# WHEAT ACREAGE RESPONSE: A REGIONAL ECONOMETRIC INVESTIGATION

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### Abstract

An econometric model of planted wheat acreage was estimated for five distinct production regions in the United States. This structural investigation represents an update of previous published work with specific attention given to policy program variables, weather, production cost, risk, market price influences, and program participation. Estimated results indicated regional divergence in responsiveness to government program variables. The most significant divergence occurred in the Cornbelt and Southeast—soft red winter wheat areas. Results indicate that management of the wheat program from the USDA level will contain countervailing production incentives unless these regional characteristics are taken into consideration in policy directives.

*Key words:* regional supply, econometrics, policy, program participation.

Management of farm programs at the national level requires information on the expected supply response of grain farmers to various policy program variables. These response estimates are essential for maintaining the crop sector near program guideline levels that include loan rates, target prices, release prices, and market price objectives. A major problem in realigning the crop sector during periods of excess supplies involves selection of the appropriate policy mix and levels to serve as economic incentives to induce sufficient acreage reductions. Houck and Ryan were among the first to formulate supply-inducing prices for crop producers that utilized the effects of government program variables and market price information to estimate national crop acreage response models. Hoffman developed regional acreage equations based on similar specifications in an attempt to improve acreage projections and government program analysis. More recently, Gallagher et al. estimated spring and winter wheat equations using polynomial lags to quantify expectations of supply inducing prices. Their analysis produced reasonable estimates of acreage response; however, model performance outside the period of fit has not been sufficiently reliable to support current program analysis. Hence, it is the objective of this study to build from this research base and to estimate a regional acreage response function for wheat. The study is sensitive to the influence of both government programs and market forces on acreage response analysis and to examining these influences on the regional distribution of wheat acreage.

## BACKGROUND CONSIDERATIONS

Costs of operating USDA crop programs in the early 1980's ranged between $7 and 8 billion. However, in the 1984/85 Reduced Acreage, Paid Diversion, Payment-In-Kind (PIK) year, costs of operating the farm program amounted to approximately $18 billion. Several factors are associated with this inflated program cost. First, expectations of market expansion at the initiation of the 1981 Farm Bill have not materialized. In fact, wheat exports have declined from a high of 1,771 million bushels in 1981/82 to 1,429 million bushels in 1983/84. At trend yield levels of 35 bushels per acre, this reflects a loss of planted area for exports alone of 9.9 million acres. However, the planted area associated with the 1981/82 export level remains in

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the USDA Agricultural Stabilization and Conservation Service (ASCS) base land area. The difference between this land base and the level of supplies necessary to meet current domestic and foreign demand reflects the degree of government exposure to costs in managing the wheat programs.

Second, the current farm program contains little or no modification for regional considerations. Loan rates for wheat, for example, do vary by region; however, this differential is questionable. All regions except the Northwestern States have essentially the same loan levels. This pattern of loan rates does not conform to corresponding market forces. For example, soft red wheat grown in the Southeast normally sells at a 30- to 40-cent discount to hard red wheat grown in the Midwest. This imbalance is further complicated by the yield differential between hard and soft red wheat. Soft red wheat is a higher yielding variety. Hence, government incentives via the loan rate are more conducive to the expansion of soft wheat production under similar cost and market expectation conditions.

A third factor is associated with the relative loan rates across commodities. Legislation that results in escalation of the loan rate of a particular commodity relative to others normally produced in the same region will send erroneous signals for expansion. An examination of wheat loan rates in the Southeast, modified by per unit of production cost and relative to similar deflated ratios for cotton, corn, and soybeans, indicates that loan rates for wheat have outpaced other commodities since 1972, Figure 1.

## OBJECTIVES

The objectives of this study are to build from the research base previously discussed by extending wheat acreage response equations into regions similar to the Hoffman and Gallagher studies and to reexamine specifications for clarity of government and market

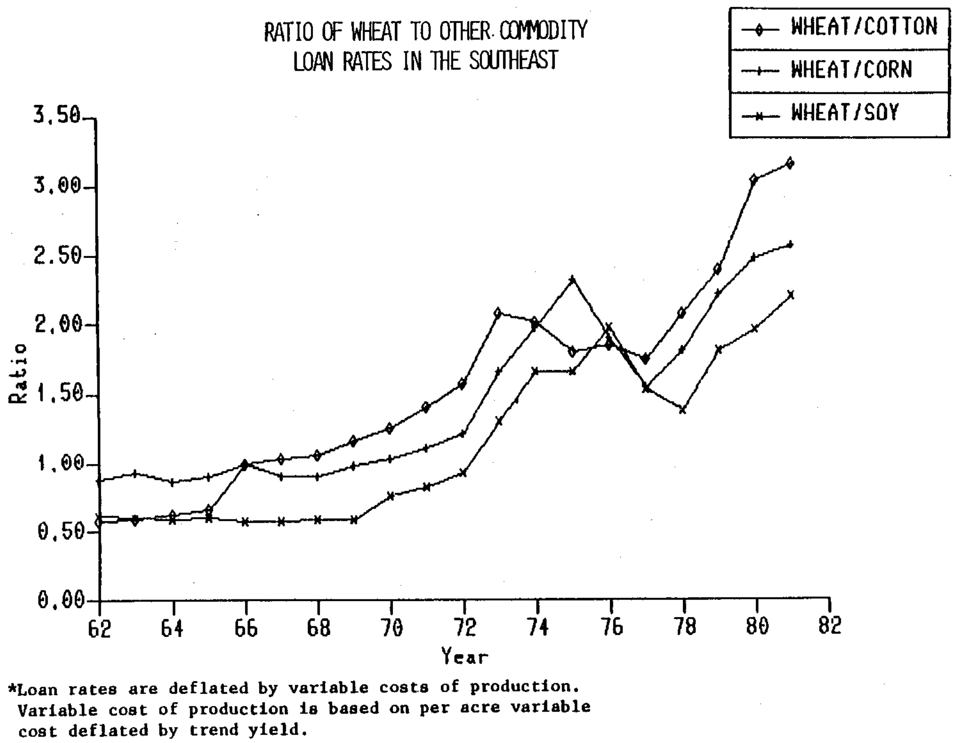


**Figure 1. Ratio of Wheat of Other Commodity Loan Rates in the Southeast.**

forces associated with the rapid acceleration in wheat acreage since the mid-1970's in the Southeast and Midwest regions. More specifically, the objectives of this study are to: (1) specify a supply inducing price that incorporates as a single variable the influence of market price and government program via a weighting process conditioned on actual program participation, (2) specify and estimate regional supply response equations to counteract the heterogeneous nature of wheat producing regions, and (3) examine farm program influence on the regional distribution of wheat acreage in the late 1970's and early 1980's.

This study examines the implication of these factors on area planted to wheat in the United States. Since a major focus of this research is on the regional implication of farm program design, considerable attention is given to the development and quantification of farm policy program variables.

## THEORETICAL RISK MODEL

Assuming the decisionmaker is an expected utility maximizer, a theoretical model for acreage response is derived under conditions of risk and uncertainty. An acreage response function is in fact an input demand function and will be derived here by maximizing a stochastic utility of profit function with respect to acreage planted. The deterministic and stochastic models presented below were first described by Hazell and Scandizzo and were later modified by T. Ryan.

### Deterministic and Stochastic Models

Following Hazell and Scandizzo's specification (p.235), the objective of the individual farmer is to,

$$(1)\quad \max_{x}\ \pi = \hat{p}'\,Mx - c'\,Mx,$$

where: $\hat{p}$ = an nx1 vector of expected product prices,
$c$ = an nx1 vector of per bushel production costs,
$x$ = an nx1 vector of acreage planted, and
$M$ = an nxn diagonal matrix of crop yields with jth diagonal entry $m_j$.

The model assumes all variables are known with certainty. Although producers know input prices with certainty at the beginning of a production period, output prices and yields are not known. Therefore, assuming yield to be a source of risk, a production vector for a representative farmer now becomes $y=Nx$, where N is an nxn diagonal matrix of stochastic yields with jth diagonal element $e_j$. Stochastic yields imply stochastic supply functions and give rise to stochastic market prices p.

Hence, one can describe the following stochastic profit function,

$$(2)\quad \pi = p'\,Nx - c'\,Nx,$$
or
$$\pi = p^{*\prime}\,Nx,$$

where $p^*$ is an nx1 vector of expected product prices net of unit costs.

Given this stochastic profit function, it becomes obvious that a decision criterion other than maximizing the expectation of equation (1) is required. Hence, the negative exponential utility function will be used to access the decisionmaker's preferences between alternative risky choices. Also, assumming that the farmer's subjective distribution is a normal distribution of net returns per acre, equation (2) can be expressed as,

$$(3)\quad \max_{x}\ EU = E[p^{*\prime}\,Nx] - \frac{\Phi}{2}V[p^{*\prime}\,Nx],$$

where $\Phi$ is a measure of absolute risk aversion.

Given a set of behavioral assumptions utilized by Hazell and Scandizzo (p. 236), the first order necessary conditions for expected utility maximization are:

$$(4)\quad Mp^* - \Phi\,Wx = 0,$$

where M is the expected value of the matrix N and W is an nxn covariance matrix of acreage revenues. Assuming W is nonsingular, equation (4) can be rearranged to yield the following input demand function for acreage planted,

$$(5)\quad x^* = \frac{1}{\Phi}W^{-1}Mp^*.$$

Assuming yields are either known with certainty or that variability is negligible and that there are only two competing crops, the following input demand function can be derived in much the same way T. Ryan derived his supply function,[1]

[1] In order to derive equation (6), follow steps (7) through (11) in T. Ryan's paper (pp. 36-7).

$$(6)\quad x1^{*} = f\left[\frac{\sigma_1^2}{P_1^{*}}, \frac{\sigma_{12}}{P_1^{*}\sigma_2^2}, \frac{\sigma_1^2\sigma_2^2}{P_2^{*}\sigma_{12}}, \frac{\sigma_{12}}{P_2^{*}}\right],$$

where: $\sigma_i^2$ = the variance of crop price i, and

$\sigma_{ij}$ = the covariance of crop prices i and j, $i \neq j$.

### Dynamic Model

In deriving a dynamic model, equation (6) can be expressed in general form as:

$$(7)\quad x1_t^{*} = a + bp1_t^{*} + cp2_t^{*} + dR_t + u1_t,$$

where: $x1^{*}$ is the optimal acreage planted to crop 1, $p1^{*}$ is the acreage inducing price of the primary crop, $p2^{*}$ is the acreage inducing price of the competing crop, R is some measure of price risk, and u1 is a random error term where $E[u1_t] = 0$ and $V[u1_t] = \sigma_{u1}^2$.

It should be emphasized that the superscript $^{*}$ in equation (7) denotes x to be at an optimal utility maximizing level. However, in any given time period, a producer may not be able to adjust the actual level of x to its optimal level. Hence, Nerloves partial adjustment model is used and equation (7) can be rewritten as:

$$(8)\quad x1_t = (1 - g)x1_{t-1} + ga + gbp1_t^{*} + gcp2_t^{*} + gdR_t + gu1_t,$$

where g is an element of the set (0,1).

## METHODOLOGY

A review of acreage planted to wheat indicates there are at least five separate and distinct production regions in the United States. Given these heterogeneous regions, it is asserted that regional supply equations will be necessary to reflect farmers' decision making processes. The regional subdivision is similar to the geographic areas selected by Hoffman.

The statistical specification follows directly from the theoretical specification in equation (7). The model is expressed as follows:

$$(9)\quad PT_{1j}(t) = a_{1j} + b_{1j}[EP_{1j}(t)/VC_{1j}(t)] + c_{1j}[EP_{2j}(t)/VC_{2j}(t)] + d_{1j}DP_{1j}(t) + f_{1j}PT_{1j}(t-1) + K_{1j}(t) + e_{1j}(t),$$

where: $PT_{ij}(t)$ = acreage planted to commodity i in region j and time period t,

$EP_{ij}(t)$ = expected price of commodity i in region j and time period t,

$VC_{ij}(t)$ = variable cost of commodity i in region j and time period t,

$DP_{ij}(t)$ = effective voluntary diversion rate for commodity i in region j and time period t,

$K_{ij}(t)$ = all other relevant input demand shifters for commodity i in region j and time period t,

$e_{ij}(t)$ = a mean-zero, serially independent random variable with finite variance for commodity i in region j and time period t, and

$i = 1,2;\ j = 1,\ldots,5.$

The expected prices used in the model are calculated as follows:

$$(10)\quad EP_{ij} = (PRI_{ij} \bullet PF_{ij}) + (PRO_{ij} \bullet PM_{ij}),$$

where: $PRI_{ij}$ = percent of acreage complying with the farm program for commodity i in region j,

$PRO_{ij}$ = percent of acreage not complying with the farm program for commodity i in region j,

$PF_{ij}$ = effective support price for commodity i in region j,

$PM_{ij}$ = lagged season average price received by farmers for commodity i in region j, and

$i = 1,2;\ j = 1,\ldots,5.$

It is assumed that if a farmer participates in the farm program, PF, reflecting government support variables, will be the relevant acreage inducing price. On the other hand, if a farmer decides not to join the farm program, PM, an expected market price, will be the relevant acreage inducing price. Hence, the variable EP has the advantage of representing both farmers in and outside the farm programs.

### Effective Support and Diversion Rate Variables

The government policy variable (PF) was constructed for wheat, corn, sorghum, barley, and cotton in a manner consistent with empirical work done earlier by Ryan and Abel (1972; 1973 (a) and (b)). The conceptual framework utilized in the construction of policy variables in this study was discussed extensively by Houck et al. Hence, the government policy variable PF was specified for the time period 1961 to 1981, with a modification in program design beginning in 1974, as follows:

1961-1973: and 1974-1981:

$$(11)\quad PF_j = \lambda(P_j + GP_n) = \lambda(PA_j) \qquad (12)\quad PF_j = \lambda(P_j + EDP_n) = \lambda(PA_j),$$

where:

$P_j$ $= LR_j$ if $LR_j \geq PM_{t-1,j}$
$= PM_{t-1,j}$ if $LR_j < PM_{t-1,j}$ with

$LR_j$ = regional average loan rate for region j and

$PM_{t-1,j}$ = lagged season average farm price for region j;

$PA_j$ $= P_j + GP_n$, for the time period 1961-1973 or
$= P_j + EDP_n$, for the time period 1974-1981;

$PF_j$ = effective support rate for region j;

$\lambda$ = a weighting factor reflecting planting restrictions;

$GP_n$ = national government direct payment per bushel;

$EDP_n$ = national deficiency payment per bushel, and

j = 1,...,5.

Further clarification of $\lambda$, the weighting factor reflecting the planting restrictions in the farm programs, is given as:

$$(13)\quad PF = \frac{1}{n}\sum_{k=1}^{n}(\lambda_k \bullet PA),$$

where: $\lambda_k = 1 - w_k$,
$w_k$ = regional government acreage reduction at participation level k (percent), and
$PA_k$ = total government payment on acreage planted by participants at level k, and
k = 1,...,n.

The objective of the weighting factor is to take into consideration varying levels of participation in the farm program. If there is a minimum and a maximum level of participation, k = 1,2, a simple average of the two levels is taken. It should be noted that PA reflects payments on acreage planted.

The effective diversion payment, DP, is calculated as follows:

$$(14)\quad DP = \frac{1}{n}\sum_{k=1}^{n}(w_k \bullet PR_k),$$

where: DP = effective voluntary diversion rate,
$PR_k$ = payment rate for diverted or set-aside land at participation level k, and
k = 1,...,n.

It should also be noted that PR reflects a payment on diverted or set-aside acreage.

Ryan and Abel (1972; 1973 (a) and (b)) calculated the effective support rate using the loan rate plus direct payments as the total supply price PA and used a separate variable to reflect the influence of market price. This study departs from their definition of the effective support rate in that the market price is utilized when it is greater than the loan rate. Farmers form expectations about the market price of their output at or before planting time. Decisions relative to participation in the farm programs and acreage to plant are conditioned on expectations that may involve the higher of the loan rate or the "expected" market price, plus any other program benefits.[2] Therefore, a lagged regional season average farm price is used as a proxy for the "expected" market price and the higher of this price and the regional loan rate is used in the calculation of PF. No change has been made in the manner in which Ryan and Abel (1972; 1973 (a) and (b)) calculated the effective diversion rate variable, other than a slightly different interpretation of the support price.

## Other Variables and Data

The regional data, used in specification of the policy and other exogenous variables in the model, were calculated from data reported at the state level and from the USDA's ten crop producing regions. The state and ten region data were transformed to the five

[2] It should be noted that winter wheat producers frequently receive farm program announcements and/or modifications after they plant their crop. However, program designers understand this and are able to modify these producers' acreage planted for harvest by offering sufficient financial incentives.

regions utilized in this study by use of acreage weights, constructed by dividing state acreage planted by regional acreage planted. The data source for state acreage planted was *Agricultural Statistics* (United States Department of Agriculture).

Regional loan rates were constructed by first taking the simple average of the county loan rates as reported in the *Federal Register* in order to produce a state average loan rate, and then averaging these across the five regions via the acreage weights. Regional market prices were constructed in a similar way by averaging the state seasonal average farm prices as reported in the USDA's *Agricultural Prices* by the acreage weights. The participation rate PRI (PRO) was calculated from the ten region data by dividing acreage participating in (out of) the farm programs by total acreage planted (total acreage planted plus acreage set-aside or diverted). The participation rates were then transformed from the ten region data to five region data via the acreage weights. The data source for the variables used in calculation of the participation rates was from the Agricultural Stabilization and Conservation Service (USDA). Variable costs of production were calculated on a per bushel or per hundredweight basis in a manner similar to the participation weights. The ten region variable cost of production was divided by a five-year moving average yield per planted acre and then it was transformed to the five region data by the acreage weights. The source for the ten region variable cost of production data was *Economic Indicators of the Farm Sector* (United States Department of Agriculture).

The weather variable used in the model was constructed by first creating a weighted precipitation variable and then calculating a monthly departure from normal precipitation. Weights were created for each crop reporting district that contained significant acreages of wheat. The weights were then multiplied by the monthly precipitation and summed to give weighted monthly precipitation levels over the 20-year period. The mean was then taken and a monthly departure from normal precipitation was calculated. Since precipitation during the months preceding, during, and after planting would affect planting decisions the most, the departures from normal precipitation of these months were summed over the historical period to yield the weather variables used in this study.

The risk variable incorporated in the statistical model was specified by Gallagher from T. Ryan's paper as follows:

$$(15)\quad RISK_{ij} = (lagPM_{ij} - MAC_{ij})^2/MAC_{ij},$$

where: $MAC_{ij} = .33[(\sum_{k=2}^{4} lagk(PM_{ij})]$

and

$PM_{ij}$ = seasonal average price received by farmers for commodity i in region j.

## EMPIRICAL ESTIMATES

Regional equations were estimated via ordinary least squares for the time period 1962-1981, Table 1. Variables were generally maintained in the equation when "t" statistics were greater than the absolute value of 1. Although the presence of multicollinearity rendered some parameter estimates statistically insignificant, the variables were maintained if correct signs were obtained and the included variable conformed to previous research and *a priori* expectations associated with planted acreage of wheat. Also, in order for the model to respond to announced government farm programs, it was necessary that the program variables be maintained in the model specification in order to accurately reflect the structure of the wheat industry.

Using these criteria, all of the variables specified earlier were found to be statistically related to planted acreage except specifications that contained variable costs of production. Empirical results indicated that the specification for variable cost of production rendered the price variables statistically insignificant and generated incorrect signs. Further examination revealed that the variable cost of wheat increased faster over time than wheat prices, producing a downward trend in the deflated price variable and thus yielding a negative relationship with the upward trend of wheat acreage planted in most regions. For these reasons, variable cost of production as specified in this study was not incorporated in these models.

The expected price of wheat (WTBEPj), which considers both participants and nonparticipants in the farm program, was found to be relatively significant[3] in all five regions.

[3] Relatively significant is defined as any estimated coefficient that has the correct *a priori* sign and has a "t" ratio greater than or equal to one.

TABLE 1. OLS ESTIMATES FOR WHEAT ACREAGE PLANTED, BY REGION, 1962-81

| Region and variable[a] | Coefficient | t-statistic | $R^2$ | SSE |
|---|---|---|---|---|
| SOUTHERN PLAINS: | | | | |
| Constant ........ | 13,215.76 | 3.03 | 0.88 | 40,040,475 |
| WTBEP1 ........ | 3,267.10 | 3.70 | | |
| WHEEDRR1 .. | −4,378.97 | −0.83 | | |
| CTBEP1 ........ | −14.49 | −0.30 | | |
| DFN1 .......... | 286.06 | 0.98 | | |
| RISK1 ........... | −1,142.47 | −1.56 | | |
| WHLRPTR1 .. | 0.36 | 2.08 | | |
| NORTHERN PLAINS: | | | | |
| Constant ........ | 20,277.11 | 3.97 | 0.93 | 26,691,485 |
| WTBEP2 ........ | 980.48 | 1.60 | | |
| WHEEDRR2 .. | −7,244.61 | −1.86 | | |
| OATRPTR2 .... | −1.28 | −2.93 | | |
| RISK2 ........... | −19.09 | −0.06 | | |
| DFN2 ............ | −338.20 | −1.61 | | |
| WHLRPTR2 ... | 0.33 | 2.56 | | |
| NORTHWEST: | | | | |
| Constant ........ | 1,958.90 | 2.20 | 0.86 | 4,607,962 |
| WTBEP3 ....... | 456.08 | 1.80 | | |
| WHEEDRR3 .. | −1,220.50 | −0.79 | | |
| RISK3 ......... | −50.44 | −0.35 | | |
| WHLRPTR3 ... | 0.55 | 2.90 | | |
| CORN BELT: | | | | |
| Constant ........ | 7,218.69 | 3.79 | 0.79 | 9,218,074 |
| WTBEP4 ........ | 1,791.69 | 5.34 | | |
| WHEEDRR4 ... | −567.41 | −0.27 | | |
| SOYRPTR4 .... | −0.18 | −3.51 | | |
| RISK4 ............ | −386.55 | −1.02 | | |
| WHLRPTR4 ... | 0.12 | 0.70 | | |
| SOUTHEAST: | | | | |
| Constant ........ | −1,080.57 | −1.10 | 0.66 | 11,560,451 |
| WTBEP5 ....... | 748.26 | 2.32 | | |
| WHEEDRR5 . | −550.19 | −0.23 | | |
| RISK5 .......... | −514.37 | −0.92 | | |
| WHLRPTR5 .. | 0.97 | 2.55 | | |

[a] Variables and regions are defined as:

Southern Plains - Region 1 (Wyoming, Colorado, Nebraska, Kansas, Oklahoma, Texas, New Mexico): WHERPTR1 - wheat, all types, acreage planted, region 1, thousand acres; WTBEP1 - wheat, all types, expected price, region 1, \$/bu.; WHEEDRR1 - wheat, all types, effective voluntary diversion rate, region 1, \$/bu.; CTBEP1 - cotton, upland, expected price, region 1, \$/cwt.; DFN1 - weather, departures from normal precipitation, region 1, inches; RISK1 - regional price risk variable, region 1; and WHLRPTR1 - wheat, all types, lagged acreage planted, region 1, thousand acres.

Northern Plains - Region 2 (Montana, Minnesota, North Dakota, South Dakota): WHERPTR2 - wheat, all types, acreage planted, region 2, thousand acres; WTBEP2 - wheat, all types, expected price, region 2, \$/bu.; WHEEDRR2 - wheat, all types, effective voluntary diversion rate, region 2, \$/bu.; OATRPTR2 - oats, acreage planted, region 2, thousand acres; RISK2 - regional price risk variable, region 2; DFN2 - weather, departures from normal precipitation, region 2, inches; WHLRPTR2 - wheat, all types, lagged acreage planted, region 2, thousand acres.

Northwest - Region 3 (Washington, Oregon, California, Nevada, Utah, Arizona): WHERPTR3 - wheat, all types, acreage planted, region 3, thousand acres; WTBEP3 - wheat, all types, expected price, region 3, \$/bu.; WHEEDRR3 - wheat, all types, effective voluntary diversion rate, region 3, \$/bu.; RISK3 - regional price risk variable, region 3; WHLRPTR3 - wheat, all types, lagged acreage planted, region 3, thousand acres.

Corn Belt - Region 4 (Wisconsin, Iowa, Missouri, Ohio, Illinois, Indiana, Michigan, and 11 other northeast states): WHERPTR4 - wheat, all types, acreage planted, region 4, thousand acres; WTBEP4 - wheat, all types, expected price, region 4, \$/bu.; WHEEDRR4 - wheat, all types, effective voluntary diversion rate, region 4, \$/bu.; SOYRPTR4 - soybeans, acreage planted, region 4, thousand acres; RISK4 - regional price risk variable, region 4; WHLRPTR4 - wheat, all types, lagged acreage planted, region 4, thousand acres.

Southeast - Region 5 (Arkansas, Louisiana, Mississippi, Alabama, Kentucky, Tennessee, West Virginia, Virginia, North Carolina, South Carolina, Georgia, Florida): WHERPTR5 - wheat, all types, acreage planted, region 5, thousand acres; WTBEP5 - wheat, all types, expected price, region 5, \$/bu.; WHEEDRR5 - wheat, all types, effective voluntary diversion rate, region 5, \$/bu.; RISK5 - regional price risk variable, region 5; WHLRPTR5 - wheat, all types, lagged acreage planted, region 5, thousand acres.

A 10 cent increase in WTBEPj was estimated to induce an increase of approximately 326,710 acres in the Southern plains, 45,608 acres in the Northwest, 179,169 acres in the Corn Belt, and 74,826 acres in the Southeast region.

The effective voluntary diversion rate variable (WHEEDRRj) was significant in only the Northern Plains model. Strong correlations with the expected price of wheat and the lagged dependent variable are the most likely reasons for insignificance in the other regions. A 10 cent increase in WHEEDRRj in the Northern Plains was estimated to induce a reduction of 724,461 acres in wheat acreage planted.

Major crops in each region were tested for competition with wheat for production resources. In the Southern Plains, cotton price (CTBEP1) had the correct sign and, although statistically insignificant, it was maintained because of the presence of multicollinearity. In the Northern Plains, oats acreage (OATRPTR2) was found to be significant with the correct sign. The results suggest that for every acre planted to oats, 1.278 acres was diverted from wheat production. Oat acreage was used as a proxy for cross price expectations due to strong multicollinearity of the price variable. Given that the coefficient is greater than 1, this variable is likely representing other economic impacts. Barley price and acreage were tested in the Northwest region model and were found to be insignificant with improper signs. Therefore, they were not included in the model. In the Corn Belt, soybean acreage (SOYRPTR4) had the correct sign and was significant. This implied that a 100 acre increase in soybean acreage reduces wheat acreage by 18 acres. Corn and cotton are the major crops competing for wheat production resources in the Southeast; however, neither was found to be significant. Thus, they were not included in the model.

The risk variable (RISKj) was found to have the correct sign, but was insignificant in all regions. The low "t" statistics may be due to the presence of multicollinearity from the expected price of wheat.

The coefficient for the lagged dependent variable (WHLRPTRj) was significant in all models except for the Corn Belt region. This tends to confirm the hypothesis of Nerlove's partial adjustment model; farmers do not adjust their acreage planted instantaneously to changes in prices and technology. Rather, they adjust to the optimum acreage level over time. The coefficient in the Southeast region was the largest and suggests this is essentially a first difference model implying no adjustment to economic and technological stimulation.

## ACREAGE RESPONSE MEASURES

Calculated elasticities from this analysis plus the Hoffman model for the period 1950-1970 are given in Table 2. The price elasticities are difficult to compare because this analysis incorporates market and program variables in a single term (WTBEP), while Hoffman's study maintained government program (ESR) and market price ($PF_{t-1}$) terms as two separate variables. A weighted average of Hoffman's elasticities suggests greater responsiveness in the Southern and Northern Plains relative to this study. The current study indicates relatively greater responsiveness to price incentives in the Corn Belt and Southeast, two regions characterized by soft winter wheat production.

The elasticities calculated at the 1981 level are greater in all regions except the Southeast, indicating farmers in those four regions were more price responsive in 1981 than in preceding years. The smaller elasticity for the Southeastern region in 1981 is not indicative of the 89 percent increase in acreage planted, suggesting farmers exceeded the price incentive as measured by the direct price elasticity; i.e., acreage increased significantly greater than the change in direct price.

TABLE 2. COMPARISON OF REGIONAL WHEAT ACREAGE RESPONSE ELASTICITIES

| Region | Bailey and Womack WTBEP[a] | Bailey and Womack WTBEP 81[b] | Hoffman ESR[c] | Hoffman $PF_{t-1}$[d] |
|---|---|---|---|---|
| Southern Plains .... | 0.246 | 0.333 | 0.500 | 0.420 |
| Northern Plains .... | 0.128 | 0.167 | 0.390 | 0.430 |
| Northwest ............ | 0.172 | 0.226 | 0.080 | n.a. |
| Corn Belt ............ | 0.547 | 0.698 | 0.140 | 0.840 |
| Southeast ............. | 0.620 | 0.374 | 0.010 | 0.410 |

[a]WTBEP = wheat expected price elasticity, evaluated at the mean;
[b]WTBEP81 = wheat expected price elasticity, evaluated at 1981;
[c]ESR = wheat effective support rate elasticity, evaluated at the mean;
[d]$PF_{t-1}$ = wheat lagged farm price elasticity, evaluated at the mean.

## ACREAGE FORECASTS AND MODEL VALIDATION

The derivation of the acreage weights and variables used in the construction of the regional exogenous variables were described earlier in the methodology section. A different approach was used in the construction of these variables for forecasting purposes because of the limited amount of information available prior to planting. For example, national average loan rates are announced to farmers prior to planting. However, the county loan rates, used in the construction of the regional effective support and diversion rate variables, are published in the *Federal Register* (United States National Archives and Record Service) well after planting time. Hence, regional loan rates for 1982-83 were estimated by regressing the regional loan rates on the national loan rates. Once this relationship was estimated, the announced national loan rates were used to generate "estimated" regional loan rates. Lagged regional farm prices were generated in much the same way, except forecasted prices were used for the 1982 crop year. Effective support and diversion rate variables for 1982-83 were calculated from the announced farm program figures. Acreage numbers used exogenously in the model were USDA preliminary figures for 1982 and forecasted figures for 1983. Regional participation rates were reported for 1982 by ASCS and were calculated for 1983 from a USDA news release on March 22, 1983. Regional participation rates are given in Table 3.

TABLE 3. WHEAT PROGRAM PARTICIPATION RATES, BY REGION, 1982 AND 1983

| Region | 1982 compliance level (%) | 1983 compliance level (%) |
|---|---|---|
| Southern Plains .... | 44.8 | 90.0 |
| Northern Plains .... | 70.4 | 96.0 |
| Northwest ............ | 20.6 | 84.0 |
| Corn Belt ............ | 22.3 | 62.0 |
| Southeast ............ | 17.0 | 67.0 |
| United States total | 48.2 | 87.0 |

Acreage forecasts are presented in Table 4. The Southern, Northern, and Corn Belt regional equations indicated an acreage decline from 1981 to 1982 with drastic reductions from 1982 to 1983. Acreage increased slightly in the Northwest region from 8.04 million in 1981 to 8.1 million in 1982, and then dropped to 6.49 million in 1983. The Southeast region has expanded significantly since 1979. Acreage planted to wheat in the Southeast region increased from 2.45, to 4.02, to 7.62 million acres in 1979, 1980, and 1981, respectively. The 1982 and 1983 forecasts indicated plantings of 8.73 and 8.68 million acres, respectively. The 1983 forecast for the Southeast region was 354 percent of the acreage planted in 1979.

The 1982 forecast for wheat planted in all regions of the United States was 86.7 million acres. The production figure from the 1984 edition of *Acreage* (United States Department of Agriculture) for all wheat acreage planted in 1982 was 86.2, which means the forecast was off by only 0.52 percent. The 1983 national forecast called for a 18.3 million acre reduction in wheat acreage planted from 86.7 in 1982 to 68.4 million acres in 1983. Much of this acreage reduction can be attributed to the PIK Program announced in January 1983.[4] The acreage forecast for 1983 *without* the announced PIK option calls for 87.0 million acres, an increase of 282,031 acres from 1982. The figure for all wheat acreage planted in 1983 was 76.4 with 61.4 million harvested. Since a considerable amount of wheat was planted prior to the January PIK announcement and later was taken out of production by the program option, the 76.4 million planted area exaggerates actual plantings for harvest. If the normal differential of 8 million acres between planted and harvested area is applied, actual plantings for harvest would be about 69.4 million acres. The 1983 forecast of 68.4 million acres under this program design is certainly an indication that the model is adaptable to current farm programs.

TABLE 4. WHEAT ACREAGE FORECASTS, BY REGION, 1982 AND 1983

| Region | 1982 | 1983 |
|---|---|---|
| | ..............million acres | ................. |
| Southern Plains .... | 36.9 | 30.0 |
| Northern Plains .... | 24.8 | 16.7 |
| Northwest ............ | 8.1 | 6.5 |
| Corn Belt ............ | 8.1 | 6.6 |
| Southeast ............ | 8.7 | 8.7 |
| United States total | 86.7 | 68.4 |

## SUMMARY AND CONCLUSIONS

The general objective of providing policymakers with regional acreage response models that more accurately capture the structure of the wheat industry is supported to some extent by the behavior of the model outside the period of fit, especially under the conditions of a PIK program for which very little previous information existed.

A regional approach to supply analysis proved to be successful with considerable improvement in equation performance relative to more aggregated equation specifications. The government policy variables tended to be significant in explaining acreage planted across regions. The expected wheat price modified to include historical participation was relatively significant in all cases and was a very strong explanatory variable. Variable costs of production were generated in all regions at a considerable expense of time and effort, but the variable was not significant in any of the acreage response models estimated. However, the trend in recent years of wheat price relative to variable cost per bushel has been slightly upwards, suggesting that this variable may be important and should certainly be given consideration in future studies.

Acreage planted in the Southeast region has increased significantly in recent years. This pattern of responsiveness by wheat producers suggests different supply inducing expectations, depending upon the region of production. Low wheat prices are an incen-

[4] This forecast was obtained by treating the PIK options as a special paid diversion with PIK grain valued at the higher of the regional loan rate or the expected market price.

tive for program participation in major producing regions. However, this pattern is not reflected in planted areas in the Southeast and Corn Belt. This conflicting behavior is certainly related to the fairly sharp upturn in loan rates for wheat relative to other major crops (adjusted for variable production costs) in these regions. Both regions produce soft red winter wheat that carries a market price differential of about 30 cents per bushel below hard red winter wheat grown in other regions. However, differences among loan rates are fairly constant across all regions. Also, given the differential in yield growth in these two regions, producers can sustain or increase production while other regions are reducing. This additional comparative advantage is strengthened by the fact that acreage reduced in other regions implies less total production and therefore higher price expectations for the Southeast and Corn Belt regions, especially given the loan rate advantage for soft red wheat.

Thus, management of wheat acreage from the USDA point of view contains countervailing incentives. Attempts to reduce acreage cannot be achieved unless these regional characteristics are taken into consideration. Modification requires more careful attention to the relative level of loan rates for wheat across regions, especially in the soft and hard wheat areas, plus crop loan price implications with cotton, corn, and soybeans in the Southeast. Otherwise, land control incentives by the administration that do not reflect regional comparative advantages will not receive uniform participation across regions.

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