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THE EFFECTIVENESS OF GOVERNMENT POLICY IN CONTROLLING AGRICULTURAL OUTPUT

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Abstract

H. Alan Love, Gordon C. Rausser, and John Freebairn--The Effectiveness of Government Policy in Controlling Agricultural Output

A new model is presented to assess the effects of changes in agricultural target prices, support prices, diversion payments, and eligibility requirements on farmer's production decisions. The central features of this paper are (1) complete incorporation of the past and current program offerings into the farmer's objective function, (2) the entire period of estimation is over a time in which program compliance was voluntary, (3) consideration is given to the effects of government programs on both acreage and yield responses, and (4) Zellner's seemingly unrelated regression method of estimation was used to estimate the entire system of equations. The estimated elasticities indicate that, while sectoral government programs can be used to reduce acreage, they are relatively ineffective in reducing total output.

Key words: government policy, acreage diversion, participation, target prices and support prices.

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Introduction

The Agricultural Act of 1933 established production controls as the kingpin of U. S. agricultural policy. Prior to the early 1960s, whenever agricultural commodity surpluses arose, the government responded by requiring mandatory acreage reductions or, in some years, by offering incentives to reduce input use--primarily land. However, since 1963, the government has not imposed any kind of mandatory controls on production and, instead, has relied solely on voluntary programs.

During the past 20 years, the particular provisions contained in farm programs for restricting production have changed from farm act to farm act. However, even with the large number of programs that have been enacted, the basic features of each program have remained amazingly similar (Love, Rausser, and Freebairn). The principal policy instruments for controlling crop production are (1) support and target price protection and other benefits which are contingent on reducing acreage planted and (2) direct payments made to farmers who reduce their acreage planted of specified crops. The general consensus in the literature is that these voluntary programs have been fairly successful from the standpoint of reducing excess supplies, but they have also been costly to U. S. taxpayers.

The purpose of this paper is to establish a model of farmer response to the various policies that have been offered to farmers since 1961. The theoretical structure is built up from the individual farmer level so that it provides an understanding of the incentive structure that each farmer faces in deciding whether to participate in the programs being offered and how much to produce. Empirical models are developed for the feed grains (corn and grain sorghum), wheat, and soybeans at the national level. Hypothesis tests are constructed to test the statistical significance of the policy and economic variables. Estimated elasticities of supply for changes in prices and policy levels are reported.

The previous work concentrated on predictive models for acreage response alone (Houck and Ryan; Houck et al.; Gardner; Gallagher; Morzuch, Weaver, and Helmberger; Chavas, Pope, and Kao; and Moe, Whittaker, and Oliveira). Most of the models incorporate the policy variables developed in Houck et al. A major flaw in the Houck et al. policy variables is their implicit assumption of a continuous acreage response between the program compliance and noncompliance decisions. This flaw results in the undesirable comparative static characteristic that an increase in the diversion requirement always results in a decrease in acreage planted (Love, Rausser, and Freebairn).

The model presented differs substantially from its predecessors. First, the model includes specific elements of each government program. Second, the entire period of estimation is over a time in which program compliance was voluntary. Third, Zellner's seemingly unrelated regression (SUR) method of estimation was used to estimate the entire system of equations. Fourth, consideration is given to the effect of government programs on both acreage and yield responses in evaluating policy effects on production.

Theoretical and Empirical Model

At planting time, a farmer must decide, given his resource constraints, (1) whether to participate in any government programs that are offered, (2) the number of acres of each crop to plant, and (3) what level of variable inputs to use on each acre of land planted. The decision to participate in government programs imposes additional constraints on the farmer's actions. Thus, in making this set of decisions, a farmer must first determine the optimal input decisions for land and variable inputs for both compliance and noncompliance with government programs, and then he must evaluate which of these options is most profitable.

When a farmer decides not to participate in any program, he is free to plant the crops of his choice. His only constraints are his available land and resources, his production function, and his market price expectations. His choice variables are the acreage of each crop, a_i, and the amount of variable input applied to each acre of each crop, x_i. Expected price is specified as a function of the observed cash market price, the support price, and the anticipated rate of farmer compliance in any government programs that are being offered.

When a farmer decides to participate in a government program offered for any particular crop, this restricts his entire crop choice because of cross-compliance requirements. The decision to comply involves giving up acreage that could otherwise be planted. In return, the farmer receives a guaranteed minimum income (deficiency payments plus support price protection); reduced costs of production; interest rate subsidy; and, for some programs, additional cash payments. If the farmer complies, he is constrained (1) to reduce his acreage by an amount at least equal to the diversion requirement, (2) by his production function, (3) by his market price expectations, and (4) by his available land. His choice variables are (1) the amount of land he plants as long as it is below the maximum allowable; (2) the amount of variable inputs he applies to each acre planted; and (3) in some years, he is also able to divert additional acreage (beyond the amount required for basic program participation) for an additional per acre diversion payment.

Ignoring fixed costs and assuming risk neutrality, a farmer's objective function and the formal derivation of a two-stage maximization problem, i.e., the discrete choice of participation, nonparticipation, and continuous choices of acreage planted and input utilization is presented in Love, Rausser, and Freebairn. The informal presentation that follows comes from that derivation.

Consider, first, a farmer who makes the decision not to participate in any program. In this case the acreage allocation will depend on the marginal profitability of each competing crop. For example, with no program participation, the acreage equation for feed grains (corn and grain sorghum) could be written as:

$$A_i = \beta_{0i} + \beta_{1i}\left[\frac{(p_{fg}\,y_{fg} - c_{fg})}{LR}\right] + \beta_{2i}\left[\frac{(p_w\,y_w - c_w)}{LR}\right] + \beta_{3i}\left[\frac{(p_s\,y_s - c_s)}{LR}\right] + \mu_i \qquad (1)$$

where i is feed grains (fg), wheat (w), and soybeans (s); p_i is expected price of crop i; y_i is expected yield of crop i; c_i is variable per acre cost of producing crop i; LR is land rental; and μ_i is an error term for each crop i.

The noncompliance acreage decision for a crop is then based on the net per acre profitability for each crop deflated by the land rental rate. Assuming locally constant returns to scale, average cost and marginal cost will be identical. Thus, the farmer's optimal decision in equation (1) implies the allocation of acreage among crops so that the marginal revenue from each crop is equal to the marginal cost of producing each crop. The net profit is calculated using variable costs since cost of production data that include returns to management and land are of questionable quality and difficult to interpret. Net profits are deflated by the land rental rate to reflect the notion that the decision to plant is an investment decision and what is important to the farmer is the return on investment.

Now consider the farmer who decides to participate in government programs. The farmer made the decision to participate in the program in order to guarantee a minimum level of income, one provided by the program. To obtain this guarantee, however, the farmer must restrict his planted acreage to the base acreage less the amount he must divert to nonproductive use. In addition, once he is in compliance with the basic program, the farmer may choose to divert even more land from production by participating in the additional voluntary program.

The acreage equation for the farmer complying with the program is:

$$BA_i\ (1 - DR_i) - (d_i^m)\ (BA_i)$$

$$\doteq \alpha_{1i} + \alpha_{2i}\left(\frac{\{(1 - DR_{fg})\ [p_{fg}^t\ y_{fg}^p + p_{fg}^s(y_{fg} - y_{fg}^p)}{LR}\right.$$

$$(2) \qquad \left.\frac{+ (r - r_{ccc})\ p_{fg}^s\ y_{fg} - c_{fg}] + p_{fg}^d\ DR_{fg}\}}{LR}\right)$$

$$+ \alpha_{3i}\left(\frac{\{(1 - DR_w)\ [p_w^t\ y_w^p + p_w^s\ (y_w - y_w^p) + (r - r_{ccc})\ p_w^s\ y_w - c_w]}{LR}\right.$$

$$\left.\frac{+ p_w^d\ DR_w\}}{LR}\right) + \alpha_{4i}\ \frac{p_i^{vd}}{LR} + e_i \qquad i = fg, w, s$$

where BA_i is base acreage for crop i, DR_i is diversion requirement for crop i, y_i^p is per acre program yield for crop i, p_i^t is target price for crop i,

p_i^{vd} is per acre additional voluntary diversion payment, p_i^d is per acre diversion payment, d_i^m is maximum allowable additional voluntary paid diversion, p_i^s is support price for crop i, and e_i is error term for crop i. Soybeans are not included in equation (2) since no acreage programs are offered by the government.

An acreage response equation is obtain by restricting $\beta_{1i} = \alpha_{2i} = \gamma_{2i}$, $\beta_{2i} = \alpha_{3i} = \gamma_{3i}$, $\beta_{3i} = \gamma_{ri}$, and $\alpha_{4i} = \gamma_{5i}$, subtracting equation (2) from equation (1) and recognizing that farmers can only make partial adjustments to their desired acreage in any time period so that the hypothesized functional form for the aggregate acreage equations is:

$$
\begin{aligned}
A_{i,t} = {} & \phi\, \gamma_{0i} + \phi\gamma_{1i}\, [(1 - DR_i)\, BA_i - d_i^m\, BA_i] \\
& + \phi\, \gamma_{2i} \left[\left(\frac{p_{fg}\, y_{fg} - c_{fg} - \{(1 - DR_{fg})\, [p_{fg}^t\, y_{fg}^p + p_{fg}^s(y_{fg} - y_{fg}^p)}{LR}\right.\right. \\
& \qquad \left.\left. \frac{+ (r - r_{ccc})\, p_{fg}^s\, y_{fg} - c_{fg}] + p_g^d\, DR_{fg}\}}{LR}\right)\right] \\
(3) \qquad & + \phi\, \gamma_{3i} \left[\left(\frac{p_w\, y_w - c_w - \{(1 - DR_w)\, [p_w^t\, y_w^p + p_w^s\, (y_w - y_w^p)}{LR}\right.\right. \\
& \qquad \left.\left. \frac{+ (r - r_{ccc})\, p_w^s\, y_w - c_w] + p_w^d\, DR_w\}}{LR}\right)\right] \\
& + \phi\, \gamma_{4i} \left[\frac{(p_s\, y_s - c_s)}{LR}\right] + \phi\, \gamma_{5i} \left(\frac{p_i^{vd}}{LR}\right) + (1 - \phi)\, A_{i,t-1} + \phi\, v_{it}.
\end{aligned}
$$

The empirical yield equation must include variables for (1) expected net profits from not complying with any program, (2) the minimum net profit from participating in the program, and (3) the acreage diversion requirement. The hypothesized functional form for the aggregate yield response equation is:

$$Y_i = \omega_{0i} + \omega_{1i} T + \omega_{2i} (p_i y_i - c_i) + \omega_{3i} \{(1 - DR_i) [p_i^t y_i^p + p_i^s (y_i - y_i^p) + (r - r_{ccc}) p_i^s y_i - c_i] + p_i^d DR_i\} + \omega_{4i} DR_i + e_i \qquad i = fg, w, s \tag{4}$$

where T is time trend variable representing technology, ω_{3s} is 0 (since there are no soybean acreage programs) and e_i is random error term.

The model now consists of six equations: three acreage equations and three yield response equations. These six equations represent subcomponents of the same decision that farmers must make at planting time. Therefore, there may be a correlation between the random error terms (v_i, e_j), (v_i, v_j), (e_i, e_j) in the different equations. This contemporaneous error reflects common omitted factors such as weather, the state of the general economy, and the export outlook for agricultural commodities. Given the presence of contemporaneous covariance, it is possible to gain efficiency by considering all six equations in a joint SUR model. The results for the SUR partial adjustment model, estimated from equations (3) and (4), are presented in table 1. All of the coefficients have the expected signs. Furthermore, the t ratios generally indicate that most coefficients are statistically significant.

Conclusions, Implications, and Areas for Additional Research

The two-step maximization process developed for the individual farmer provides a good perspective for analyzing the various farm programs offered to grain producers. Moreover, the model that is adopted from this analysis remedies many of the problems that appear in the Houck, et al. specification. The estimated empirical model maintains enough structure so that analysis can be

Table 1. Empirical Estimated Acreage and Yield Equations

Dependent variable	AS	AW	AFG
Intercept	- 13.000* (3.650)	31.164* (3.795)	42.426* (2.924)
FGI	- .023892* (2.165)	- .044698* (1.746)	.05275* (2.266)
S1	.066068* (4.049)	- .051973* (1.733)	- .036931 (1.346)
W1	- .049812* (2.746)	.16773* (4.751)	- .042466 (.954)
AFGL			.34731* (3.801)
ASL	.39358* (3.236)		
AWL		.49857* (5.005)	
AFGPA			.27212* (2.576)
AWPA		.20569* (4.452)	
T	1.6658* (6.124)		
DVDFG			- .05473* (2.357)
DVDW		- .069296* (2.599)	
D h	- 1.1375	1.737	1.8216
RHO	- .1992	.3274	.3509
R-2	.9830	.9194	.8321

	YLDS	YLDW	YLDFG
Intercept	16.213* (13.308	15.953* (16.652)	15.458* (3.458)
T	.32235* (5.705)	.44744* (5.927)	1.6900* (6.787)
NPFGN			.094974* (2.437)
NPFGP			.14094* (2.975)
DRFG	9.6021* 2.913)		48.240* (3.868)
NPWN		.0010523 (.063)	
NPWP		.0057948 (.184)	
DRW		3.8190* (2.391)	
NPSN	.031291* (3.115)		
D7480	- 3.8841* (6.041)		- 15.630* (6.109)
DW	2.4682	1.4774	1.9397
RHO	- .3231	.2365	.0205
R-2	.8698	.8522	.9342

(Continued on next page.)

Table 1--continued.

*Significant at the 5 percent level in a single-tailed t test.

AS = acres of soybeans planted.

AW = acres of wheat planted.

AFG = acres of feed grains planted.

YLDS = yield of soybeans per planted acre.

YLDFG = yield of feed grains per planted acre.

AFGL = acreage of feed grains lagged one year.

ASL = acreage of soybeans lagged one year.

AWL = acreage of wheat lagged one year.

T = time trend representing technology.

D7480 = dummy variable: 1 for 1974 and 1980, 0 elsewhere.

DRFG = DR_{fg}, diversion requirement for program compliance for feed grains.

DRW = DR_w, diversion requirement for program compliance for wheat.

AFGPA = $(1 - DR_{fg})\, BA_{fg} - d^m_{fg}\, BA_{fg}$.

AWPA = $(1 - DR_w)\, BA_w - d^m_w\, BA_w$.

FG1 = (NPFGN - NPFGP)/LR.

S1 = NPSN/LR.

W1 = (NPWN - NPWP)/LR.

DVDFG = p^{vd}_{fg}/LR.

DVDW = p^{vd}_w/LR.

NPFGN = $p_{fg}\, y_{fg} - c_{fg}$.

NPFGP = $(1 - DR_{fg})\, [p^t_{fg}\, y^p_{fg} + p^s_{fg}\, (y_{fg} - y^p_{fg}) + (r - r_{ccc})\, p^s_{fg}\, y_{fg} - c_{fg}] + p^d_{fg}\, DR_{fg}$.

NPWN = $p_w\, y_w - c_w$.

NPWP = $(1 - DR_w)\, [p^t_w\, y^p_w + p^s_w\, (y_w - y^p_w) + (r - r_{ccc})\, p^s_w\, y_w - c_w] + p^d_w\, DR_w$.

NPSN = $p_s\, y_s - c_s$.

conducted to determine the aggregate response to various changes in market and government parameters.

Various short-run response elasticities from the model are presented in table 2. The elasticities indicate that, while government programs can be used to reduce acreage, they are relatively ineffective--and even less effective in reducing total output. For example, the calculated elasticity of wheat acreage response with respect to the minimum diversion requirement for wheat is -.01, while the corresponding elasticity for feed grain production is -.04. This indicates that, as a group, farmers are not very willing to forego planting their land without some additional incentive. At the group level, an increase in the diversion requirement, all else constant, forces those farmers out of the program who were just willing to comply with the program before the increase (because they were at the break-even point between compliance and noncompliance with the program). These farmers probably will increase their acreage planted once they are out of the program. Only those farmers who were most willing to be in the program, in the first place, remain in the program by diverting additional land. In all probability, this latter group has the most variance in land quality, making their noncomplaince profits lower than their compliance profits. Thus, as the government raises the diversion requirement, all else constant, it forces the lowest quality land out of production while leaving the total acreage planted nearly unchanged.

The estimated coefficients for diversion requirements in the yield equations indicate that, as the diversion requirement is increased, yields also rise. The estimated elasticities of the aggregate yield response with respect to a change in the diversion requirement are .03 for wheat, .08 for the feed grains, and .05 for soybeans. The diversion requirement for feed grain is

Table 2. Estimated Short-Run Elasticities[a]

Variable	Wheat			Feed grains			Soybeans		
	Acreage	Yield	Total	Acreage	Yield	Total	Acreage	Yield	Total
FPC	-.14		-.14	.12	.17	.30	-.10		-.10
FPW	.28	.00	.29	-.05		-.05	-.11		-.11
FPS	-.15		-.15	-.07		-.07	.25	.13	.38
TPC	.10		.10	-.08	.18	.11	.07		.07
TPW	-.21	.02	-.19	.04		.04	.08		.08
DRFG				-.04	.08	.05	.00	.05	.05
DRW	-.01	.03	.02						
VDPC				-.01		-.01			
VDFG				-.02		-.02			
VDPW	-.02		-.02						
VDW	-.01		-.00						

[a]Calculated at mean values.

included in the soybean yield equation since many farmers produce both corn and soybeans. When they decide to divert low-quality land from production, this increases the expected yields for both the feed grains and soybeans. Once again, a good explanation of these positive elasticities is that increases in the diversion requirement push the lowest quality land out of production, thus raising the national average yield per acre.

The elasticities reported in table 2 for the target price indicate that the government must offer very large prices (deficiency payments) to farmers to induce them to reduce acreage just a little. The calculated elasticity of acreage response with respect to the target price is -.21 for wheat and -.08 for feed grains. Both are very inelastic. Furthermore, even though the higher target price may not induce individual farmers to increase variable input use, since they only get deficiency payments on the government-determined yield, it does result in an increase in the aggregate yield response by allowing farmers to take their lowest quality land out of production. Thus, the total supply response may go in a direction opposite to that desired by the government. This is, indeed, the case for feed grains. The estimated elasticity of the supply of feed grains with respect to the target price for feed grains is .11, indicating that the yield effect overwhelms the acreage effect for changes in the target price. It must be kept in mind, however, that these elasticities are calculated at mean values; in general, this adverse supply response need not be true.

Most of the effects in the model appear to be the result of redistributing planted acreages from one farm to another in such a way that the lowest quality land goes out of production. One way to explore this hypothesis would be to work with the theoretical model developed for the individual farmer and with data on individual farms. The data should be separated into two regions--one for compliance and one for noncompliance--to estimate the model. A third equation could be estimated using the probit or logit framework to get an equation for the compliance, noncompliance decision.

References

Chavas, J. P., R. D. Pope, and R. S. Kao. "An Analysis of the Role of Futures Prices, Cash Prices and Government Programs in Acreage Response." Western J. Agr. Econ. 9(1983):27-33.

Gallagher, P. "The Effectiveness of Price Support Policy--Some Evidence for U. S. Corn Acreage Response." Dep. Agr. and Applied Econ. Staff Paper P78-5, University of Minnesota, 1978.

Gardner, B. L. "Futures Prices in Supply Analysis." Amer. J. Agr. Econ. 58(1976):81-84.

Houck, J. P., and M. E. Ryan. "Supply Analysis for Corn in the United States: The Impact of Changing Government Programs." Dep. Agr. and Applied Econ. Staff Paper P72-4, University of Minnesota, 1972.

Houck, J. P., M. E. Abel, M. E. Ryan, P. W. Gallagher, R. G. Hoffman, and J. B. Penn. "Analyzing the Impact of Government Programs on Crop Acreage." U. S. Economic Research Service, Tech. Bul. 1548. Washington, D. C., 1976.

Judge, G. G., R. C. Hill, W. E. Griffiths, H. Lutkepohl, and T. C Lee. Introduction to the Theory and Practice of Econometrics. New York: John Wiley and Sons., 1982.

Moe, D. K., J. K. Whittaker, and R. A. Oliveira. "The Constancy of the U. S. Wheat Acreage Supply Elasticity." Agricultural Experiment Station, Special Report 546, Oregon State University, 1979.

Morzuck, B. J., R. D. Weaver, and P. G. Helmberger. "Wheat Acreage Supply Response under Changing Farm Programs." Amer. J. Agr. Econ. 62(1980): 29-37.

Love, H. Alan, Gordon C. Rausser, and John Freebairn. "Agricultural Output and Effectiveness of Government Policy," University of California, Dep. Agr. Res. Econ., Working Paper No. 294, Berkeley, 1984.