = U.S. price of wheat (dollars per bushel).
VA82 = Dummy variable for 1982.
WHCASH = Cash received from wheat in Oklahoma (million dollars).
WPR = Value of wheat production (million dollars)/
YEAR = Trend from 50 to 86.

Sources

For the Oklahoma variables data were obtained from the Oklahoma Agricultural Statistics. For the U. S. variables Agricultural Statistics. Weather variables were obtained from Weiss, et. al. (1987). Other data were obtained from the USDA commodity service.

YEAR	OKPRDO	USPRDO	OKAPTB	OKAHTB	OKPRTB	USAHTA	EFDID8	OKYIBU	USCAT1
1972	1.70	1.71	5700	3900	112181.5	47301	0.04	23	33.50
1973	3.56	3.72	6000	5260	150361.5	53869	0.16	30	42.80
1974	3.95	3.90	7000	6400	137523.5	65613	0.00	21	33.60
1975	3.43	3.37	7400	6700	162043.3	69656	0.00	24	32.20
1976	2.78	2.73	7800	6300	150424.4	49460	0.00	24	33.70
1977	2.32	2.28	7800	6500	167791.5	49664	0.00	27	34.40
1978	3.03	3.01	7000	5400	143385.7	38491	0.00	27	48.50
1979	3.91	3.79	7000	5700	207937.1	43427	0.00	38	66.10
1980	3.83	3.83	7500	6500	187483.7	51494	0.00	30	62.40
1981	3.83	3.65	7900	6400	177734.6	58476	0.00	27	58.60
1982	3.65	3.50	8000	6900	214990.4	57633	0.00	33	56.70
1983	3.51	3.48	7800	4300	150622.2	47584	0.95	35	55.50
1984	3.36	3.33	7700	5300	180089.1	51513	0.65	36	57.30
1985	2.91	3.09	7800	5500	167953.5	47953	0.27	30	53.70
1986	2.30	2.42	7400	5200	159280.8	43205	0.22	29	57.75
1987	2.72	2.56	7200	5300	143100.1	39317	0.00	27	64.65

YEAR	WHCASH	GOVPAY	CATPRI	USAHT1	CATPRO	CAVPRI	TARPRI	CAVAPR	CACASH
1972	151041	119.40	34.60	47300	2047	43.90	3.02	718.21	926.27
1973	470450	66.90	45.00	54100	2111	59.10	3.39	965.04	1257.32
1974	510800	14.40	33.60	65400	2252	38.10	2.05	761.51	913.57
1975	538654	18.80	30.00	69500	2085	27.90	2.05	621.31	873.87
1976	389121	27.70	33.00	70900	2063	35.10	2.29	682.64	1023.40
1977	430040	84.10	33.20	66700	1999	38.30	2.90	670.30	943.48
1978	330072	102.00	49.60	56500	1983	60.30	3.40	990.91	1420.50
1979	836965	41.70	69.90	62500	2171	87.30	3.40	1461.51	1822.35
1980	712220	34.90	62.70	71100	2364	74.60	3.63	1490.33	1839.51
1981	673485	124.50	57.40	80600	2184	62.70	3.81	1261.74	1479.66
1982	752242	127.00	54.10	77900	2297	58.90	4.05	1244.27	1727.96
1983	563697	351.70	51.40	61400	2073	60.40	4.30	1080.72	1334.62
1984	550685	309.40	51.00	66900	2118	58.50	4.38	1083.89	1387.92
1985	578196	249.50	49.90	64700	2092	62.30	4.38	1050.11	1349.09
1986	369308	393.00	51.00	60700	2127	62.10	4.38	1148.14	1434.35
1987	350247	393.00	57.60	55900	2112	79.30	4.38	1372.08	1718.79

YEAR	USCOST	TOCOST	NETINC	WPR	NONMIC	TOCASH	SIP	INTERE
1972	51688	1305	319.00	152490	87.70	1395	1.50	5.25
1973	64554	1792	608.00	561768	108.90	2197	1.54	8.03
1974	70980	1798	268.20	530880	122.90	1896	2.97	10.81
1975	75043	1739	330.00	551544	138.50	1869	3.01	7.86
1976	82742	1821	279.60	420336	141.10	1886	2.76	6.84
1977	88885	2147	9.90	407160	165.10	1864	2.63	6.83
1978	103249	2187	495.50	441774	224.00	2319	2.60	9.06
1979	123305	2860	817.80	846906	256.00	3335	2.53	12.67
1980	133139	2971	595.80	746850	350.00	3184	3.43	15.27
1981	139444	3198	174.70	661824	404.00	2820	3.53	18.87
1982	139978	3018	795.90	831105	432.50	3177	3.46	14.86
1983	140375	3024	425.00	528255	403.50	2608	3.54	10.79
1984	142669	2921	554.00	641088	406.70	2688	3.45	12.04
1985	133696	2700	694.00	480150	334.40	2680	3.46	9.93
1986	122052	2541	852.00	346840	288.70	2582	3.43	8.90
1987	120025	3046	951.30	338325	264.90	2752	2.82	8.22

VITA

Manuel R. Del-Valle

Candidate for the Degree of

Doctor of Philosophy

Thesis: A REGIONAL ECONOMETRIC MODEL FOR POLICY EVALUATION: THE AGRICULTURAL SECTOR OF OKLAHOMA

Major Field: Agricultural Economics

Biographical:

Personal Data: Born in Ayacucho, Huamanga, Perú, June 29 1953, the son of Ing. Benjamín Del Valle and Sra. Elva Jesús Lara de Del Valle.

Education: Graduated from Cimarron High School, New Mexico 1971; received Bachelor of Science degree from Universidad Peruana Cayetano Heredia in 1980; received the Master of Arts degree from Central State University, Edmond, Oklahoma in 1982; completed the requirements for the Doctor of Philosophy degree from Oklahoma State University with a major in Agricultural Economics in May 1989.

Professional Experience: Data Management, First National Bank of Oklahoma City 1981-1983. Teaching Assistant, Economics Department, Oklahoma State University 1984-1987. Research Assistant, department of Agricultural Economics at Oklahoma State University, 1988.

Professional Organizations: Member of the American Agricultural Economics Association and Western Agricultural Economics Association.