Regional Supply Analysis and Program Participation for U.S. Corn and Wheat: A Comparative Application of Alternative Response Specifications

by

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REGIONAL SUPPLY ANALYSIS AND PROGRAM PARTICIPATION FOR U.S. CORN AND WHEAT: A COMPARATIVE APPLICATION OF ALTERNATIVE RESPONSE SPECIFICATIONS

Duncan M. Chembezi and Abner W. Womack*

Much literature exists that has examined the impact of farm programs on the supply of agricultural products (Houck and Subotnik; Houck and Ryan; Lidman and Bawden; Garst and Miller; Gallagher; Lee and Helmberger; Morzuch, Weaver and Helmberger; McIntosh and Shideed; Bailey and Womack; Young). In the development of policy variables, the basic methodology adopted by most studies is one developed by Houck and Subotnik who collapsed the price support level with the program acreage restriction requirements into one composite explanatory variable termed "effective support price". Even though Gallagher retains the basic Houck-Subotnik formulation, he notes that this specification does not allow for producers' response to market prices. By assuming weak and strong market conditions, Gallagher developed a composite producer price expectations variable that incorporated both market price and current support price. The reasoning behind this formulation was that when market conditions are weak, the expected producer price collapses to the target price. The expected price is higher than the support price when market conditions are strong. The weakness with this formulation is that the expected producer price is always above the support level, except when target and farm prices are equal. Thus, the approach exaggerates producers' price expectations when market conditions are weak. This discrepancy is important to recognize, especially in recent years when farm prices have consistently fallen below the support level, forcing the target price to reign as the supply-inducing variable. Besides this method results in nonlinear relationships among observable variables, creating estimation problems.

Recent developments in supply response also suggest that much of the work in previous studies has failed to develop a consistent analytical scheme that isolates the factors affecting producers' decision to participate from the factors affecting their planting decisions. Most studies have estimated program and nonprogram planted acres in a single equation. This ignores the potential offsetting effects of participants' and nonparticipants' planted acres and imposes questionable restrictions on the impact of policy variable changes on aggregate plantings. For instance, the effective support price analysis by Houck and Subotnik assumes that an increase in support price will almost always increase aggregate planted acreage. This may not always be the case. Higher support prices may actually reduce aggregate plantings as increased program participation results in more acres being idled. In the presence of government programs a more effective method of estimating supply response is to estimate producers' program participation response first and then relate this to program planted acres. Nonprogram acreage response is estimated separately; and is inversely related to participants' response. de Gorter and Paddock conceived a framework that accounts for such considerations.

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Subotnik contends that the estimation of the discrete and continuous decision model proposed by de Gorter and Paddock requires single farm observations and cannot be estimated successfully given the aggregate annual data published by the USDA. Besides, the procedures for estimating such models are cumbersome. He instead suggests a methodology in which the decision to participate in the program, as measured by the amount of acreage enrolled in the program, is estimated independently from the planting decisions in and outside the program. Thus, program and nonprogram planting decisions are estimated conditional on the decision to participate.

The general objective of this paper is to present empirical estimates from analytical schemes by de Gorter and Paddock and also by Subotnik which seem to offer reasonable alternatives to conventional methods. The models are applied at the regional level to assess the impact of farm programs on acreage response for corn in the Cornbelt and Lake States and wheat in the Northern Plains. Two policy scenarios are analyzed for 1989. First, the impacts of a 10 percent decrease in target price; and second, the impacts of introducing a 10 percent paid land diversion (PLD) at $1.10 per bushel on program participation and planting decisions are investigated. The performances of the two models are compared to assess their aptness for policy analysis.

Theoretical Model

A brief description of the theoretical model to the extent required for the purpose of this paper is presented. The interested reader is advised to consult Chembezi; de Gorter and Paddock; and Subotnik for further details. Consider the case of corn production, where a producer may elect to plant corn within or outside the program. Under the program the producer idles land and abides by a corn acreage limitation in return for a diversion payment. The set-aside equals a percentage of the base acreage, the latter reflecting historical acreage allocation. The diversion payment equals a payment rate per bushel, known in advance, times established program yield, times a specified proportion of base acreage diverted under paid land diversion program. A deficiency payment equal to target price minus expected average market price exists. An additional voluntary diversion provision also exists in some years for which a producer is compensated to elicit participation.

Model I

The starting point in this model, hereafter referred to as 'Model I', is a single farmer attempting to maximize profit. The farmer is faced with the joint decisions of whether or not to participate in the program and the level of production. A farmer considering the participation decision evaluates the profit functions inside and outside the program, and chooses to produce under conditions in which the value of the profit function is the highest. The participating farmer maximizes profit in equation (1.1) subject to the constraint that acres planted in the program plus those idled do not exceed base allocation (equation (1.2)). For theoretical consistency and ease of analysis, idled acres are expressed in terms of program planted acres. Note that this specification has no competing crops because program provisions do not permit planting of other crops.

$$(1.1) \quad \pi_p = P_1 A_p Y_m + P_d \delta A_p Y_p - C(A_p, P_i),$$

$$(1.2) \quad A_b \geq A_p(1 + \delta),$$

where P_1 is the expected price for program participants, A_p is the number of acres planted in the program, A_b is base acreage, $C(.)$ is a variable cost function, P_d stands for diversion payments, Y_m and Y_p are market and program yields, respectively, P_i is a vector of input prices, and δ is the proportion of acres planted that must be diverted. The Lagrangean and first-order necessary conditions for profit maximization are as follows:

$$(1.3) \quad L = P_1 A_p Y_m + P_d \delta A_p Y_p - C(A_p, P_i) + \mu(A_b - A_p(1+\delta)),$$

$$(1.4) \quad L_1 = P_1 Y_m + \delta P_d Y_p - MC(A_p, P_i) - \mu(1+\delta) = 0,$$

$$(1.5) \quad L_2 = A_b - A_p(1+\delta) = 0.$$

Assuming yield is constant for ease of exposition, the first-order conditions yield the following solution:

$$(1.6a) \quad A_p = A_b/(1+\delta) \quad \text{if} \quad \mu > 0,$$

$$(1.6b) \quad A_p = A_p(P_1, P_d, P_i, A_b, \delta) \quad \text{otherwise}.$$

This solution also implies that in the absence of set-aside requirements (δ), acres planted in the program are equal to base acres which are also equal to total acres enrolled in the program.

Nonparticipants have no base acreage and have the option for alternative crops. Their planting decision is determined according to the principle of 'marginal costs equal marginal revenue'. Thus, nonprogram acreage response function is specified as a function of own output price, prices of competing crops and input prices.

Define π^*_p and π^*_m as the i^{th} farmer's indirect profit functions associated with program participation and lack of it, respectively, then the i^{th} farmer will join the program if $\pi^*_p \geq \pi^*_m$ and will not join if $\pi^*_p < \pi^*_m$. The decision to participate will depend upon the factors affecting π^*_p and π^*_m. This analysis assumes that the farmer is risk-neutral although it is evident that other factors such as risk-aversion or the need to build a crop base on farms with little or no base will also influence the decision to participate. Defining participation rate, k^*, as the amount of acres enrolled in the program as a proportion of base acreage, then optimal participation rate and acres planted outside the program (A_m) are determined as follows:

$$(1.7) \quad k^* = f(P_1, P_2, P_d, P_s, P_i, \delta), \qquad 0 \leq k^* \leq 1,$$

$$(1.8) \quad A_m = g(P_2, P_s, P_i; k^*),$$

where P_2 is nonparticipants' expected price, P_s is a vector of prices for competing crops and the other variables are as defined before. Given equations (1.7) and (1.8), total program acres (A_q) become k^*A_b, and program planted acres reduce to $k^*A_b/(1+\delta)$.

Model II

The second specification, hereafter referred to as 'Model II', explicitly addresses the question of voluntary diversion requirements. Voluntary diversion is viewed as an alternative activity, up to a point, competing with the program crop for the available land. Thus, as it becomes more lucrative to idle land, less is actually planted. A program participant maximizes profit in (1.9) subject to constraints in (1.10) and (1.11).

$$(1.9) \quad \pi_p = P_p Y_m A_p + P_v Y_p A_v - C(A_p, P_i),$$

$$(1.10) \quad \AE_b = A_b(1-\theta_1-\theta_2) \geq A_p + A_v,$$

$$(1.11) \quad A_v \leq \Phi \AE_b,$$

where P_p is the program production inducing price, P_v is the voluntary diversion payment, A_v is voluntary diversion acreage, θ_1 and θ_2 are minimum required diversion and set-aside rates, respectively, $\Phi = [\theta_3/(1-\theta_1-\theta_2)]$ is maximum voluntary diversion rate of the effective base ($\AE_b$), and θ_3 is the announced voluntary diversion rate. A_b, A_p, $C(.)$, Y_m and Y_p are as defined in Model I. The effective base is defined as the maximum amount of land that can be planted after the minimum set-aside requirements for program benefits have been met. The program production inducing price is the sum of expected market price and deficiency payments (or direct payments for years prior to 1974) where they existed, expressed in terms of market yield. From equations (1.9) to (1.11) the Lagrangean for profit maximization becomes:

$$(1.12) \quad L = P_p Y_m A_p + P_v Y_p A_v - C(A_p, P_i) + \mu(\Phi \AE_b - A_v) + \tau(\AE_b - A_p - A_v).$$

The Kuhn-Tucker conditions are as follows:

$$(1.13) \quad L_1 = P_p Y_m - MC(Y_m, A_p) - \tau \leq 0,$$

$$(1.14) \quad L_2 = P_v Y_p - \mu - \tau \leq 0,$$

$$(1.15) \quad L_3 = \Phi \AE_b - A_v \geq 0,$$

$$(1.16) \quad L_4 = \AE_b - A_p - A_v \geq 0.$$

The solutions for planted and diverted acres are obtained under four assumptions regarding constraints: (i) both constraints are binding, (ii) only voluntary diversion constraint is binding, (iii) only acreage constraint is binding, and (iv) neither constraint is binding. Holding yield constant as in Model I, the respective solutions are:

$$(1.17) \quad A_p = (1-\Phi)\AE_b \text{ and } A_v = \Phi \AE_b,$$

$$(1.18) \quad A_p = f(P_p, P_i) \text{ and } A_v = \Phi \AE_b,$$

$$(1.19a) \quad A_p = g((P_p - P_v), P_i) \text{ and } A_v = \AE_b - g((P_p - P_v), P_i),$$

$$(1.19b) \quad A_p = \AE_b \text{ and } A_v = 0,$$

$$(1.20) \quad A_p = \AE_b \text{ and } A_v = 0.$$

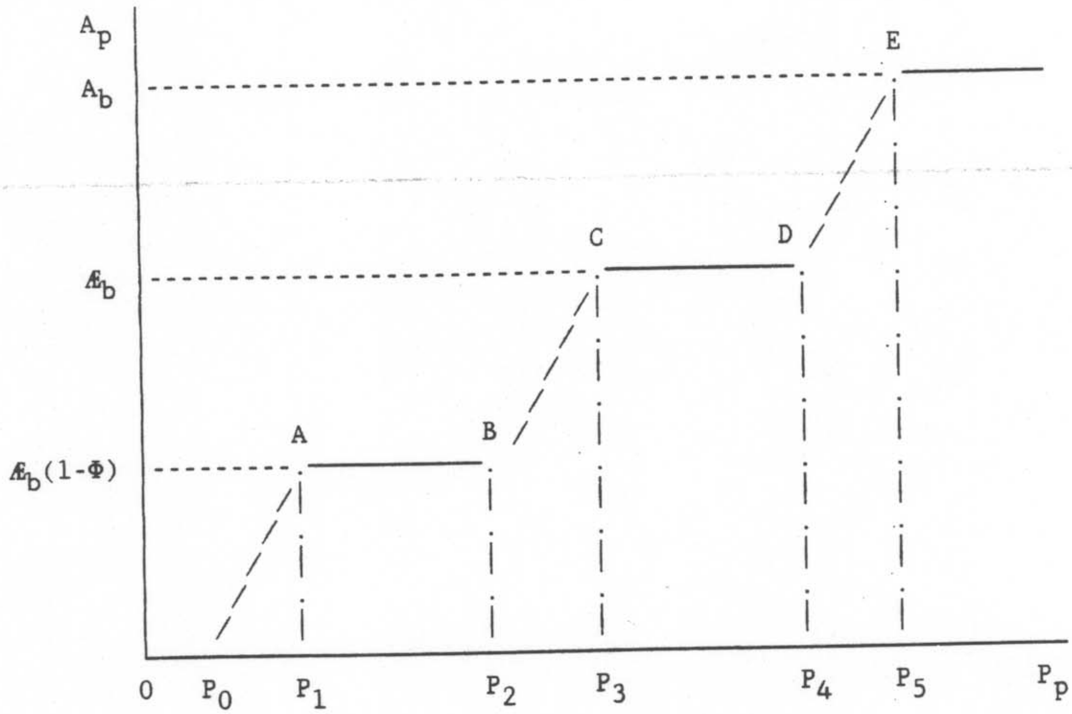

Figure 1: Acreage Response Under Different Policy Regimes

To enhance intuitive understanding. the derivation of optimal solutions is also illustrated in Figure 1 which shows the level of program planted acres at every level of price (P_p). At any price $P_p < P_0$, no acres are planted since the price is less than marginal costs. The farmer may enroll in the 0/92 reduced planting provision to protect his base. However, the maximum number of acres permitted under voluntary diversion program ($\Phi Æ_b$) are diverted. In the price interval $P_0 \leq P_p \leq P_1$, the farmer continues to divert $\Phi Æ_b$ and the planting decision is based on the principle 'marginal costs (MC) equal marginal revenue (MR)'. Some slack of acres may remain. At any price, $P_1 \leq P_p \leq P_2$, the farmer plants $(1-\Phi)Æ_b$ and diverts $\Phi Æ_b$. Price and diversion payments have no effect since both constraints are binding and all the slack has been exhausted. As price exceeds P_2 and approaches P_3, only the acreage constraint is binding. Acreage is determined according to MC=MR. The marginal revenue here is the difference between price and voluntary diversion payment. In the price range $P_3 \leq P_p \leq P_4$, price is rendered impotent as acreage becomes a constraint. In the price interval $P_4 \leq P_p \leq P_5$, none of the constraints is binding although the farmer must still abide by the available base allocation. Here we have an unconstrained profit maximization problem. Initially, not all the base is planted, but as price exceeds P_5, the entire base is planted and price ceases to have any impact on acreage allocation as long as the farmer remains in the program. Acres planted in the program equal those enrolled in the program which also equal total base allocation. The curve P_0ABCDE in Figure 1 may be thought of as a locus of points tracing the supply curve for program planted acres. The derivation of nonprogram acreage response and the decision to participate is achieved in much the same way as in Model I.

Empirical Model

The specification of the models follows the discussion presented in the preceding section. Model I endogenizes participation rate (k^*) and nonprogram acres. The participation decision is based on the comparison of per acre net returns within and outside the program (Skold and Westhoff). The theoretical limitations and statistical advantages of net returns as explanatory variables in supply response models are discussed elsewhere (Chembezi). Program net returns (NR_p) are expected to have positive effects on program participation, while market net returns (NR_m) are expected to have negative effects. The dummy variable (D1) acts as an intercept when acreage reduction programs are in effect. In the absence of these programs, an intercept is not necessary since program acres equal base acres, implying that participation rate is a 100 percent. This constraint is accounted for by D2 (1 if no acreage reduction programs, 0 otherwise; D1 is the opposite of D2). The planting decision outside the program is estimated conditional on the decision to participate. Mathematically, the model is specified as follows:

$$(1.21) \quad k^* = D1*(1 + \alpha_1 NR_p + \alpha_2 NR_m + \alpha_3 NR_s) + \alpha_4 D2 + \epsilon_1,$$

$$(1.22) \quad A_m = \beta_0 + \beta_1 NR_m + \beta_2 NR_s + \beta_3 (k^* A_b) + \beta_4 A_{m-1} + \epsilon_2,$$

$$-1 \leq \beta_3 < 0; \quad 0 \leq \beta_4 \leq 1; \quad \alpha_4 = 1.$$

Where α_i and β_i are parameters to be estimated, NR_s stands for per acre net returns for competing crops, ϵ_i are error terms. All the variables are as defined in the preceding section. The information available to participants is also available to nonparticipants through the inclusion of total program acres

(k^*A_b). The difference between participants and nonparticipants is the decision each group takes based on the same information set.

Empirical specification for Model II accounts for the different policy regimes depicted in Figure 1. This is conveniently achieved with the help of dummy variables that permit equations (1.17) to (1.20) to be estimated as a single equation. The overall outcome is much the same as a switching regression model. Acres enrolled in the program are used as a proxy for participation decision. Program and nonprogram planted acres are estimated conditional on this decision. As in Model I, all the information for deciding whether or not to participate is embedded in A_q. The general model specification is as follows:

$$(1.23)\quad A_q = D1*(1 + \mu_1 P_p + \mu_2 P_m + \mu_3 P_s + \mu_4 P_d) + \mu_5(D2*A_b) + \epsilon_1,$$

$$(1.24)\quad A_p = D3*[\tau_1(P_p - P_v) + \tau_2 A_q + \tau_3 D\%] + \tau_4(D2*A_b) + \tau_5[D4*(1-D\%)A_q] + \epsilon_2,$$

$$(1.25)\quad A_m = \varphi_0 + \varphi_1 P_m + \varphi_2 P_s + \varphi_3 A_q + \epsilon_3,$$

$$0 < \tau_2, \tau_5 \le 1; \quad -1 \le \varphi_3 < 0; \quad [\mu_5, \tau_4] = 1.$$

Where μ_i, τ_i and φ_i are parameters to be estimated, $D\% = (\theta_1 + \theta_2 + \theta_3)$ is the sum of minimum set-aside and voluntary diversion rates, D1 is a dummy variable, zero if neither constraint is binding; one otherwise. D2 is the reverse of D1. D3 is zero if neither or only acreage constraint is binding, and is one otherwise. D4 is one if both constraints are binding, and is zero otherwise. All the other variables are as defined before.

Data and Empirical Results

Annual data for 24 years (1966-89) from various publications by the United States Department of Agriculture were used in the analysis. Specific sources were 'Statistical Summary for Wheat and Feed Grains', 'Annual Crop Summary', 'State-Level Feed Grain Statistics, 1949-86', and 'Agricultural Prices: Annual Summary'.

The market prices used for corn, wheat and competing crops were the regional market-year average prices received. The regional averages were developed by using share of regional production to weight state average prices. The diversion payment variable (P_d) in Model II was formulated as a nonlinear function of voluntary diversion payments and payments on minimum required diversion (Chembezi; Subotnik). In Model I, the per acre program net returns were calculated as the sum of expected market revenue, expected deficiency payments, diversion payments less variable costs (Skold and Westhoff; Chembezi). Market returns were calculated simply as expected market revenue less variable costs.

The two models were estimated using ordinary least squares technique. The estimates are presented in Table 1. The Durbin-Watson and Durbin h-statistics reveal no sign of serial correlation. The models' explanatory power is very good and the parameter estimates are all significant at the 10 percent level, except for price of wheat and lagged dependent regressor in equations 5 and 7, respectively. Both program net returns and program production inducing price would seem to capture program effects reasonably well.

In equations 1 and 6, it seems clear that participation decision is based on comparison of per acre program and market net returns for the crop. Profitability of other crops is also important. Soybean net returns in the participation rate equation for wheat are positive and significant at the 10 percent level, implying that wheat and soybeans are complements. This relationship may be due to existence of double-cropping of wheat and soybeans.

Overall, farm programs show strong influence on plantings outside the program. Ideally, there must be a one-to-one correspondence between program and nonprogram acres. An acre enrolled in the program should reflect a unit acre decrease in nonprogram acres. The parameter estimates with respect to program acres for corn are -0.933 in equation 2 and -0.956 in equation 5. Both estimates are very close to the ideal estimate of -1.0. However, nonprogram acreage equations for wheat reveal substantial amount of slippage. An acre enrolled in the program reduces nonprogram plantings for wheat by about 0.563 acres in equation 7 and 0.409 acres in equation 10. There are several reasons why the substitution may not be acre for acre. Nonparticipants may choose to plant other crops or set-aside land that cannot be used to grow the program crop profitably. Besides, idled land may be marginal land which would not be planted even if there were no incentives for diversion or set-aside.

The lagged dependent variable was introduced in equation 7 to reflect the fact that farmers do not adjust to supply shocks instantaneously. The coefficient of adjustment is 0.707, suggesting that about 71 percent of the discrepancy between the desired or optimal and actual acreages is eliminated in a year. The estimate is, however, not significant at the 10 percent level. This specification was tried in the corn model but the coefficient of the lagged dependent regressor was too insignificant to be retained even though the sign was correct. Lack of statistical significance for the lagged dependent regressors is not surprising given that plantings in and outside the program are driven substantially by program variables.

Acreage enrolled in the program also influences acreage planted in the program. This is less surprising since program planted acres form a larger portion of total acres enrolled. The parameter estimates with respect to program acres are 0.808 for corn (equation 4) and 0.731 for wheat (equation 9), suggesting that for every acre enrolled in the program, only 81 percent for corn and 73 percent for wheat is planted since about 19 percent and 27 percent of the same acre is idled to meet the various land retirement programs. These rates are consistent with those actually observed over the historical period. Equations 4 and 9 also support the assertion that in those years in which both constraints were binding, program planted acres are approximated by the effective base. The estimates with respect to $(1\text{-}D\%)A_q$, a proxy for effective base, are 0.998 for corn and 0.982 for wheat. In equations 3, 4, 8 and 9 of Table 1, the responses to base acres are all equal to unity, as expected, supporting the contention that for years in which none of the constraints was binding, program planted acres equal total program acres which also equal base acres. For the same reason the estimate with respect to D2 in equations (1) and (6) is unity.

Elasticity Estimates

The estimates presented here are total elasticities reflecting the direct price effects and also indirect or expansion effects from increased participation. All the estimates are presented in Table 2. The elasticities for nonprogram acres are generally larger than those of program planted acres, reflecting the restrictions programs impose on planting decisions within the program. This is also explained in terms of substitution between program and nonprogram acres given a change in target or program inducing price. Thus, for every acre enrolled in the program, less than an acre is planted since the remaining must be used to meet set-aside requirements.

Elasticities with respect to target or program inducing price for total planted acres are negative for corn and positive for wheat suggesting that policy instruments have been effective for corn but ineffective for wheat in reducing plantings. These results confirm de Gorter and Paddock's contention that the effects of program variables like target price on total production may be ambiguous (i.e. cannot be signed a priori) because of the offsetting effects between program and nonprogram plantings. If the positive effects of target price on program planted acres outweigh the negative effects on nonprogram acres, the net result is a positive effect on aggregate planted acres, and vice versa. It must also be mentioned that under the 1985 Farm Bill, market prices have consistently fallen below the target price for both corn and wheat. As result, the target price has become the supply-inducing price. Participation rate for both crops has been very high in the latter half of the 1980s. It seems reasonable to expect program planted acres and hence total planted acres to respond positively to an increase in target price. This is also reflected in the policy simulation exercise in Table 3 for Corn Model II and both wheat models where a reduction (increase) in target price in 1989 reduces (increases) total planted acres.

The elasticity estimates reported here for corn (0.119 and 0.166) compare favorably with 0.112 and 0.185 by Gallagher, 0.130 by Houck and Ryan, and 0.137 by Shideed, et al. They are, however, smaller than 0.223 by Subotnik, 0.240 by de Gorter and Paddock, and 0.249 by Lee and Helmberger. The estimates with respect to target price (-0.060) and program production inducing price (-0.043) are also consistent with Subotnik's estimate of -0.036. In the case of wheat, values of 0.124 by Bailey and Womack, 0.390 by Hoffman, and 0.111 by Young do compare with 0.131 and 0.110 in this study.

Alternative Policy Simulations

The impacts of a 10 percent decrease in target price in 1989 were analyzed. Table 3 shows that such an action would reduce program participation rate for corn by about 3 percent. (Model I). Nonprogram plantings would increase by nearly 10 percent, causing total plantings to increase by just under two percent. In Model II, total plantings for corn decline slightly as the increase in nonprogram acres fails to compensate for the decrease in program planted acres. A decrease in target price also decreases total planted acres for wheat. Participation rate and hence program acres and program planted acres decrease. Nonprogram acres increase but the increase is not enough to offset the decrease in program planted acres.

An introduction of a 10 percent paid land diversion (PLD) in 1989 at \$1.10 per bushel results in a decrease in total acres planted for both crops (Table 4). Corn models suggest that the increase in program acres is associated with an increase in program planted acres although this increase is not adequate to undo the decrease in nonprogram acres. Wheat models, on the other hand, show an increase in program acres and a reduction in both nonprogram and program planted acres as more land is idled.

Concluding Remarks

This study has presented findings from two alternative schemes that offer significant results and valuable insights on producers' acreage response behavior. These schemes are an improvement over traditional methods which model program and nonprogram planted acres in a single equation. This is less preferred to an approach in which program and nonprogram planted acres are estimated separately conditional on producers' decision to participate in the program. This provides a more realistic and intuitive portrayal of producers' decision making process.

The response estimates presented here compare favorably with those of similar studies. Both program production inducing price and program net returns adequately reflect the economic incentives for producers to participate. Other policy variables such as diversion payments are also important. The estimates, however, fail to provide a basis for selecting a 'better' model of the two just presented. The theoretical limitations associated with expected net returns as explanatory variables in a response model offer some grounds for selection; but this must be weighed against the practical and statistical advantages of such formulation.

Market prices under the 1985 Farm Bill have consistently fallen below the support level, forcing target price to operate as the supply-inducing price as producers attempt to shield themselves against the uncertain market conditions. Unless market prices rebound drastically or the target price is reduced, the target price may continue to direct producers' production decisions even as we enter the 1990 Farm Bill.

The analysis in this study has focussed on previous government programs up to the end of 1985 Farm Bill. As we enter the 1990s, the question as to the appropriateness of current methods in evaluating the effects of the 1990 Farm Bill is already being asked. Given the triple base (flex acreage) in this new Bill, determination of participation rate requires careful consideration. Obviously, current analytical schemes will have to be adjusted and modified to accommodate the post 1990 era.

Table 1: Participation Rate and Acreage Response Equations for Corn and Wheat (1966-1989)

Corn Model I: Cornbelt & Lake States:

1. $PRT = 0.095\,[D1*(NR_p - NR_c)] - 0.119\,(D1*NR_s) - 0.381\,(D1*NR_w) + 0.993\,D1 + 1.00\,D2$
   (3.654) (-2.026) (-2.396) (7.223) (21.009)

   $R^2 = 0.982$ D-W = 1.636 RMSE = 0.117

2. $AC_m = 55.143 + 2.121\,NR_c - 2.062\,NR_s - 3.968\,NR_w - 0.933\,(PRT*A_b)$
   (17.701) (1.971) (-3.048) (-2.612) (-16.396)

   $R^2 = 0.944$ D-W = 1.946 RMSE = 2.656

Corn Model II: Cornbelt & Lake States:

3. $AC_q = 701.321\,(D1*PP_c) - 723.805\,(D1*PC_m) - 276.202\,(D1*PS_m) + 309.438\,(D1*PD_d) + 1.00\,(D2*A_b) + 46.950\,D1$
   (1.907) (-2.197) (-2.866) (3.995) (18.672) (6.995)

   $R^2 = 0.984$ D-W = 1.943 RMSE = 5.303

4. $AC_p = 164.820\,[D3*(PP_c - PV_d)] + 0.808\,(D3*AC_q) - 16.572\,(D3*ID\%) + 0.998\,[D4*(1-ID\%)AC_q] + 1.00\,(D2*A_b)$
   (5.793) (34.500) (-7.852) (62.648) (82.078)

   $R^2 = 0.998$ D-W = 1.878 RMSE = 1.206

5. $AC_m = 57.865 + 150.941\,PC_m - 77.019\,PS_m - 101.043\,PW_m - 0.956\,AC_q$
   (17.535) (1.778) (-2.064) (-1.437) (-17.869)

   $R^2 = 0.951$ D-W = 2.032 RMSE = 2.478

Wheat Model I: Northern Plains:

6. $PRT = 0.106\,[D1*(NR_p - NR_w)] - 0.279\,(D1*NR_c) + 0.191\,(D1*NR_s) + 0.859\,D1 + 1.00\,D2$
   (2.713) (-3.572) (2.641) (10.161) (26.989)

   $R^2 = 0.992$ D-W = 1.734 RMSE = 0.091

7. $AC_m = 26.711 + 5.438\,NR_w - 2.713\,NR_s - 13.875\,NR_o + 0.293\,LAG(AC_m) - 0.563\,(PRT*A_b)$
   (4.160) (1.879) (-2.333) (-2.475) (1.587) (-3.507)

   $R^2 = 0.939$ Durbin h = 0.391 RMSE = 3.989

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Table 1: --continued--

Wheat Model II: Northern Plains:

8. $AC_q = 275.555\,(D1*PP_w) - 269.896\,(D1*PW_m) - 225.873\,(D1*PC_m) + 15.652\,(D1*PD_d) + 1.00\,(D2*A_b) + 36.319\,D1$

$(2.766) \quad (-2.812) \quad (-2.305) \quad (2.326) \quad (30.657) \quad (10.338)$

$R^2 = 0.994$ D-W = 1.735 RMSE = 2.871

9. $AC_p = 114.292\,[D3*(PP_w-PV_d)] + 0.731\,(D3*AC_q) - 18.690\,(D3*ID\%) + 1.00\,(D2*A_b) + 0.982\,[D4*(1-ID\%)AC_q]$

$(1.808) \quad (11.923) \quad (-2.189) \quad (33.213) \quad (24.933)$

$R^2 = 0.986$ D-W = 1.529 RMSE = 2.499

10. $AC_m = 23.001 + 189.826\,PW_m - 191.596\,PC_m - 203.273\,PG_m - 0.409\,AC_q + 10.261\,D5$

$(3.616) \quad (2.169) \quad (-2.413) \quad (-2.232) \quad (-2.928) \quad (6.221)$

$R^2 = 0.887$ D-W = 1.651 RMSE = 2.697

Numbers in parenthesis are asymptotic t-statistics. All estimates are significant at the 10 percent level or better, except for PW_m and LAG(AC_m) in equations 2 and 5.

VARIABLE DEFINITION:

AC_m = Nonprogram Planted Acres (Million).
AC_p = Program Planted Acres (Million).
AC_q = Program Acres (same as $PRT*A_b$) (Million).
A_b = Base Acreage (Million).
PP_c = Corn Program Production Inducing Price per bushel.
PP_w = Wheat Program Production Inducing Price per bushel.
PC_m = Corn Market Price per bushel.
PW_m = Wheat Market Price per bushel.
PS_m = Soybean Market Price per bushel.
PG_m = Sorghum Market Price per bushel.
PD_d = All Diversion Payments per bushel.
PV_d = Voluntary Diversion Payments per bushel.
PRT = Program Participation Rate (%).
NR_p = Program Net Returns per acre.
NR_c = Corn Net Returns per acre.
NR_o = Oats Net Returns per acre.
NR_s = Soybean Net Returns per acre.
NR_w = Wheat Net Returns per acre.
ID% = Sum of Idle Rates (including Voluntary Diversion) (%).
D1 = Dummy Variable (0 if 1974-77 or 1980-81; 1 Otherwise).
D2 = Dummy Variable (1 if 1974-77 or 1980-81; 0 Otherwise).
D3 = Dummy Variable (0 if neither or acreage constraint is binding; 1 Otherwise).
D4 = Dummy Variable (1 if both constraints are binding; 0 Otherwise).
D5 = Dummy Variable (1 if 1982-85; 0 Otherwise).

Table 2: Estimates of Acreage Elasticities for Corn and Wheat

Crop\Region\Variable	MODEL I Program Acres Total	MODEL I Program Acres Planted	MODEL I Non-Program	MODEL I Total Planted	MODEL II Program Acres Total	MODEL II Program Acres Planted	MODEL II Non-Program	MODEL II Total Planted
Corn - Cornbelt & Lake States:								
Program Inducing Price	-	-	-	-	0.677	0.715	-1.254	-0.043
Announced Target Price	0.586	0.701	-1.276	-0.060	-	-	-	
Expected Corn Price	-0.370	-0.454	1.034	0.119	-0.622	-0.609	1.404	0.166
Expected soybean Price	-0.364	-0.447	0.586	-0.049	-0.595	-0.581	0.780	-0.057
Expected Wheat Price	-0.481	-0.521	0.729	-0.039	-	-	-0.202	-0.078
Minimum Diversion Payment	-	-	-	-	0.018	0.051	-0.084	-0.001
Voluntary Diversion Payment	-	-	-	-	0.184	0.109	-0.339	-0.063
Weighted Diversion Payment	0.181	0.222	-0.486	-0.051	-	-	-	-
Wheat - Northern Plains:								
Program Inducing Price	-	-	-	-	0.391	0.517	-1.883	0.049
Announced Target Price	0.186	0.216	-0.607	0.055	-	-	-	-
Expected Wheat Price	-0.120	-0.139	1.243	0.131	-0.322	-0.272	1.689	0.110
Expected Corn Price	-0.767	-0.892	1.221	-0.155	-0.204	-0.172	-0.420	-0.220
Expected Soybean Price	0.252	0.293	-0.988	-0.062	-	-	-	-
Expected Sorghum Price	-	-	-	-	-	-	-0.805	-0.157
Expected Oats Price	-	-	-0.833	-0.162	-	-	-	-
Minimum Diversion Payment	-	-	-	-	0.037	0.031	-0.072	0.011
Voluntary Diversion Payment	-	-	-	-	0.125	-0.073	-0.243	-0.106
Weighted Diversion Payment	0.087	0.101	-0.563	-0.028	-	-	-	-

The average shares of acres planted within and outside the program over the estimation period are 0.615 and 0.385, respectively, for Corn Models and 0.805 and 0.195 for Wheat.

Table 3: Impacts of a 10% Decrease in 1989 Announced Target Price

Crop\Region\Variable	MODEL I			MODEL II		
	Baseline	Simulation	Impact (%)	Baseline	Simulation	Impact (%)
Corn - Cornbelt & Lake States:						
Participation Rate (%)	78.912	76.628	-2.981	-	-	-
Total Program Acres (Mn.)	-	-	-	37.303	35.714	-4.260
Program Planted Acres (Mn.)	36.289	35.819	-1.312	34.790	33.173	-4.875
Nonprogram Planted Acres (Mn.)	11.999	13.313	9.870	13.077	14.596	10.407
Total Planted Acres (Mn.)	48.288	49.132	1.718	47.867	47.769	-0.204
Wheat - Northern Plains:						
Participation Rate (%)	87.504	86.277	-1.422	-	-	-
Total Program Acres (Mn.)	-	-	-	35.101	33.949	-3.393
Program Planted Acres (Mn.)	33.369	32.301	-3.306	31.126	29.806	-4.429
Nonprogram Planted Acres (Mn.)	7.445	7.792	4.453	7.354	7.825	6.019
Total Planted Acres (Mn.)	40.814	40.093	-1.798	38.480	37.631	-2.256

Table 4: Impacts of Introducing a 10% PLD in 1989 at $1.10 per Bushel

Crop\Region\Variable	MODEL I			MODEL II		
	Baseline	Simulation	Impact (%)	Baseline	Simulation	Impact (%)
Corn - Cornbelt & Lake States:						
Participation rate (%)	78.912	83.493	5.487	-	-	-
Total Program Acres (Mn.)	-	-	-	37.303	40.626	9.557
Program Planted Acres (Mn.)	36.289	37.312	2.743	34.790	36.013	3.396
Nonprogram Planted Acres (Mn.)	11.999	9.873	-21.533	13.077	10.669	-22.570
Total Planted Acres (Mn.)	48.288	47.185	-2.338	47.867	46.682	-2.538
Wheat - Northern Plains:						
Participation Rate (%)	87.504	91.173	4.024	-	-	-
Total Program Acres (Mn.)	-	-	-	35.101	36.779	4.561
Program Planted Acres (Mn.)	33.369	33.287	-0.247	31.126	30.483	-2.109
Nonprogram Planted Acres (Mn.)	7.445	6.411	-16.129	7.354	6.668	-10.285
Total Planted Acres (Mn.)	40.814	39.698	-2.811	38.480	37.151	-3.577

Note: Baseline refers to the value the model predicts before the shock.

References

Bailey, K.W., and A.W. Womack, "Wheat Acreage Response: A Regional Econometric Investigation", Southern Journal of Agricultural Economics, 17(2), 1985.

Chembezi, D. M. "Regional Supply Analysis, Program Participation and Government Policy Variables: An Econometric Investigation of Five U.S. Field Crops". A Ph.D. Dissertation, University of Missouri-Columbia, 1990.

de Gorter, H., and H. Paddock, "The Impact of U.S. Price Support and Acreage Reduction Measures on Crop Output", International Trade Policy Division, Agriculture Canada, 1985.

Garst, G.R., and T.A. Miller, "Impact of the Set-Aside Programs on U.S. Wheat Acreages", Agricultural Economics Research, 27:30-37, 1975.

Gallagher, P., "The Effectiveness of Price Support: Some Evidence for U.S. Corn Acreage Response", Agricultural Economics Research, 30:8-14, 1978.

Hoffman, R.G., "Wheat Regional Supply Analysis", Wheat Situation, ERS, USDA, pages 15-24, 1973.

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

Houck, J.P., and M.E. Ryan, "Supply Analysis for Corn in the United States: The Impact of Changing Government Programs", American Journal of Agricultural Economics, 54:184-91, 1972.

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

Lidman, R., and D.L. Bawden, "The Impact of Government Programs on Wheat Acreage", Land Economics, 50:327-35, 1974.

McIntosh, C.S., and K.H. Shideed, "The Effects of Government Programs on Acreage Response Over Time: The Case of Corn Production in Iowa", Western Journal of Agricultural Economics, 41(1):38-44, 1989.

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

Shideed, K.H., F.C. White, and S.J. Brannen, "The Responsiveness of U.S. Corn and Soybean Acreage to Conditional Price Expectations: An Application to 1985 Farm Bill", Southern Journal of Agricultural Economics, 19:153-161, 1987.

Skold, K.D., and P. Westhoff, "An Analysis of Corn and Soybean Supply Response to Changing Government Programs", Paper Presented at the AAEA Annual Meeting, Michigan State University, August 2-5, 1987.

Subotnik, A., "Program and Nonprogram Acreage Response Functions for U.S. Corn". Center for National Food and Agricultural Policy, Department of Agricultural Economics, University of Missouri, 1990.

Young, R.E., "Secretarial Discretion Under the Food Security Act of 1985". A Ph.D. Dissertation, University of Missouri-Columbia, 1986.