Journal of Agricultural and Resource Economics, 20(1):96–107

Program and Nonprogram Wheat Acreage Responses to Prices and Risk

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Wheat acreage responses to expected wheat price and price risk are reversed for program- and nonprogram-planted acreage in the northern plains, central plains, southern plains, and U.S. Expected wheat price has a strong negative effect on program-complying wheat acreage. Government support prices have a positive effect on program-complying and program-planted acreage. Price risk has a positive effect on program-complying wheat acreage and a negative effect on nonprogram-planted acreage. Estimated price elasticities are higher than in studies where risk was ignored.

Key words: censored regression, government programs, risk, wheat acreage

Introduction

Estimates of acreage response to changes in prices and government programs are important parameters in many agricultural policy analyses. Reliable acreage response estimates are particularly important when predicting the impacts of changing trade policies on U.S. agricultural markets. Previous analyses of wheat acreage response (Bailey and Womack; Burt and Worthington; Chembezi and Womack; Houck et al.; Just; Morzuch, Weaver, and Helmberger) have produced a wide range of price elasticity estimates. The range of results is largely due to the variety of ways that expected market prices, government support prices, and other government program parameters have been modeled; although, different time periods, levels of data aggregation, and estimation methods also have contributed. Most analyses of wheat acreage response have ignored price risk, despite evidence that risk affects acreage of other crops (Chavas and Holt; Brorsen et al.; Traill). Furthermore, with the exception of Chembezi and Womack, previous analyses have not addressed possible differences between wheat program acreage responses and nonprogram acreage responses.

Chembezi and Womack establish an economic rationale for estimating program acreage response separate from nonprogram acreage response. Their results indicate that although a support price variable[1] has a strong positive effect on program-planted acres, the expected market price for wheat has a negative effect on program-planted acres and a positive effect on nonprogram-planted acres. The price effects on program-planted acres of wheat are particularly important in the northern plains states (North Dakota, South Dakota, Minnesota, and Montana) because most wheat in this region is usually planted under government programs. During the period 1966–92, an average of 84% of northern plains wheat acres,

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Funding for this research was provided by the USDA-CSRS Northern Plains International Trade Research Program, grant number 90-34192-5675.

[1] In place of support or target price, Chembezi and Womack use a "program production-inducing price" which equals the expected market price plus the deficiency payment or value of market certificates weighted by the ratio of program yield to average yield.

74% of central plains (Nebraska, Kansas, Colorado, and Wyoming) wheat acres, and 60% of southern plains (Oklahoma and Texas) wheat acres were planted under the wheat program whenever acreage set-aside or acreage reduction provisions were in effect (Langley).[2]

Methods of incorporating government program parameters in other acreage response analyses have varied. Houck et al. constructed effective support rate and diversion rate variables using multiple program parameters. Changes in the wheat programs were reflected in the effective support and diversion rate calculations. Total planted acres were then estimated as a function of the effective support rate, effective diversion payment, and lagged market price. Just multiplied the support price by the proportion of program participation and then estimated total planted acres as a function of adjusted-support price, an expected-returns measure based on past prices and yields, a risk measure based on past prices and yields, and the wheat allotment. Bailey and Womack constructed simple effective support price and diversion payment variables, but estimated total planted acres as a function of a weighted average of the support and lagged regional market prices. Bailey and Womack also included regional price risk variables, but did not find statistically significant effects for risk. Morzuch, Weaver, and Helmberger split the data into two parts: years that quotalike programs were in effect and years of more voluntary programs. Then they estimated separate acreage responses to futures market prices. Burt and Worthington used a series of dummy variables to reflect changes in policy, then estimated total planted acres as a function of current and lagged market prices plus deficiency or certificate payments.

Previous studies have shown that wheat acreage responses vary by region, primarily due to different classes of wheat, substitute crops, government program parameters, and production costs in each region. Morzuch, Weaver, and Helmberger found the smallest elasticities of acreage response to wheat price in the hard red winter (HRW) wheat states of the central plains, an intermediate response for soft red winter (SRW) wheat acreage in the corn belt states, and the greatest response for hard red spring (HRS) wheat acreage in the northern plains states. Bailey and Womack found that the elasticity of acreage response to expected wheat price was much higher in the southeast and corn belt regions than in the southern plains, northern plains, and Northwest regions. Burt and Worthington found much higher long-run price elasticities for wheat acreage response in most of the northern plains states than in central plains or southern plains states.

Among previous studies, only Just and Bailey and Womack considered the effects of risk on wheat acreage response. Just found negative and statistically significant effects of risk on wheat acreage in two California counties. The coefficient of risk was negative but statistically insignificant in the Bailey and Womack study. However, Just and Bailey and Womack combined acreage planted under government programs and nonprogram-planted acreage. We hypothesize that price risk encourages wheat planting under government programs, but discourages nonprogram wheat planting. The aggregate effect is difficult to predict and may often be insignificant.

The objective of this study is to contrast regional and U.S. wheat acreage responses to expected wheat price, expected price for competing crops, government program parameters, and risk. Following Chembezi and Womack, this study separates program-complying acreage and program-planted acreage from nonprogram-planted acreage. This study departs from Chembezi and Womack by considering the effect of price risk, changing the definition of expected price, and using censored regression models to estimate the complying and

[2] All years in the period 1966–92, except 1973–77, and 1980–81.

program-planted acreage because there was no program participation decision in several years.

An Econometric Model for Acreage Responses

In the presence of a voluntary government program, an expected profit-maximizing crop farmer allocates acres among competing crops and conservation uses by maximizing (Lee and Helmberger; Morzuch, Weaver, and Helmberger)

$$(1) \qquad \Pi = EP_w q_w NPA_w + EP_s'(q_s \# A_s) + WSPq_p PA_w + P_d A_d - c'x - TFC,$$

where Π is expected profit; EP_w is the expected price of wheat; q_w is the expected yield for wheat; NPA_w is nonprogram-planted acres of wheat; EP_s is a vector of expected prices for substitute crops; q_s is a vector of expected yields for substitute crops; A_s is a vector of acres for substitute crops; the symbol # denotes element-by-element multiplication; WSP is the government's wheat support or target price; q_p the government's program yield for wheat; PA_w is program-planted acres of wheat; P_d is the government's payment for diverting acres to conservation uses; A_d is acres diverted to conservation uses; c is a vector of variable input prices; x is a vector of variable input levels; and TFC is total fixed costs. In order to focus on price effects and limit the number of independent variables, the econometric model considers only one substitute crop for each region and ignores the variable input levels. Following Chavas and Holt, risk-averse farmers maximize expected utility. The econometric model assumes that the expected utility function of wheat farmers is a function of both profit, as defined in equation (1), and the variance of market wheat price.

Farmers with acres eligible for the wheat program (henceforth called base acres)[3] have three options: (*a*) participate in the program, (*b*) plant wheat outside the program, or (*c*) plant a substitute crop. Program participation is defined here as agreeing not to plant wheat on the required percentage of base acres in order to qualify for receiving the support or target price for that year. In some years, program participation also allowed farmers to divert additional acres in exchange for diversion payments.

The choice among the three options is determined by their relative expected profit and relative risk. Program compliance (CA_t) is encouraged by a high support or target price (WSP_t) and an attractive, optional paid land-diversion payment (DP_t). Conversely, whenever expected market prices for wheat (EP_t^w) or substitute crops (EP_t^s) are high, program participation will be discouraged. Program participation among risk-averse farmers is encouraged by high uncertainty (R_t) about the expected market price, because the support or target price received by program participants is known at planting time. Furthermore, whenever these parameters favor program participation, the number of complying acres depends on the number of eligible base acres (BA_t). Therefore, the equation for program complying acres is

$$(2) \qquad CA_t = f_C(EP_t^w, EP_t^s, R_t, WSP_t, BA_t, DP_t, e_{1t}).$$

[3] Acres eligible for government programs have been labeled "allotment acres" from 1961–77, "program acres" from 1977–81, and "base acres" from 1982 to the present.

Following the Chembezi and Womack model, wheat acres planted by farmers participating in the government program (PA_t) are essentially fixed by the number of program-complying acres (CA_t) and the required acreage set-aside provisions (ARP_t), unless an optional acreage diversion payment (DP_t) is offered that year. An exception is the wheat program from 1971 to 1973, in which marketing certificates were only paid for wheat produced on a small "domestic allotment" acreage, but participating farmers were able to plant wheat on more than the "domestic allotment" acres. An intercept shift variable ($D7173_t$) accounts for this change in the base acre definition. Participating farmers may fallow more than the required number of acres or may plant nonprogram crops on acres that are not part of the set-aside, but this can reduce their future base acres. A high support or target price (WSP_t) encourages participating farmers to plant all eligible acres to wheat. Therefore, the equation for program-planted acres is

$$(3) \qquad PA_t = f_p(WSP_t, CA_t, ARP_t^*, DP_t, D7173_t, e_{2t}).$$

For farmers who do not participate in the government program, planted wheat acreage (NPA_t) is encouraged by a high expected wheat price (EP_t^w) and discouraged by high expected prices for competing crops (EP_t^s). Risk-averse farmers also will be discouraged from planting wheat by high uncertainty (R_t) about the expected wheat price. Since the number of acres that are well adapted to wheat production is finite, a high number of program-complying acres (CA_t) reduces the number of nonprogram wheat acres. The Conservation Reserve Program (CRP_t), begun in 1986, also has removed many acres from wheat production, thereby reducing nonprogram-planted acres. However, the sudden increase in wheat prices in 1973 encouraged many farmers to cultivate additional cropland acres, which shifted the intercept for nonprogram wheat acres for years after 1973 ($SHIFT_t$):

$$(4) \qquad NPA_t = f_N(EP_t^w, EP_t^s, R_t, CA_t, CRP_t, SHIFT_t, e_{3t}).$$

There were no government program participation decisions in 1974–77 and 1980–81 because there were no allotment or set-aside requirements in those years. The program-complying acres (CA_t) and program-planted acres (PA_t) variables are therefore censored at zero in these six years. Ordinary least squares (OLS) estimates are biased in this case (Tobin). Consistent estimates can be obtained using the tobit model, which is specified as

$$(5) \qquad Y_t = \begin{cases} X_t'\beta + e_t & \text{if } X_t'\beta + e_t > 0, \text{ and} \\ 0 & \text{otherwise,} \end{cases}$$

where Y_t is the dependent variable; X_t' is a vector of explanatory variables; β is a vector of unknown parameters; and e_t is a random error term which is assumed independently, normally distributed with mean zero and variance σ^2. In the tobit model, the expected value of the dependent variable is

$$(6) \qquad E(Y_t) = X_t'\beta\ F(z) + \sigma f(z),$$

where $X_t'\beta / \sigma, f(z)$ is the normal probability density function, and $F(z)$ is the normal cumulative density function.

Data and Procedure

Price and planted-acreage data for 1965–92 were obtained from various issues of *Agricultural Statistics* (USDA). Wheat base acres and program-planted acres data were obtained from James Langley at USDA-ASCS. Regional values for these variables were calculated by weighting state values by their wheat production in each year. The support price was multiplied by one minus the proportion of acres required to be placed in set-aside or acreage reduction in order to qualify for the support price. The support price for 1991 and 1992 was also multiplied by 0.85, the proportion of acres qualifying for deficiency payments under normal flex acreage provisions. All prices are deflated by the Index of Prices Paid by Farmers for Production (USDA).

The expected market prices are assumed to equal a weighted average of the average price received by farmers for the previous three years, where the weights are 0.50 for the previous year (t–1), 0.33 for two years before (t–2), and 0.17 for three years before (t–3).[4] The price risk variable used in the model is the weighted variance of prices received in the previous three years around the expected prices in those years. The weights are the same as for the expected prices: 0.50 for the previous year (t–1), 0.33 for two years before (t–2), and 0.17 for three years before (t–3). The weights and calculation procedure are the same as those used by Chavas and Holt.

Because the complying-acres variable used in the program-planted acre and nonprogram-planted acre equations is endogenous, (3) and (4) were estimated using an instrumental variable for complying acres. The complying-acres estimate determined by (2) was used as the instrumental variable for equation (3) since it meets the criterion of zero correlation between the instrumental variable and the residuals of (3). Zero correlation between the instrumental variable and the residuals of (4) was not obtained by any instrument that included expected market prices. An acceptable instrumental variable for complying acres in (4) was obtained by estimating complying acres as a function of wheat base acres, the wheat support price (set to zero for those years with no participation decision), the optional diversion payment, and lagged complying acres.

Complying acres and program-planted acres were estimated with the tobit model for censored data in the LIMDEP econometrics software package (Greene). Nonprogram acres in the northern plains, central plains, and southern plains were estimated with LIMDEP's generalized least squares (GLS) estimator for seemingly unrelated regressions. The LIMDEP procedure for estimating individual equation autocorrelation coefficients and re-estimating the system of equations was employed. Nonprogram acres in the United States were estimated using the maximum likelihood estimator of Beach and MacKinnon as implemented in LIMDEP (Greene) in order to correct for first-order autocorrelation.

[4]This is the weighting scheme used by Chavas and Holt. Alternative weighting schemes were used to evaluate the sensitivity of the results obtained to the specification of expected prices. The alternative weights used were (1, 0, 0), (0.8, 0.15, 0.05), (0.7, 0.2, 0.1), (0.5, 0.3, 0.2), and (0.33, 0.33, 0.33). The chosen weighting scheme produced higher log-likelihood and R^2 measures for most of the estimates. Signs and statistical significance levels for government program variables were not affected by alternative weights. The statistical significance and elasticities for price and risk variables are sometimes affected by the use of alternative weights.

Because the program-planted acreage and nonprogram-planted acreage equations include a complying-acre variable and complying acres are a function of several prices (1), elasticities of acreage response to prices for these equations include the indirect influences of prices acting through the complying-acreage variable. Dropping the time subscripts, the total elasticities for program-planted acreage responses, including both direct and indirect price effects, are as follows:

(7) $$\xi_{PM} = \left[\frac{\partial PA}{\partial CA} \frac{\partial CA}{\partial P_M} \right] \frac{P_M}{PA}, \text{ and}$$

(8) $$\xi_{PG} = \left[\frac{\partial PA}{\partial P_M} + \frac{\partial PA}{\partial CA} \frac{\partial CA}{\partial P_G} \right] \frac{P_G}{PA},$$

where ξ_{PM} is elasticity of program-planted acreage to market prices or price risk, ξ_{PG} is elasticity of program-planted acreage to the government support price, P_M is market price or price risk, and P_G is the government support price. The total elasticities for nonprogram-planted acreage responses are as follows:

(9) $$\xi_{NM} = \left[\frac{\partial NPA}{\partial P_M} + \frac{\partial NPA}{\partial CA} \frac{\partial CA}{\partial P_M} \right] \frac{P_M}{NPA}, \text{ and}$$

(10) $$\xi_{NG} = \left[\frac{\partial NPA}{\partial CA} \frac{\partial CA}{\partial P_G} \right] \frac{P_G}{NPA},$$

where ξ_{NM} is elasticity of nonprogram-planted acreage to market prices or price risk, and ξ_{NG} is elasticity of nonprogram-planted acreage to the government support price. All elasticities are calculated at the means.

Results and Discussion

The estimated coefficients for wheat program-complying acreage confirm that program participation rises with increases in support prices and falls when wheat market prices rise (table 1). When support prices are high relative to expected market prices, farmers plant wheat under the government program in order to qualify for the support price. Coefficients for the wheat support price are statistically significant at a 1% level for all regions and the United States. Coefficients for the expected market price of wheat are statistically significant at a 1% level for the central and southern plains, but only significant at a 10% level for the northern plains and United States. Price risk increases wheat program compliance in each of the regions and the United States. This suggests that farmers are more inclined to plant wheat under the government program when market prices are highly variable because then

Table 1. Tobit Estimates of Wheat Program-Complying Acreage by Region: 1966–92

Variables	Plains: Northern	Plains: Central	Plains: Southern	United States
Intercept	4525.1	4900.3	5184.8	44101
Pw^e	–4729.8	–6538.4	–3286.0	–14005
	(1.68)	(2.91)	(2.62)	(1.69)
Pb^e	–2584.7			
	(0.63)			
Ps^e		–3867.9	–2925.6	–28555
		(1.35)	(2.02)	(3.00)
RISK	696.8	5782.9	4325.5	13072
	(0.90)	(5.07)	(4.76)	(3.48)
WSP	2452.5	3484.2	1874.5	10914
	(3.34)	(6.08)	(5.03)	(5.18)
BASE	1.0177	1.0687	0.8429	0.7547
	(0.70)	(10.95)	(6.62)	(8.21)
DP	558.70	432.44	656.47	4102.6
	(1.10)	(0.82)	(2.46)	(2.61)
SD of residuals	1347.5	1472.7	797.3	4351.9

[a]The values in parentheses are *t*-statistics.
Notes: Pw^e = expected price of wheat in \$/bu.; Pb^e = expected price of barley; Ps^e = expected price of sorghum; *RISK* = weighted variance around expected prices over previous three years; *BASE* = wheat base acres (1000 acres); *WSP* = support price or target price for wheat, adjusted for acreage reduction programs, acreage set-aside, and normal flex acres provisions; and *DP* = optional land-diversion payment.

they receive a certain support price. The price risk effect is statistically significant at a 1% level for the United States and all regions except the northern plains.

The expected market prices of barley and sorghum have negative, but insignificant, effects on program compliance in the northern or central plains. However, the level of statistical significance of the negative sorghum price effect on program compliance is 5% in the southern plains and 1% in the United States. The differences between the regional price effects suggest that most wheat farmers in the northern and central plains are strongly committed to growing wheat under the government program each year, but that wheat farmers in the southern plains and elsewhere in the United States consider sorghum (or corn, whose price is highly correlated with the sorghum price) to be a good substitute crop.

As expected, program-complying acreage is positively and strongly correlated with wheat base acres. This reflects the high rates of program participation whenever the government programs are in effect and the zero values for both base acres and complying acres whenever there is no acreage set-aside or reduction program. Program-complying acreage is also positively correlated with the magnitude of optional land-diversion payments. The optional land-diversion programs provide an additional incentive to participate in the government program, but this incentive is small (the maximum elasticity of complying acreage response to diversion payments is 0.033).

Table 2. Tobit Estimates of Program-Complying Acreage by Region: 1966–92

Variables	Plains Northern	Plains Central	Plains Southern	United States
Intercept	– 4297.6	–3746.8	–2418.9	–19031
WSP	1297.8	988.23	731.59	6112.9
	(2.37)[a]	(1.90)	(2.16)	(4.13)
CA(1–*ARP*)	1.0073	1.0213	0.9410	0.8188
	(12.11)	(9.19)	(8.71)	(11.62)
DP	–1066.4	–35.29	– 467.52	4599.3
	(1.33)	(0.05)	(0.90)	(2.06)
*D*7173	8024.7	6983.3	3410.9	19675
	(3.99)	(3.37)	(2.62)	(3.53)
SD of residuals	2560.3	2490.0	1638.0	7016.3

[a]The values in parentheses are *t*-statistics.
Notes: *WSP* = support price or target price for wheat, adjusted for acreage reduction programs, acreage set-aside, and normal flex acres provisions; *CA* = complying wheat program acres; *ARP* = proportion of complying acres that must be set-aside under acreage reduction program or set-aside provisions; *DP* = optional land-diversion payment; and *D*7173 = dummy variable, equals one for 1971–73.

Table 3. Estimates of Nonprogram Wheat Acreage by Regions: 1966–92

Variables	Plains Northern	Plains Central	Plains Southern	United States
Intercept	432.0	–1175.0	–1747.8	– 6053.7
Pw^e	3152.8	7391.1	5045.4	38225
	(1.93)[a]	(4.09)	(4.31)	(4.12)
Pb^e	–164.73			
	(0.06)			
Ps^e		–5034.5	–2983.1	–32085
		(1.43)	(1.21)	(1.79)
RISK	–1513.8	–2789.1	–3460.7	–12766
	(3.28)	(4.02)	(4.78)	(4.12)
CA	– 0.7299	– 0.5225	– 0.4241	– 0.5232
	(10.39)	(5.81)	(4.11)	(5.20)
CRP	– 0.3590	–2.0276	–1.0075	–1.2644
	(0.70)	(3.24)	(1.86)	(1.97)
SHIFT	15396	10755	9521.8	40859
	(12.59)	(11.46)	(16.98)	(8.79)
SD of residuals	1983.4	1953.4	1242.3	8128.6
R^2	0.95	0.92	0.92	0.93

[a]The values in parentheses are *t*-statistics.
Notes: Pw^e = expected price of wheat in \$/bu.; Pb^e = expected price of barley; Ps^e = expected price of sorghum; *RISK* = weighted variance around expected prices over previous three years; *CA* = complying wheat program acres; *CRP* = acres enrolled in Conservation Reserve Program (1,000 acres); and *SHIFT* = dummy variable, equals one after 1973.

Program-planted acres have an extremely strong positive correlation with complying acres adjusted for acreage reduction or set-aside requirements (table 2). The expected positive correlation between the wheat support price and program-planted acres is also confirmed. The optional paid land-diversion payment has the expected negative effect on program-planted acreage, but the effect is only statistically significant for the United States.

Price and risk effects are generally opposite for nonprogram-planted acreage than for program-complying acreage. The expected wheat price has the expected positive influence on nonprogram-planted acreage in every region and the United States (table 3). Price risk has a highly significant, negative effect on nonprogram-planted acreage in every region and the United States.

Expected prices for substitute crops have negative effects on nonprogram-planted acreage in all of the regions and the United States, but most of these results are not statistically significant. High levels of positive correlation between expected wheat and substitute price variables may be partly responsible for the weak effects in the regional estimates. Correlation coefficients between the expected prices for substitute crops and wheat range from 0.95 to 0.97.

Wheat program-complying acreage has a highly significant, negative influence on nonprogram acres because acres put into the government program are not available for nonprogram wheat planting. The magnitude of the wheat base acreage effect is highest in the northern plains, where the expected price effect is weakest. The strong positive effect for the intercept shift variable reflects the expansion of wheat acreage in response to large increases in wheat exports and prices in 1972 and 1973. The Conservation Reserve Program has the expected negative effect on nonprogram-planted acres.

The estimated elasticities of program-complying acreage response to wheat support prices range from 0.53 for the northern plains to 0.98 for the central plains (table 4). The estimated elasticity of 0.53 for the northern plains is only slightly higher than the 0.414 elasticity for the northern plains reported by Chembezi and Womack. Elasticities of program-planted acreage responses to wheat support price range from 0.90 in the northern plains to 1.28 in the central plains. The elasticities of nonprogram acreage response to wheat support price range from –0.26 in the southern plains to –0.64 in the northern plains. The northern plains estimate for the program-planted acreage elasticity is substantially higher than the 0.461 reported by Chembezi and Womack. The northern plains estimate for the nonprogram acreage elasticity is much lower than the –1.383 reported by Chembezi and Womack.

The estimated elasticities of program-complying acreage response to expected wheat prices range from –0.95 in the northern plains to –1.59 in the central plains (table 4). Again, the northern plains elasticity is substantially greater than the –0.319 estimated by Chembezi and Womack. Considering both the wheat price effect on complying acreage and the complying acreage effect on program-planted acreage results in elasticities of program-planted acreage response to expected wheat price that range from – 0.88 for the United States and –1.07 for the northern plains to –1.63 for the central plains. Chembezi and Womack's estimate for this elasticity in the northern plains is –0.234. Possible reasons for this large gap in elasticity estimates include: (*a*) Chembezi and Womack's omission of a price risk variable, and (*b*) Chembezi and Womack's use of a one-year lagged price to represent expected price. The risk variables exhibit high correlation with the expected price variables, with correlation coefficients ranging from 0.70 to 0.81. Since the risk variable has statistically significant effects on wheat acreage that are opposite in sign to the expected wheat price effects, analyses that ignore risk tend to understate the expected wheat price effect.

Table 4. Elasticities of Wheat Acreage Response by Regions: 1966–92

Regions	Prices			Risk	Support Price
	Wheat	Barley	Sorghum		
	Program-Complying Acreage Elasticities				
Northern Plains[a]	– 0.952*	– 0.317		0.048	0.527***
Central Plains	–1.595***		– 0.657	0.319***	0.983***
Southern Plains	–1.183***		– 0.770**	0.267***	0.764***
United States	– 0.932**		–1.310***	0.200***	0.808***
	Program-Planted Acreage Elasticities[b]				
Northern Plains	–1.071	– 0.357		0.054	0.904**
Central Plains	–1.629		– 0.671	0.326	1.282*
Southern Plains	–1.289		– 0.770	0.291	1.179**
United States	– 0.889		–1.250	0.191	1.247***
	Nonprogram-Planted Acreage Elasticities[b]				
Northern Plains	2.392*	0.380		– 0.248***	– 0.691
Central Plains	3.818***		– 0.741	– 0.464***	– 0.743
Southern Plains	2.407***		– 0.476	– 0.339***	– 0.337
United States	3.557***		– 0.923*	– 0.352***	– 0.496

[a]The northern plains include North Dakota, South Dakota, Minnesota, and Montana. The central plains include Kansas, Nebraska, Colorado, and Wyoming. The southern plains include Oklahoma and Texas.
[b]Including the indirect effects on complying acreage and the complying acreage effect.
Notes: *** denotes statistical significance of the direct effect at the 1% level, ** denotes statistical significance of the direct effect at the 5% level, and * denotes statistical significance of the direct effect at the 10% level.

The estimated elasticities of direct nonprogram acreage response to expected wheat market prices range from 1.14 in the northern plains to 2.61 in the central plains and 2.98 for the United States. The total elasticities of nonprogram acreage response to expected wheat price suggested by Chembezi and Womack also consider the effects of the expected wheat price on complying acres (negative) and the complying acres' effect on nonprogram acres (negative).These total elasticities of nonprogram acreage response to expected wheat price range from 2.39 for the northern plains to 3.82 for the central plains, and 3.56 for the United States (table 4). The total elasticity of nonprogram acreage response to expected wheat price reported by Chembezi and Womack for the northern plains is a much lower 1.52.

Elasticities of program-complying acreage response, program-planted acreage, and nonprogram acreage response to risk are small in all regions and the United States (table 4). In each of the regions and the United States the program-planted acreage responses to risk and the nonprogram acreage responses to risk have opposite signs. As a result, the elasticity of total planted wheat acreage response to risk[5] is very close to zero in every region. The elasticity of total planted acreage response to risk ranges from –0.062 in the northern plains to 0.003 in the central plains, and is –0.018 for the United States. These estimated elasticities of total planted wheat acreage response to risk are very close to the long-run income risk

[5]Calculated as the weighted average of elasticities for program-planted and nonprogram acres, where the weights equal the ratios of mean program-planted acres and mean nonprogram-planted acres to total acres.

elasticities range of -0.009 to -0.059 reported by Brorsen, Chavas, and Grant for rice acreage and the own-revenue risk elasticities of 0.020 and –0.087 reported by Chavas and Holt for corn and soybean acreage, respectively.

These results, like those of previous studies, indicate that wheat acreage supply responses vary across regions. The elasticities of program-complying and program-planted acreage response to support price are weakest in the northern plains. The elasticities of complying acreage response to the expected wheat price, expected substitute crop price, and price risk also are weaker in the northern plains than in the central or southern plains. The relatively weak response of complying acreage to prices in the northern plains suggests that northern plains wheat farmers are the most dependent on the government programs and the least likely to leave those programs as program parameters or market prices change. The elasticity of nonprogram-planted acreage response to the expected wheat price also is weakest in the northern plains. Together, these results suggest that northern plains wheat farmers have relatively few attractive alternatives to growing wheat. Responses to expected market prices are highest for the central plains and United States, in which there are more attractive substitute crops.

Conclusions

The most significant finding of this study is that expected price and price risk have very different effects on program-complying acreage than on nonprogram-planted acreage. The expected wheat price has a strong negative effect on program-complying acreage and has a strong positive effect on nonprogram-planted acreage. Furthermore, the wheat support price has a positive effect on program-complying and program-planted wheat acreage, but a negative, indirect effect on nonprogram-planted acreage. Price risk increases program-complying acreage but reduces nonprogram-planted acreage. The net effect of price risk on total planted acres is small. However, omitting risk variables from acreage supply response models may bias estimates for the own-expected price effects, because expected price and risk often are positively correlated but have statistically significant and opposite effects on program-complying and nonprogram-planted wheat acreage. The significant price risk effects also suggest that the predictability of support prices may be just as important to wheat farmers as the support price levels.

The determinants of wheat acreage also vary by region. Program-complying and program-planted acreage in the northern plains are less responsive to changes in support price and expected market prices than in other regions. Price risk also has the weakest effects on northern plains program-complying acreage. The response of nonprogram-planted acreage to the expected wheat price also is weakest in the northern plains. These results suggest that wheat producers in the central plains, southern plains, and elsewhere in the United States have better opportunities to substitute other crops for wheat than do producers in the northern plains. Policy analyses must consider these regional differences in order to make reliable predictions of how changes in government program parameters or trade policies will affect wheat acreage.

Previous analyses of wheat acreage responses have obtained a wide range of results partly because they used different schemes for combining market variables with government program variables to estimate total planted acreage. Since expected market prices and government support prices have opposite effects on program-planted acreage, the ways in which expected market prices and government support prices have been combined have largely determined the estimated responses of total acreage to a single price variable. Separating the estimation of program-planted acreage from nonprogram acreage removes some biases introduced by model specification and clarifies the economic relationships. Separating the estimation of program-compliance from the estimation of planted acreage provides additional information about program participation decisions and further clarifies the economic relationships. Future wheat acreage supply analyses should endeavor to refine the specifications of price variables and government program parameters within separate complying-acreage, program-planted acreage, and nonprogram acreage models.

[*Received August 1994; final version received March 1995.*]

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