Title
Oregon State University: the case of the United States wheat sector

Authors
Love, H. Alan
Rausser, Gordon C.

Publication Date
1988-09-01

494

DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS
DIVISION OF AGRICULTURE AND NATURAL RESOURCES
UNIVERSITY OF CALIFORNIA, Berkeley.

Working Paper No. 494

FLEXIBLE PUBLIC POLICY: THE CASE OF THE UNITED STATES WHEAT SECTOR

by

H. Alan Love and Gordon C. Rausser

California Agricultural Experiment Station
Giannini Foundation of Agricultural Economics
September 1988

FLEXIBLE PUBLIC POLICY: THE CASE OF THE UNITED STATES WHEAT SECTOR

H. Alan Love
Department of Agricultural and Resource Economics
Oregon State University
Corvallis, Oregon 97331

and

Gordon C. Rausser
Department of Agricultural and Resource Economics
University of California
Berkeley, California 94720

September 1988

FLEXIBLE PUBLIC POLICY: THE CASE OF THE UNITED STATES WHEAT SECTOR

During the early 1980s, U.S. agriculture underwent its worst financial crisis since the Great Depression in spite of record spending on government agricultural programs. This paper tests the hypothesis that the severity of the crisis may have been moderated if agricultural policy had been more flexible. Prior to the 1985 Farm Bill (Food Security Act of 1985 [USDA 1986]), agricultural policy instruments were set within narrow limits and were changed little from their predetermined levels regardless of changes in the economy or international conditions during the life of the farm bill. For example, in the early 1980s, the strong dollar and large crop production worldwide resulted in large reductions in U.S. grain exports and large increases in U.S. grain inventories, driving prices to support levels. During this period, the U.S. maintained its grain support prices at levels set in the 1981 Farm Bill. This had the effect of keeping U.S. commodity prices above world levels, exacerbating and extending the duration of weakness in U.S. shipments, raising inventory levels and extending the period of depression in prices beyond that which would have occurred if the U.S. price had been allowed to fall to the world level.

Flexible policy rules (also described as automatic adjustment rules or conditional policies) were proposed for agriculture by Just [1981]. According to Just, the practice of changing agricultural policy substantially every four years imposes unnecessary costs on the agricultural sector. Inefficiencies result from production and investment decisions based on unrealistic expectations about the effect new programs will have on the sector and uncertainty regarding what programs will be adopted in future years. However, self-adjusting policies could be implemented by tying program instruments to changes in market conditions. These rules could then be made known to producers so that they could develop more informed expectations about the future economic and policy environment.

A more detailed proposal for flexible agricultural policies was set forth by Just and Rausser [1984]. They argue that agricultural markets are inherently unstable and the inability of farmers to adequately share risk with other agents in the economy represents a market failure that can be used to justify market intervention through agricultural policies. In their view, however, traditional agricultural policies often contribute to, rather than reduce, the instability in the market by generating situations of "government failure." Government failure occurs when policies are formulated on the basis of expectations of economic conditions that fail to materialize. This causes a "policy disequilibrium" to arise and creates pressure for change in policy instruments, adding to the inherent instability of the market [Rausser 1982].

Just and Rausser [1984] have pointed out that the potential benefits from flexible policy rules include: 1) allowing the appropriate setting of policy instruments under evolving economic conditions, 2) permitting the market to transmit appropriate signals to farmers and consumers, while insulating them from the worst shocks, 3) allowing farmers to plan for future policy settings based on forecasts of economic activity and publicized policy rules, and 4) reducing program cost uncertainty.

In this paper, automatic adjustment rules (flexible policies) are obtained for the wheat sector using optimal control methods. A policy criterion function is used to compare the performance of these rules with the 1985 Farm Bill under various economic scenarios. The organization of this paper roughly corresponds with the structure of the control problem [e.g., Rausser and Hochman 1979]. First, the constraints of the control problem are obtained using standard econometric methods. The constraint structure, representing the behavior of producers and consumers, is a quarterly model of the U.S. wheat sector. Particular emphasis is given to incorporating agricultural policy instruments into equations of the constraint structure concerning acreage planted, yield per planted acre and inventories. Second, the objective function (policy criterion function) used in the control problem is obtained using a revealed preference approach [Rausser and Freebairn 1974]. The policy criterion function permits an unequal weighting of producer and consumer surpluses, reflecting the observed pattern of redistribution of income among various groups in society. It is assumed that the government maximizes the policy criterion function subject to the constraint structure. Thus, in the third section, an optimal solution for the policy instrument settings is obtained in feedback form to give a set of flexible policy rules for target price, support price, diversion requirement and diversion payment for wheat. A feedback control solution gives the optimal policy instrument settings as functions of lagged endogenous variables, so that changes in these variables "feedback" and influence subsequent policy instrument settings.

In the final sections of the paper, a comparison is made between the 1985 Farm Bill and the automatic adjustment rules. In addition, elasticities of changes in optimal instrument settings with respect to changes in macroeconomic variables are calculated so that the automatic adjustment rules can be interpreted in terms of changing macroeconomic conditions. It is shown that the automatic adjustment rules developed in this paper outperform instrument settings from the 1985 Farm Bill across a wide spectrum of economic conditions.

Specification and Estimation of the Constraint Structure

The constraint structure for the wheat block[1/] is represented by a system of 12 simultaneous equations. On the supply side, there are equations for acreage, yield, production, program compliance and rental value for land in wheat producing areas. On the demand side, there are equations for domestic food use, other domestic utilization, and exports. Behavioral equations are also developed for the farmer-owned grain reserve, government-owned inventories and market inventories plus stocks held in regular commodity credit corporation (CCC) loan positions.

Wheat production decisions are inexorably linked to government program decisions. At planting time, a farmer must decide, given his resource constraint, 1) whether to participate in any government programs that are offered, 2) how many acres of each crop to plant, and 3) what level of variable inputs to use on each acre of land planted. In making this set of decisions, he must first determine the optimal use decisions for land and variable inputs for both compliance and noncompliance with government programs, and then he must evaluate which of these options is most profitable.

When a farmer decides to participate in a government program offered for any particular crop, this restricts his entire crop choice because of cross-compliance requirements. The decision to comply involves giving up acreage that could otherwise be planted. In return for the lost revenue, the farmer receives a guaranteed minimum income (deficiency payments plus support price protection), reduced costs of production (less land is planted), interest subsidy for stored grains, and, during some years, additional land diversion payments.

Models of acreage allocations based on program profitability have been estimated by Love, Rausser, and Freebairn [1984] and Lee and Helmberger [1985]. The key variables in these models are the marginal profitabilities associated with program compliance and noncompliance for each alternative crop, additional voluntary diversion payments, the amount of land that must be diverted from production for program compliance, and historic acreage. This last variable is included to model acreage response as a partial adjustment process. The estimated wheat acreage equation for this study is presented in Table 1.[2/]

Aggregate wheat yield response is expressed as a function of the profits before payment of land rental (variable profits) associated with program compliance and noncompliance and weather in wheat producing areas (Table 1). Variable profits are included for a number of years to measure the incentive for adoption of technological improvements. These variables were selected as an alternative to the usual practice of including a trend variable for technology. The ratio of the acreage diverted to the total acreage that is planted and diverted is included to indicate the effect on average yield of farmers diverting their least productive land when they participate in acreage diversion programs.

Equations for program compliance rate and for land rental rate are also presented in Table 1. The decision of whether or not to comply with any particular program depends on the marginal benefits of participation, the marginal benefits of nonparticipation, and the amount of land that must be diverted for participation. Furthermore, the participation rate for other crops should be included in the compliance equation since cross-compliance was required in most years. The land rental value in any particular year represents the residual expected profit from production because land is a fixed input. Thus, land rental value can be specified as a function of expected variable profits from compliance and non-compliance.

Domestic consumption of wheat is divided into feed utilization and other domestic consumption (Table 2). Feed demand is specified as a derived demand. Since broilers consume most of the wheat that is fed, feed demand for wheat is specified as a function of own price and corn price, each relative to the price of broilers, and the number of broilers on feed. The prior year's utilization is included, representing the adjustment process that occurs as broiler producers increase or decrease the size of their operations. Domestic per capita food demand for wheat is specified as a function of the real price of wheat and real per capita income. Lagged food use is included to represent slowly changing consumption patterns.

Exports are specified as a reduced form equation of rest-of-world supply and demand for U.S. wheat. As such, exports are a function of the real exchange-rate-adjusted price, rest-of-world production, lagged export shipments, and the exchange rate [Chambers and Just 1979, 1981]. Rest-of-world production is included in two separate variables. The first is trend-rest-of-world production, defined as a three-year moving average of rest-of-world production. The other variable is the difference of current rest-of-world production from trend. These variables are included to measure the effect of a number of successive good or bad crop years and the effect of a single crop short-fall or bumper crop (Table 2).

Inventories are separated into three components: Farmer-Owned Reserve (FOR) inventories, government-owned inventories, and the combined category of market inventories and inventories held under outstanding regular CCC loans (Table 3). Each category is modeled to reflect the various constraints imposed on release from, and entry into, publicly controlled positions and the differing returns from holding stocks in the various inventories.

Private storage, which includes both freely held stocks and stocks held under regular outstanding CCC loans, is modeled as a profit maximizing activity (Table 3). Profits from storage are obtained from holding inventories to ensure a smooth flow of commodities through the market (the transactions motive) and from price gains on intertemporal sales (the speculative motive). The speculative motive is captured by including variables for current price and expected price. Expected price is modeled simply as lagged price, thus incorporating adaptive expectations. The transactions motive is modeled implicitly by allowing different coefficients for market stocks in each quarter. Costs of storage are reflected in the constant term and by interest rates. The government interest rate subsidy on CCC loans is also included to measure the incentive to hold inventories to obtain these low-cost loans. The quantity held in public positions, FOR and government owned stocks, are also included in the market inventory equation since public stocks represent a substitute for private stocks. Demand for stocks from the private sector is modeled as an inverse demand function for storage, with the real difference in cash price and support price as the dependent variable.

Specific rules for the FOR have changed substantially from year to year since it was formed in 1977, to the point of making empirical modeling of the FOR difficult [Wright 1985]. Therefore, the Farmer-Owned Reserve is simply specified as a function of inventories in the FOR during the previous quarter, the real price of the commodity, the real release price for the FOR and the real support price for the FOR. The equation for FOR inventories was estimated using the first difference of FOR inventories as the dependent variable and included endogenous variables with one, four and eight quarter lags.

Government-owned stocks are modeled as an identity (Table 3). The ending level of government-owned stocks is specified as the prior period's ending inventory of government stocks plus entries less sales during the period. Government outflows or sales, are treated as a constrained government control variable. Purchases, or inflow, of government-owned stocks are specified as a function of real cash price, real support price, program compliance rate and lagged change in government-owned stocks.

Estimation of the Policy Criterion Function

The establishment of a valid policy criterion function is of central importance in determining the appropriateness of any proposed policy. The arguments in the policy criterion function should be related to welfare measures considered important to the participants in the market [Rausser and Freebairn 1974]. Common criteria for measuring economic performance are used: producer and consumer surpluses and government costs. In addition, a valuation of ending inventories is used to indicate the current value of providing supplies for future periods.

Two producer groups are distinguished: those who participate and those who do not participate in farm programs. The participating group will likely have a larger weighting in the policy criterion function than the nonparticipating group. The political process must implicitly prefer those farmers for whom it has created a special welfare-enhancing program.

The weight on government expenditures should be less than that on producer surplus, since a redistribution of income from taxpayers to producers takes place through agricultural policy. In some years, income is also redistributed from consumers to participating farmers and to nonparticipating farmers through higher market prices induced by the programs. Only the economic surplus of domestic consumers is counted in the criterion function since there is little reason to believe that U.S. policymakers are sufficiently concerned with the welfare of foreigners to alter domestic agricultural policy to directly affect their well-being. Of course, U.S. policymakers and farmers do value high levels of exports, since higher exports are one way of raising prices in domestic markets. The welfare effects of higher exports are included in domestic market surpluses.

Federal expenditures are specified separately so that the policy criterion weight associated with the taxpaying group may differ from the weight associated with domestic wheat consumers. This specification will admit the possibility that policies which rely mostly on acreage restrictions may be revealed preferred to policies that rely mostly on redistribution of income from taxpayers to farmers through direct payments. Restricting supply through acreage controls may require less federal budget financing than transfers made to farmers. This flexibility in the criterion function might be especially important for policy analysis in a period of high budget deficits when there are large political payoffs associated with budget-cutting programs.

The value of ending inventories is included in the policy criterion function as a measure of the contribution to current welfare of having stocks available for the next year. The marginal value of these inventories should decline as the size of the carryover stock increases since large stocks will depress future prices for producers and consumers will experience diminishing marginal utility from increasing consumption in future periods.

The policy criterion function is specified as

$$W = W(W_{pnc}, W_{pc}, W_c, W_g, W_i; b) \tag{1}$$

where W is policy criterion level achieved by the settings of the policy instruments; W_c is consumer surplus; W_g is government cash transfer payments (equal to the taxes necessary for the government to operate the wheat program); W_i is the value of carryover inventories; W_{pc} is producer surplus, complying farmers; W_{pnc} is producer surplus, noncomplying farmers, and b is the set of unknown parameters. These surpluses are defined in terms of the equations in the constraint structure.

Consumer surplus is calculated using the demand curves in Table 2. It is assumed that all domestic consumers of wheat have equal weighting, so W_c is then the sum of consumer surplus from feed demand and consumer surplus from food demand. Since the estimated income elasticity of demand is very small for wheat, the uncompensated demand measure of consumer surplus provides an accurate measure of welfare [Willig 1976]. Foreign consumer surplus from export sales of wheat is excluded.

Producer surplus for farmers who do not comply with government programs, W_{pnc}, is based on payments received for the wheat they sell, domestic utilization plus exports, less storage costs. The surplus for participating farmers, W_{pc}, is calculated as the sum of cash sales net of storage costs plus transfer payments from the government in the form of support payments on nonrecourse loans, deficiency payments based on the target price, storage payments for the FOR, diversion payments and, in some years, additional voluntary diversion payments.[3/]

Federal expenditures, W_g, are equal to government transfers to farmers adjusted for receipts from sales of grain from government positions and the cost of storing government-owned grain. Government storage costs are calculated as interest costs plus the rent paid for elevator space. Government receipts from sales of government-owned stocks are calculated as market price times government sales.

Ending inventories have a potential value to both producers and consumers. For consumers, carryover stocks represent food security and higher levels of consumption in future periods. For producers, they represent a potential means of obtaining additional profits. However, as the size of the carryover stocks rises, the marginal contribution of that stock to society must fall since 1) it is costly to store grain inventories, 2) current consumption must be reduced and 3) higher carryover inventories will depress future prices. Thus, the marginal value of inventories to society will be inversely related to the size of total inventories. A simple nonlinear function was chosen for the marginal valuation of inventories, and calibrated to reflect the actual value for the 1986-1987 crop year. The function chosen is given as

$$VW = \exp(-a_0\ KWE)\ a_1 \tag{2}$$

where KWE represents ending wheat inventory, and VW is the marginal value (price) of ending inventories of wheat.[4/] The marginal value of inventories was then divided by the consumer price index to put it in real terms and multiplied by the quantity of ending inventories to give the total current value of ending inventories, W_i.

A revealed preference approach is used to obtain the weights, b, for the policy criterion function. It is assumed that observed policies result from a process in which policymakers have maximized a criterion function subject to the constraints imposed by market actions of producers and consumers. Estimates of parameters in the policy criterion function can be obtained indirectly by finding the set of weights in the criterion function which generate the observed policy instrument settings [Rausser and Freebairn 1974]. In this study, policy instrument settings from the 1985 Farm Bill are taken as optimal for the 1986-87 crop year. The parameters of the criterion function are developed through the repetition of several steps using various functional forms until a valid policy criterion function is obtained. First, a functional form is assumed; to keep the computations manageable, the functional forms examined were limited to those which have first-order conditions linear in the parameters of the policy criterion function. One of the parameters is designated as a numeraire and set to -1 so that the number of unknown parameters is reduced to four, the number of policy instruments being investigated (target price, support price, diversion requirement and diversion payment). The resulting criterion function is defined to within a multiplicative constant.

Second, the policy criterion function is maximized with respect to the policy instruments, yielding a set of first-order conditions linear in the criterion function parameters. These can be written in matrix form as

$$Mb = m \tag{3}$$

where each row in matrix M represents a set of partial derivatives with respect to a policy instrument, e.g. support price. The vector b represents the unknown parameters of the policy criterion function. Each element of vector m is a partial derivative of the policy criterion function with respect to the numeraire parameter. M is a 4 x 4 matrix and the vectors b and m are 4 x 1.

Third, the parameters in vector b are then obtained empirically by substituting numeric derivatives evaluated in a neighborhood of the policy settings for the 1985 Farm Bill for the analytic derivatives in M and m and solving for b. There was a technical difficulty involved in this process. Because of the nature of agricultural policy, the period of analysis must be one crop year, but the detailed agricultural model is quarterly. This presented two problems: 1) how to evaluate the criterion function as a single value and 2) how to take numeric derivatives of the quarterly model with respect to annual decision rules. These problems were solved by discounting the quarterly objective function by the real interest rate and summing over the four quarters to obtain a single value. Numeric derivatives were then evaluated using the change in the discounted sum for each welfare measure arising from the change in each policy instrument. The numeric derivatives were calculated using formulas similar to those in Dennis and Schnabel [1983].[5/]

Using this procedure, the policy criterion function in equation 4 was obtained.

$$W = 2727.916\ W_{pc} - 27.76679\ W_{pnc}^2 + 3030.092\ W_c - 1.853801\ W_i^2 - W_g^2 \tag{4}$$

The coefficient associated with the square of government expenditures was chosen as numeraire and set to -1. At the optimum, the Hessian was checked using numeric derivatives and found to be negative semi-definite. Thus, the optimum point is a maximum.

The estimated weights of the policy criterion function represent reduced form estimates of policymakers' weighting among various interest groups. They indicate that the policy process evaluates producer surplus for participating farmers and consumer surplus positively, while it values producer surplus of nonparticipating farmers, the value of ending inventories and federal expenditures negatively. This implies that policymakers want to maximize benefits to consumers and participating producers and to minimize federal expenditures, valuations of ending inventories and benefits to nonparticipating farmers.

There are two plausible explanations for the negative weight associated with producer surplus for nonparticipating farmers. First, nonparticipating farmers do not comply with program diversion requirements; they represent "free riders" on government programs. As participating farmers reduce production, anticipated cash price rises, benefiting nonparticipating farmers. Higher cash prices increase the incentive for noncomplying farmers to raise production, driving prices lower. Thus, the actions of noncomplying farmers can result in increased support and deficiency payments to complying farmers, raising government costs and reducing the policy criterion level. Policymakers' desire to keep benefits to nonparticipating farmers low is reflected in the negative weight in the policy criterion function.

Second, the 1985 Farm Bill set the support price well below the previous year's market and support prices. This had the effect of reducing market price and increasing the benefits of program participation. As a result of both fewer nonparticipating farmers and reduced benefits per farmer, the producer surplus of nonparticipating farmers was drastically reduced. These adverse conditions for nonparticipating farmers are reflected in the negative weight.

The negative sign for the value of ending inventories may be the result of very large carryover stocks observed at the end of the 1986-1987 crop year. Large stocks depress cash prices and raise government program costs. Since the marginal value of carryover inventories should decrease as the size of the inventory expands, it seems likely that at very high levels, the value to society of carryover stocks may be negative.

Estimation of the Automatic Adjustment Rules

The problem facing policymakers can be expressed as maximizing the expected level of the policy criterion function with respect to the policy instruments subject to the constraints imposed by the decision rules of producers and consumers.

$$\max_{z_t} \; E(W) = E\{\sum_{t=1}^{T} W_t(y_t,x_t,z_t)\} \tag{5}$$

$$\text{s.t.} \;\; f_i(y_t,y_{t-1},x_t) = u_{it} \quad i=1,N \tag{6}$$

The $f_i(.)$ represents the detailed model of the wheat sector outlined above which gives producer and consumer decision rules, N is the number of these equations, u_{it} is a vector of random variables with mean 0 and variance σ_i^2, $W_t(.)$ represents the policy criterion function at time t, x_t is a vector of exogenous variables, y_t is a vector of current endogenous variables, y_{t-1} is a vector of lagged endogenous variables, and z_t a vector of policy instruments. The function W_t has a time subscript t to denote the fact that it may vary over time. When the policy criterion function is quadratic and the constraint equations are linear, a closed form solution exists. The solution is a linear feedback equation which gives the optimal values of the policy instruments in terms of the lagged endogenous variables plus a constant term. This solution is known in control literature as the certainty-equivalence solution [Simon 1956, Theil 1958, 1964]. In general, when the constraints are nonlinear, as they are for the wheat model, analytic expressions for the feedback equations are not available. However, a number of approximate feedback solutions have been developed [Chow 1975, 1981, 1983, Fair 1984, Rausser and Hochman 1979].

The approach taken is to obtain a number of deterministic sets of policy instruments (open-loop control solutions) based on different starting values and then estimate a feedback relation from the data obtained. The solution to each open-loop problem takes the form of a vector of policy instruments (controls) with elements for target price of wheat, support price of wheat, diversion requirement for wheat, and diversion payment for wheat. While control values are optimized for four quarters, this represents one annual policy decision period. Optimization of the policy criterion function is implemented using GAMS [1982]. Data on the starting values and resulting optimal policy instrument settings are saved for a number of trials, and a regression of the policy instrument settings on lagged endogenous values is performed. These regressions express each policy instrument solution in the form of a feedback rule, or automatic adjustment rule.

Random starting values (states) are obtained from stochastic simulations of autoregressive models for variables exogenous to the wheat sector, for macroeconomic variables, rest-of-world production and weather. These are used as the inputs for the wheat model, which is solved to obtain random endogenous values. Forty simulations were run using different starting periods for the wheat model to give some diversity in the initial values for stocks.

A number of functional forms for the automatic adjustment rules were tried: linear, log-log, a Box-Cox transformation on the left-hand-side variable and a Box-Cox transformation on the right-hand-side variables. The best results are obtained with the linear model. The automatic adjustment rules are shown in Table 4.

The variables most statistically significant in the determination of the optimal target price setting are price, market inventories, government-owned inventories, defaults on CCC loans (government procurements of wheat), domestic utilization and the land rental rate. Increases in each of these variables lead to increases in the optimal target price setting. The t-statistics associated with the estimated coefficients for the other variables indicate that they are not significantly different from zero.

One interesting aspect of the automatic adjustment rule for target price is that the optimal setting rises and falls with changes in cash price from the previous season. Indeed, the elasticity of target price with respect to lagged cash price calculated at the means is 8.68. This will reduce government exposure to large expenditures on deficiency payments and allow market prices to affect farmers more directly. When prices are depressed, the rule calls for a reduced target price; when prices are high, the optimal setting will be increased. Thus, participating farmers are exposed to increased market risks and higher income instability.

Offsetting the direct price effect, however, are the positive effects of the past year's ending stock levels on the optimal setting for the wheat target price. All three ending stock positions (FOR, government-owned and market stocks) are associated with positive coefficients. When stocks are high, prices are relatively low. Thus, high stocks in the previous period would have the direct effect of increasing the optimal target price setting, but the indirect effect of lowering target price through the effect of stocks on cash price.

Higher domestic demand in the previous year is associated with a higher optimal setting for target price. Since increases in demand tend to raise price, this variable will amplify the direct price effect. The elasticity associated with domestic utilization is quite large, indicating that this variable is important in setting the optimal target price.

Increases in government stock procurement are associated with low prices and thus the positive sign associated with this variable will also offset the direct price effect somewhat. However, the elasticity associated with this variable is quite low, so its impact will be small.

While the coefficient associated with exports indicates that this variable is not significantly different from zero, the associated elasticity suggests that exports are somewhat important in the optimal target price setting. The sign associated with exports indicates that increasing exports has an effect similar to raising price.

Each of the state variables can be categorized as either pro-cyclical or counter-cyclical. State variables in the pro-cyclical category are cash price, domestic demand and exports. Increases in these variables are associated with beneficial market conditions for producers. Rises in these variables also result in a higher optimal setting for target price in the following year. Thus, these states are pro-cyclical with respect to farm income.

Counter-cyclical states are Farmer-Owned Reserve stocks, government-owned stocks, market stocks, government purchases of stocks, and production. Increasing values of these variables are associated with lower prices and worsening market conditions for farmers. With the exception of production, increases in these variables are associated with higher target prices in the following period and, thus, are counter-cyclic with respect to farm incomes. As can be seen from the relevant elasticities, acreage and yield will dominate production and, thus, production variables will exert a counter-cyclical effect. Counter-cyclical variables help to stabilize farm incomes during periods of economic adversity.

The variables most important in the determination of the optimal setting of the support price for wheat are exports, government-owned stocks, defaults on CCC loans (government procurement of stocks), and the land rental rate. All of the estimated coefficients in the support price equation have the same sign as in the target price equation, except for compliance rate, which has a negative sign in the support price equation. The estimated elasticities are also similar for both equations. This implies that the optimal support price rule is to allow free market forces a greater role in the determination of supply and demand. The negative sign on compliance rate reenforces continuing program compliance since a high compliance rate in the previous year will result in a reduction in the support price and an increase in the target price, and, thus, higher deficiency payments.

The variables most important in the optimal setting of the diversion requirement for wheat are domestic utilization, compliance rate, exports and the level of stocks in the Farmer-Owned Reserve. The optimal setting of the diversion requirement rises with increases in domestic use in the past period and decreases in past period exports. It falls with decreased domestic use and with increased exports. A reason for the positive correlation of the diversion requirement with domestic use is that high domestic utilization of wheat occurs when wheat prices are very low, so that wheat becomes competitive with feed grains and soybeans as a feed stuff. Thus, high domestic use indicates low prices and results in an increase of the optimal setting for the diversion requirement to curb production in the next period.

A high compliance rate in the previous year is associated with a reduction in the current year's optimal diversion requirement. An increase in the diversion requirement represents a cost to farmers of participation in government programs. Nonparticipating farmers raise programs costs by depressing cash price, thereby enlarging deficiency payments. So, it is desirable to keep the participation rate high to keep program costs low. A reduction of the diversion requirement in the current year will motivate continued participation. Finally, large stocks in the Farmer-Owned Reserve are associated with a higher optimal diversion requirement in the next period. This will also help contain government program cost.

The most important determinants of the optimal setting for diversion payment are market stocks and cash price. Both state variables are negatively correlated with optimal diversion payment. As prices rise or fall, stocks presumably will be moving in the opposite direction and the contribution of one variable will tend to offset that of the other. However, since the elasticity associated with price is slightly greater than the elasticity associated with market inventories, the effect of changes in price should dominate the effect of changes in market inventories in setting optimal diversion payment.

Validation and Assessment of the Automatic Adjustment Rules

In a stochastic world, feedback control rules should outperform or equal open-loop control policies in maximizing the policy criterion function. This is because feedback policy instruments incorporate information about the wheat sector from each previous period while open-loop policies do not. Both policy types would perform equally well when the economic environment which obtains is the one for which the open-loop policy was designed to work [Rausser and Hochman 1979].

The first validation test performed is to compare a one crop year quarterly simulation using the 1985 Farm Bill policy settings with a simulation using the automatic adjustment rules. Both simulations are based on the actual values at the beginning of the 1986-87 crop year for macroeconomic and agricultural variables. An aggregate policy criterion measure for the entire 1986-87 crop year was obtained by summing discounted policy criterion values obtained for the four quarter simulation period. The interest rate from the simulation was used in the discount factor. Since the parameters of the policy criterion function were obtained based on the revealed preference assumption that, given the starting conditions, the settings for the 1985 Farm Bill were optimal, the criterion level obtained from those settings must be the maximum achievable. Thus, for the automatic adjustment rules to perform well in this particular simulation, they should generate a value equal to that obtained from the 1985 Farm Bill instrument settings. The results, reported in the "Wheat Based" column in Table 5, show that the automatic adjustment rules generate approximately the same policy criterion level as the 1985 Farm Bill. The difference of .2% is due to rounding.

A more critical test compares the automatic adjustment rules with the 1985 Farm Bill settings under randomly selected economic scenarios. Random macroeconomic variables, weather and rest-of-world production values are generated from stochastic simulations of vector autoregressive models for these variables. Twenty pairs of simulations are run over various time horizons. The same set of random starting values are used in each pair. A policy criterion level is calculated for the 1985 Farm Bill settings and for the automatic adjustment rule settings under each economic scenario.

The results from these simulations, summarized in Table 5, indicate that in all twenty simulation pairs, the automatic adjustment rules outperformed the 1985 Farm Bill by generating a higher policy criterion level. The mean criterion level generated over the 20 simulations by the automatic adjustment rules is 74.3×10^6 with a variance of 5.3×10^{12}. The mean criterion level derived from the 1985 Farm Bill is 72.2×10^6 with a variance of 3.2×10^{12}. Thus, both the mean and the variance of the policy criterion level derived from the automatic adjustment rules are larger than those generated from the 1985 Farm Bill. The higher associated variance is irrelevant, however, since the policy criterion level obtained from the automatic adjustment rules is higher in all simulations; the automatic adjustment rules stochastically dominate the 1985 Farm Bill.

Toward a Simpler Set of Automatic Adjustment Rules

Economic agents having a good understanding of government policy rules is important to the performance of those rules. Just and Rausser [1984] have pointed out that the rules should be kept simple to achieve maximum benefits, allowing all participants in the market to interpret and understand them. In addition, they assert that automatic adjustment rules should provide a formal specification of changes in policy instruments as a result of changes in general economic conditions.

One way to simplify the automatic adjustment rules is to recast them in terms of major exogenous variables. This would alleviate the ambiguities encountered in the interpretation of the automatic adjustment rules where there are offsetting effects of the various wheat sector variables. These ambiguities would make multi-year planning difficult for economic agents. A farmer assessing a multi-period investment opportunity may have difficulty formulating expectations for several years into the future of policy variables endogenous to the wheat sector. However, if such policy instruments were based on general economic states, for which widely accepted forecasts are readily available, realistic planning could take place. This would make the policy rules more credible.

The automatic adjustment rules can be cast rather simply in terms of the exogenous variables. In general terms, automatic adjustment rules can be expressed as, $z = g(\, y(-1)\,)$ where $y(-1)$ is a vector of endogenous variables in the wheat sector for the previous period, $g(\ )$ is a vector of functions for the automatic adjustment rules, and z is a vector of policy instrument settings. The variables in y can be represented as a system of simultaneous equations for the wheat sector: $y = f(y, m, x)$ where m is a vector of exogenous macroeconomic variables affecting the wheat sector, $f(\ )$is a vector of functions representing the endogenous variables of the wheat sector, and x is a vector of other exogenous variables affecting the wheat sector. In theory, the endogenous variables can be solved in terms of the exogenous variables which can then be substituted into the automatic adjustment rules to obtain $z = g(\, m(-1), x(-1)\,)$.

Some algebra, in the style of Solow [1957], can be performed on these equations to obtain changes in the optimal policy settings in terms of elasticities and changes in the exogenous variables. The resulting simplified rules are

$$\frac{\dot{z}}{z(-1)} = \xi_{zm} \frac{\dot{m}(-1)}{m(-1)} + \xi_{zx} \frac{\dot{x}(-1)}{x(-1)}$$

where ξ_{zm} represents a matrix of elasticities of policy instruments z with respect to exogenous variables m and ξ_{zx} represents a vector of elasticities of policy instruments z with respect to exogenous variables x. A dot over a variable denotes the time derivative of that variable. These equations can be implemented empirically by obtaining numerical estimates for the elasticities and using discrete approximations for the time derivatives.

Estimates of the elasticities were obtained for all of the major macroeconomic variables affecting the wheat sector and for rest-of-world production of wheat. These are the variables which are important in determining the economic environment for wheat and for which relatively reliable forecasts are readily available. The elasticities are reported in Table 6.

Estimates for the optimal policy settings were obtained for the 1986-1987 crop year. They are presented in Table 5 under the "Macro Based" heading. These results indicate that the automatic adjustment rules based on macroeconomic variables would have performed as well as the 1985 Farm Bill and within a rounding error of the automatic adjustment rules based on variables in the wheat sector. This result holds promise for obtaining a meaningful set of simple policy rules that could easily be used in policy formulation. Interestingly, the automatic adjustment rules based on macroeconomic variables result in higher settings for all of the policy instruments except diversion payment when compared to the automatic adjustment rules based on last period's wheat sector variables.

From Table 6, it is easy to see that inflation (Consumer Price Index) has a dominant effect on the optimal instrument settings. During periods of high inflation, target and support prices should rise while diversion requirements and diversion payments should fall. This would have an expansionary effect on the wheat sector and help moderate consumer prices.

Rest-of-world production and the exchange rate also have large effects on the optimal instrument settings. When rest-of-world production rises, the optimal target price should rise, the optimal support price should fall, and the optimal diversion requirement and payment should rise. This would have the effect of giving farmers a greater incentive to reduce acreage and production and of keeping U.S. price competitive on world markets as excess demand abroad weakens.

As the dollar strengthens, the optimal target price should be raised, support price should be lowered, diversion requirement increased and the diversion payment slightly reduced. With the exception of its effect on the diversion payment, a stronger dollar has the same effect on optimal instrument settings as an increase in rest-of-world production. This is a very reasonable result. The effect of changes in the world price index on the optimal policy settings is similar to that induced by changes in the exchange rate. High inflation world-wide has the same effect on optimal U.S. policy instruments as does a weak dollar.

Increases in consumer incomes have the effect of raising all of the optimal instrument settings. This will benefit farmers by raising both market income and transfer payments. Transfers to farmers are possible since higher incomes make consumers more willing to transfer income.

Conclusions

In this paper, automatic adjustment rules (conditional policies) were obtained for the wheat sector. The methodology involved formulating a constraint structure representing the behavior of producers and consumers of wheat and then using the constraint structure to obtain parameter estimates of a policy criterion function. The policy criterion function was specified to allow unequal weights to be assigned to producers, consumers and taxpayers as is reflected in the observed redistribution of incomes among these groups. Optimal control techniques were then used to obtain automatic adjustment rules for target price, support price, diversion requirement, and diversion payment.

Care must be exercised in making an exact policy recommendation from the results of the control rules. These rules are based on a policy criterion function chosen from one particular year. As such, the parameters in the criterion function represent relative weights only for that year. It is possible that the weights on the surpluses change from period to period. Changing weights in the criterion function may result from one group's dissatisfaction with its level of surplus and increased political pressure to change the effective policy preference to a different arrangement, thus changing the implicit weights in the criterion function. This remains a topic of further research.

However, the results presented here demonstrate quite clearly that optimal settings of policy instruments should be market oriented even when unequal weights are assigned to producers, consumers, and taxpayers. When the automatic adjustment rules are cast in terms of macroeconomic variables, the results indicate that inflation, rest-of-world production, and the trade-weighted exchange rate are the most important factors for the optimal setting of policy instruments for the wheat sector. Using the estimated policy criterion function to evaluate performance, random simulations of the model indicate that policy instrument settings from the automatic adjustment rules outperform instrument settings from the 1985 Farm Bill across a wide spectrum of economic conditions. Beyond the gains in policy criterion level, there may be harder-to-measure benefits to farmers achieved from conditional policies. Automatic adjustment rules would provide an improved long-term planning environment and better knowledge of how the policies will be set in future periods. This would allow farmers and others in the agricultural sector to make more informed investment choices.

Footnotes

1. Blocks of equations are also estimated for feed grains, beef, pork and broilers to generate values for variables exogenous to the wheat sector. Data used in this study are from a variety of sources. References are available from the authors.

2. Equations for wheat acreage, yield, compliance and rental rate were estimated as part of a system including similar equations for corn and grain sorghum and soybeans. These equations were included to gain efficiency, but space limitations do not permit reporting of the results.

3. Support payments are made to complying farmers when they default on nonrecourse loans, causing a flow of stocks into government-owned positions. Support payments are calculated as government purchases times support price. Deficiency payments are made when the cash price is below the target price, and are calculated as the difference between the target price and the higher of the cash or support price multiplied by program yield and acreage planted in program compliance. As an incentive to participate in the FOR, storage payments are made to producers who enter grain into this program. Diversion payments are made from time to time as an additional incentive to reduce acreage. Diversion payments are calculated as per acre diversion payment times the product of diversion requirement and program compliance rate. Additional diversion payments are sometimes offered during times of extreme oversupply. The Payment-in-Kind (PIK) programs of the early 1980s are examples. The calculation for additional voluntary diversion payments is analogous to the diversion payment calculation.

4. The value of a_1 was chosen so that VW equaled the intercept of the market inventory equation when ending inventory is zero. This resulted in $a_1 = 10.75$. The value of a_0 was set so that VW would equal the price at the end of the 1986-1987 crop year given the level of ending inventories for that crop year. This resulted in a value of a_0 of .000826136.

5. In evaluating the numeric derivatives, all exogenous macroeconomic variables are set at the levels forecast from a deterministic simulation of a vector autoregressive macroeconomic model. All other exogenous variables are set at their actual level for the 1985-1986 crop year.

References

Chambers, Robert G. and Richard E. Just, "A Critique of Exchange Rate Treatment in Agricultural Trade Models," American Journal of Agricultural Economics, Volume 61, Number 2, May 1979.

Chambers, Robert G. and Richard E. Just, "Effects of Exchange Rate Changes on U.S. Agriculture: A Dynamic Analysis," American Journal of Agricultural Economics, Volume 63, Number 1, February 1981.

Chow, Gregory C., Analysis and Control of Dynamic Economic Systems, John Wiley & Sons, New York, 1975.

Chow, Gregory C., Econometric Analysis by Control Methods, John Wiley & Sons, New York, 1981.

Chow, Gregory C., Econometrics, McGraw-Hill, New York, 1983.

Dennis, J.E. and R.B. Schnabel, Numerical Methods for Unconstrained Optimization and Nonlinear Equations, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1983.

Fair, Ray C., Specification, Estimation and Analysis of Macroeconometric Models, Harvard University Press, Cambridge, Massachusetts, 1984.

Freebairn, John W. and Gordon C. Rausser, "Effects of Changes in the Level of U.S. Beef Imports," American Journal of Agricultural Economics, Volume 57, Number 4, November 1975.

(GAMS) General Algebraic Modeling System (Preliminary), Development Research Center, The World Bank, Washington, D.C., February 1982.

Just, Richard E., "Farmer-Owned Grain Reserve Program Needs Modification to Improve Effectiveness: Theoretical and Empirical Considerations in Agricultural Buffer Stock Policy Under the Food and Agriculture Act of 1977," United States General Accounting Office, CED-81-70, Volume 3, Washington, D.C., June 1981.

Just, Richard E. and Gordon C. Rausser, "Uncertain Economic Environments and Conditional Policies," in Gordon C. Rausser and Kenneth R. Farrell, editors, Alternative Agricultural and Food Policies and the 1985 Farm Bill, Giannini Foundation of Agricultural Economics, University of California, Berkeley, 1984.

Lee, David R. and Peter G. Helmberger, "Estimating Supply Response in the Presence of Farm Programs," American Journal of Agricultural Economics, Volume 67, Number 2, May 1985.

Love, H. Alan, Gordon C. Rausser, and John Freebairn. "The Effectiveness of Government Policy in Controlling Agricultural Output." Paper presented at the American Agricultural Economics Association Meeting, Cornell University, August 5-8, 1984.

MINOS, Version 5.0, Systems Optimization Laboratory, Department of Operations Research, Stanford University, Stanford, California, 1983.

Rausser, Gordon C., "Political Economic Markets: PESTS and PERTS in Food and Agriculture," American Journal of Agricultural Economics, Volume 64, Number 5, December 1982.

Rausser, Gordon C. and John W. Freebairn, "Estimation of Policy Preference Functions: Application to U.S. Beef Import Quotas," Review of Economics and Statistics, Volume 56, 1974.

Rausser, Gordon C. and Eithan Hochman, Dynamic Agricultural Systems: Economic Prediction and Control, North-Holland Book Publishing Co, Amsterdam, 1979.

(RATS) Regression Analysis of Time Series, Version 2.0, VAR Econometrics, Minneapolis, Minnesota, 1986.

Simon, H., "Dynamic Programming under Uncertainty with a Quadratic Criterion Function," Econometrica, Volume 24, 1956.

Solow, Robert M., " Technical Change and the Aggregate Production Function," Review of Economics and Statistics, Volume 39, August 1957.

Theil, Henri, Economic Forecasts and Policy, North-Holland, Amsterdam, 1958.

Theil, Henri, Optimal Decision Rules for Government and Industry, North-Holland, Amsterdam, 1964.

U.S. Department of Agriculture, The Food Security Act of 1985: Major Provisions Affecting Commodities, Agriculture Information Bulletin Number 497, Economic Research Service, United States Department of Agriculture, Washington, D.C., January 1986.

Willig, Robert D., "Consumer's Surplus Without Apology," American Economic Review, Volume 66, Number 4, September 1976.

Wright, Brian D., "An Assessment of the United States Farmer-Owned Reserve and Commodity Credit Corporation Storage as Market Stabilization Policies," American Enterprise Institute, Washington, D.C. August 1985.

Table 1. Wheat Supply Equations Estimated Annually, 1962-1986, Using Three-Stage Least Squares (asymptotic t-statistics in parentheses beneath coefficients).

Acreage

Constant	31.2590
	(3.39)
PROFNFG	.0104
	(.04)
PROFCFG	.4068
	(1.65)
PROFNW	.2862
	(1.27)
PROFCW	-.4776
	(-2.60)
PROFNS	-.1108
	(-.63)
AW(-1)	.6277
	(6.25)
VDPPAW	-.6991
	(-2.11)
DIVAW	-.2657
	(-1.82)

R^2=.8275
RBAR^2=.7412
Durbin-Watson=1.4068
Degrees of Freedom=16

Compliance Rate*

Constant	1.0417
	(1.71)
PROFNW	-.0407
	(-1.92)
PROFCW	.0116
	(.55)
VDPPAW	.1259
	(2.33)
DIVAW	-.0300
	(-1.36)
COMPFG	.8194
	(1.21)
NOPROGW	-7.0095
	(-12.45)

R^2=.9618
RBAR^2=.9491
Durbin-Watson=.9369
Degrees of Freedom=18

Yield per Acre Planted

Constant	18.1525
	(1.93)
VPROFW(-1)	-.0282
	(-.54)
VPROFW(-2)	-.0266
	(-.68)
VPROFW(-3)	-.0197
	(-.49)
VPROFW(-4)	-.0074
	(-.18)
VPROFW(-5)	.0102
	(.26)
VPROFW(-6)	.0332
	(.89)
VPROFW(-7)	.0616
	(1.28)
PDIVAW	18.0528
	(1.81)
TSP	-.3314
	(-.61)
DTSP	.1056
	(.52)
PSP	.0620
	(1.14)
DPSP	-.000026
	(-.01)

R^2=.3783
RBAR^2=.0675
Durbin-Watson=.8135
Degrees of Freedom=16

Real Rental Rate

Constant	.9048
	(1.40)
VPROFW	.0295
	(2.82)
VPROFS	.0283
	(2.82)
RRW(-1)	.8830
	(7.36)
RRW(-2)	-.1829
	(-1.48)

R^2=.8936
RBAR^2=.8723
Durbin-Watson=1.5164
Degrees of Freedom=20

Table 1. (continued)

where

AW(-1)	Acreage of wheat lagged one year
COMPFG	Compliance rate for feed grain programs
DIVAW	Diversion requirement for wheat times the base acreage of wheat
DPSP	Deviation from mean of PSP
DTSP	Deviation from mean of TSP
NOPROGW	Dummy variable for years when no government programs were in effect for wheat
PDIVAW	Ratio of diverted acres to total acres planted and diverted for wheat
PROFCFG	Expected real per acre profits from program compliance for feed grains
PROFCW	Expected real per acre profits from program compliance for wheat
PROFNFG	Expected real per acre profits from program noncompliance for feed grains
PROFNS	Expected real per acre profits from program noncompliance for soybeans
PROFNW	Expected real per acre profits from program noncompliance for wheat
PSP	Precipitation in wheat-growing areas
RRW(-n)	Real rental rate of land for wheat lagged n years
TSP	Temperature in wheat-growing areas
VDPPAW	Voluntary additional diversion requirement for wheat times real voluntary additional diversion payment for wheat
VPROFS	Real variable profits for soybeans
VPROFW	Real variable profits for wheat weighted for complying and noncomplying farmers
VPROFW(-n)	Real variable profits for wheat weighted for complying and noncomplying farmers lagged n years

* Dependent variable in the wheat compliance rate equation is ln(COMPW/(1-COMPW)) where COMPW is the compliance rate for wheat programs.

Table 2. Wheat Demand Equations Estimated Quarterly, 1973:1-1986:2 Using Two-Stage Least Squares (asymptotic t-statistics in parentheses beneath coefficients).

Feed Demand Equation for Wheat

Constant	-26.5091
	(-.38)
Q1	-.7394
	(-.04)
Q2	-14.6635
	(-.83)
Q3	39.7602
	(1.71)
DLVKW(-4)	.6769
	(5.76)
RPWPBR	-1804.1040
	(-2.12)
RPCPBR	2644.4780
	(1.84)
BROF	.000035
	(.75)

R^2=.7682
RBAR^2=.7329
Durbin-Watson=2.2201
Degrees of Freedom=46

Food Demand Equation for Wheat (per capita)

Constant	.2674
	(2.01)
Q1	.0188
	(.68)
Q2	-.2107
	(-6.41)
Q3	.3263
	(4.98)
RPAFW	-.0101
	(-1.43)
RPYD	.0531
	(2.14)
PDFW(-1)	.3030
	(2.17)

R^2=.9859
RBAR^2=.9840
Durbin-Watson=2.1778
Degrees of Freedom=47

Export Equation for Wheat

Constant	-9.2702
	(-.03)
Q1	84.7278
	(2.52)
Q2	8.4233
	(.21)
Q3	334.9503
	(6.18)
PW	-42.3194
	(-.94)
PW(-1)	68.9292
	(1.33)
PW(-2)	-110.5409
	(-2.46)
PW(-3)	66.6926
	(1.42)
PW(-4)	-20.3979
	(-.62)
EXR	103.9934
	(.89)
DRWPRDW	-.4699
	(-.75)
TRWPRDW	-.1606
	(-.36)
XW(-1)	.6621
	(4.69)
XW(-4)	.1053
	(.69)

R^2=.8231
RBAR^2=.7656
Durbin-Watson=2.3222
Degrees of Freedom=40

Table 2. (continued)

where

BROF	Number of broilers on feed
DLVKW(-4)	Feed demand for wheat lagged four quarters
DRWPRDW	Deviation from trend for current rest-of-world wheat production
EXR	Trade-weighted exchange rate index
PDFW(-1)	Per capita food demand for wheat lagged one quarter
PW	Price of wheat/(trade-weighted exchange rate times world price index)
PW(-n)	PW lagged n quarters
Q1	Dummy variable for quarter 1
Q2	Dummy variable for quarter 2
Q3	Dummy variable for quarter 3
RPAFW	Real price at farm of wheat
RPCPBR	Ratio of the real price of corn to the real price of broilers
RPWPBR	Ratio of the real price of wheat to the real price of broilers
RPYD	Real per capita personal income
TRWPRDW	Trend rest-of-world wheat production
XW(-n)	Exports of wheat lagged n quarters

Table 3. Inventory Demand Equations Estimated Quarterly 1973:1-1986:2 Using Two-Stage Least Squares (asymptotic t-statistics in parentheses beneath coefficients).

Price Equation for Wheat*

Constant	2.4416
	(4.08)
Q1	-1.4711
	(-2.20)
Q2	-1.8475
	(-3.83)
Q3	-.4610
	(-.59)
Q1KMKTWE	-.0006
	(-1.38)
Q2KMKTWE	-.0004
	(-1.09)
Q3KMKTWE	-.0008
	(-2.69)
Q4KMKTWE	-.0014
	(-3.69)
KFORWE	-.0006
	(-2.46)
KGOVWE	-.0002
	(-.51)
RDPWPSW(-1)	.5937
	(5.78)
RRATE	-.0047
	(-.29)
DRATEI	.0073
	(.38)

R^2=.9183
RBAR^2=.8944
Durbin-Watson=2.1978
Degrees of Freedom=41

Government-Owned Inventory Identity for Wheat

KGOVWE = KGOVWE(-1) + KGOVWI - KGOVWO

Farmer-Owned Reserve Inventory Equation for Wheat**

Constant	-745.8942
	(-3.11)
Q1	47.1377
	(1.21)
Q2	-23.7034
	(-.61)
Q3	-6.1096
	(-.16)
CKFORWE(-1)	.3243
	(2.04)
CKFORWE(-4)	-.4764
	(-2.89)
CKFORWE(-8)	-.3244
	(-2.01)
RPAFW	-137.3695
	(-2.09)
RRELFORW	528.6288
	(2.66)
RSPFORW	96.9148
	(.60)

R^2=.5194
RBAR^2=.3530
Durbin-Watson=1.9267
Degrees of Freedom=26

Government Inflow Equation for Wheat (KGOVWI)

DSPCPW	337.5367
	(2.44)
CKGOVWE(-1)	.5573
	(3.10)

R^2=.2052
RBAR^2=.1585
Durbin-Watson=2.1026
Degrees of Freedom=17

Table 3. (continued)

where

CKFORWE(-n)	Change in inventories of wheat in the Farmer-Owned Reserve lagged n quarters
CKGOVWE(-1)	Change in government-owned wheat inventories lagged one quarter
DRATEI	Short-term real interest rate less the real interest rate charged by the CCC on nonrecourse loans
DSPCPW	(1.25 times real support price of wheat less real price of wheat) times the compliance rate for wheat
KFORWE	Ending inventories of wheat in the Farmer-Owned Reserve
KGOVWE	Ending inventories of wheat in government-owned stocks
KGOVWE	Government-owned wheat inventory
KGOVWE(-1)	Government-owned wheat inventory lagged one quarter
KGOVWI	Inflows to government-owned stocks of wheat
KGOVWO	Sales of government-owned stocks of wheat at time t
Q1	Dummy variable for quarter 1
Q2	Dummy variable for quarter 2
Q3	Dummy variable for quarter 3
Q1KMKTWE	Quarter 1 dummy times ending market inventories for wheat
Q2KMKTWE	Quarter 2 dummy times ending market inventories for wheat
Q3KMKTWE	Quarter 3 dummy times ending market inventories for wheat
Q4KMKTWE	Quarter 4 dummy times ending market inventories for wheat
RDPWPSW(-1)	Difference between real price at farm of wheat and real support price of wheat lagged one quarter
RPAFW	Real price at farm of wheat
RRATE	Real short-term interest rate
RRELFORW	Real FOR release price for wheat
RSPFORW	Real FOR support price for wheat

* Dependent variable in the price equation for wheat is the real price of wheat less the real support price for wheat (RDPWPSW).

** Dependent variable in the Farmer-Owned Reserve inventory equation for wheat is the change in inventories of wheat in the Farmer-Owned Reserve (CKFORWE).

Table 4. Automatic Adjustment Rules.

	Target Price	**Support Price**	**Diversion Requirement**	**Diversion Payment**
Constant	-85.1170 (-.62)	-48.2750 (-.59)	6.4103 (.66)	-674.4700 (-.49)
PAFW(A)	3.8783 (1.78) [8.68]	1.1718 (.89) [4.02]	.0197 (.13) [.23]	-25.6890 (-1.17) [-3.00]
KFORWE(-1)	.0048 (.56) [.55]	.0005 (.10) [.09]	.0008 (1.36) [.51]	-.0021 (-.02) [-.01]
KGOVWE(-1)	.0076 (1.12) [.10]	.0059 (1.46) [.12]	.00002 (.05) [.002]	.0084 (.12) [.006]
KMKTWE(-1)	.0112 (1.53) [4.64]	.0036 (.82) [2.29]	.0002 (.38) [.44]	-.1139 (-1.55) [-2.46]
DDW(A)	.0763 (3.38) [10.23]	.0122 (.90) [2.51]	.0039 (2.42) [2.78]	.0497 (.22) [.35]
XW(A)	.0112 (.73) [1.57]	.0128 (1.37) [2.75]	-.0016 (-1.47) [-1.20]	-.1194 (-.77) [-.87]
AW(-1)	.3634 (.19) [12.63]	.4734 (.40) [25.24]	-.0842 (-.60) [-15.55]	13.7020 (.70) [24.85]
YLDW(-1)	.5530 (.13) [8.36]	.9065 (.36) [21.02]	-.1685 (-.56) [-13.53]	30.0870 (.71) [23.73]
PRDW(-1)	-.0095 (-.15) [-9.78]	-.0142 (-.38) [-22.39]	.0024 (.54) [13.09]	-.4805 (-.77) [-25.84]
COMPW(-1)	4.2541 (.23) [1.34]	-4.1905 (-.37) [-2.02]	-2.2666 (-1.700) [-3.78]	93.5130 (.50) [1.53]
RW(-1)	.2362 (1.71) [5.39]	.1306 (1.57) [4.57]	.0062 (.63) [.75]	.7067 (.51) [.84]

Table 4. (continued)

	Target Price	Support Price	Diversion Requirement	Diversion Payment
KGOVWI(A)	.1848	.0961	-.0046	-.9469
	(1.72)	(1.48)	(-.60)	(-.87)
	[.67]	[.53]	[-.09]	[-.18]
	R^2=.6391	R^2=.3693	R^2=.4798	R^2=.5199
	$RBAR^2$=.4787	$RBAR^2$=.0889	$RBAR^2$=.2486	$RBAR^2$=.3065

Degrees of Freedom = 27

AW(-1)	Acreage of wheat lagged one crop year
COMPW(-1)	Rate of compliance with government programs for wheat lagged one crop year
DDW(A)	Total demand for wheat, average of four quarters of prior crop year
KFORWE(-1)	Farmer-owned reserve inventories of wheat, end of prior crop year
KGOVWE(-1)	Government-owned stocks of wheat, end of prior crop year
KMKTWE(-1)	Market inventories of wheat, end of prior crop year
KGOVWI(A)	Inflows to government stocks of wheat, average of four quarters of prior crop year
PAFW(A)	Cash price of wheat, average of four quarters of prior crop year
PRDW(-1)	Production of wheat lagged one crop year
RW(-1)	Rental rate for wheat lagged one crop year
XW(A)	Exports of wheat, average of four quarters of prior crop year
YLDW(-1)	Yield for wheat lagged one crop year

Table 5. Policy Rule Performances.

Policy Instrument	1985 Farm Bill	Automatic Adjustment Rules	
		Wheat Based	Macro Based
Target Price	4.38	4.61	5.30
Support Price	2.40	3.16	3.59
Diversion Requirement	.25	.12	.23
Diversion Payment	3.51	47.07	18.90
Policy Criterion Level	75.9×10^6	76.0×10^6	75.9×10^6

Summary of Simulations (20 pairs)

Policy Criterion Level	1985 Farm Bill	Automatic Adjustment Rules (wheat based)
Mean	72.2×10^6	74.3×10^6
Variance	3.2×10^{12}	5.3×10^{12}

Table 6. Elasticities for Macroeconomic Variables

Macroeconomic Variable	Target Price	Support Price	Diversion Requirement	Diversion Payment
	Elasticities for changes in optimal policy settings with respect to changes in macroeconomic variables			
Exchange Rate ($/for. cur.)	-.79645	.37357	-2.34021	.08117
Interest Rate	-.14937	.00808	-.19559	.19801
Consumer Price Index	5.29798	1.89748	-2.82837	-11.34951
Personal Income	1.19991	.16674	.65478	.35015
World Price Index	-.37266	.05019	-.63023	.13292
World GNP	.72222	.08320	.70629	.15371
Rest-of-World Production of Wheat	.83772	-.55446	3.08755	.13371