The FAPRI U.S. Crops Model: Review and Suggestions

John R. Kruse and Chad E. Hart

Working Paper 94-WP 124
October 1994

Center for Agricultural and Rural Development
Iowa State University
Ames, Iowa USA

John R. Kruse is U.S. crops and livestock analyst, FAPRI; and Chad E. Hart is a CARD graduate research assistant.

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This paper provides a critical overview of the most striking problems in the 1994 version of the U.S. crops model. No model is ever perfect; however, as agricultural policies change and more data become available, the model can be improved. As we enter the 1995 Farm Bill debate, it becomes increasingly important to enhance the model structure to allow accurate analysis of the Farm Bill proposals. This review does not discuss every problem in the U.S. crops model, but does point out three areas that need to be improved for Farm Bill analysis. A critical review of a problem is not useful unless a possible solution can be presented. In addition to pointing out problems in the model, this paper suggests possible solutions.

0/50/92-85 Issues

Two problems with the current U.S. crops models stem from changes in U.S. policy. The first is the mechanism for handling 0/50/92-85 programs. Because this farm program was established in 1986 and changed with the 1990 Farm Bill, it has been difficult to obtain enough detailed data to do a good job in estimating this program. The basic problem in the existing model is that 0/50/92-85 is handled like a paid diversion program where all the enrolled acres are considered idle. In fact, 0/50/92-85 is a program alternative to the traditional program. It has its own participation rate, its own planted acres, and its own idled acres. The combination of base acres participating in the 0/50/92-85 program and base acres participating in the normal program represent the total participating acres and participation rate currently estimated in the model. The difficulty in the past has been getting data on the number of base acres participating in the 0/50/92-85 program, but now data are available.

Since their inception in 1986, the 0/50/92-85 programs have become a major part of U.S. farm policy. Various changes of the basic program during the past eight years, along with the growing importance of these programs, have increased new interest in the effects of the 0/92 and 50/92 programs upon U.S. agriculture. Gary Adams's paper, "Estimating Acreage Enrolled in the 0/92 and 50/92 Programs," begins the process of analyzing these programs by estimating the percentage of eligible acres enrolled in the 0/92 and 50/92 programs.

The strengths of the analysis are the use of the cross-sectional, time-series data set; the employment of a properly restrictive functional form; the use of expected returns as an explanatory variable; the inclusion of the elasticity table; and the preparation for the questions about minor oilseeds, 0/50/85, and different estimation techniques more suited to handling the estimation. The cross-sectional, time-series data set allows for the estimation of regional differences in the adoption of 0/50/92, while also yielding added degrees of freedom for the estimation. The imposed functional form restricts the estimation of the dependent variable to be between zero and one; since the dependent variable, the percentage of eligible acres enrolled, is bounded by these numbers. Economics is incorporated into the model by using expected returns as an explanatory variable; net returns on the land should drive the farmer's decision to participate or not. This might be expanded to capture the minor oilseed provision, depending on data availability. The elasticity table indicates the responsiveness of 0/50/92 participation to changes in expected net returns. Questions about the most recent changes in the 0/92 and 50/92 programs, such as the shift to the 0/85 and 50/85 programs, are brought out for discussion in a timely manner. Analysis of these changes will provide needed information for the upcoming Farm Bill debate.

As with any preliminary analysis, there are a few weak areas in Adams's paper. The weaknesses, however, lie in very important areas. First, the description of the 0/92 and 50/92 programs are inaccurate (this may be a data issue). When farms are enrolled in 0/92 or 50/92, the entire farm is enrolled, not just the acres left after flex and ARP. Flex and ARP requirements are still enforced on the farm. Thus, figures reported in the final compliance reports for flex acres and ARP acres include acres in the 0/92 or 50/92 programs. The descriptions of the payment eligible acres and the guaranteed deficiency payment in Adams's paper are accurate. Also, under the 0/92 and 50/92 programs, farmers are allowed to plant the program crop on up to 92 percent of eligible planting acreage. Farmers may plant as little as zero percent of the land under 0/92 and 50 percent of the land under 50/92. Thus, these programs give farmers the ability to choose the amount they wish to plant within certain guidelines without necessarily jeopardizing program returns. The 0/50/92-85 program represents, if you will, a separate program alternative to the regular program and should be treated as such.

Second, it appears that the data set does not have the correct acreage figures for enrollment in the 0/50/92 program. Presumably, the data originated from the final compliance reports. The data reported there are the number of acres idled under the 0/50/92 program that is not accounted for by ARP, flex, and PLD. Acres enrolled in 0/50/92 are captured in several of the categories listed in the final compliance reports. 0/50/92 acres are included in program planted acres, ARP acres, and flex acres. Thus, if the analysis is based on only the 0/50/92 acres explicitly reported in the final compliance reports, then many of the actual enrolled acres are left uncounted. Data on the total number of acres enrolled in 0/50/92 are available from the USDA-ASCS report PA-113R, a yearly listing of complying farms. The report also lists payment acres, planted acres, and minor oilseed acres for the 0/50/92 program. From this data, it can be seen that some of the 0/92 acres are indeed planted to their program crop. Finally, there is no justification given for the indicator and shift variables used in the analysis (SED86, D861, OTD86, NPD8788, OTD87, NPD89, SH891, OTD8688, OTD92, CBD8687, NPD8688, OTD8687, D89901, FWD90, FWSH91, and DSD91). Some explanation (drought, flood, etc.) for the use of the variables would give observers a better understanding of the model.

An Alternative Way to Estimate 0/50/92-85 Program Parameters

The 0/50/92-85 program can be viewed as an alternative to the regular commodity program. If this is done, participation in government programs must be split between participation in the regular program and participation in the 0/50/92-85 program. Two participation rates can be derived. The participation rate for the 0/50/92-85 program would equal the ratio of 0/50/92-85 enrolled acres and base acres. The participation rate for the regular program would equal the ratio of total complying base acres less 0/50/92-85 enrolled acres and base acres. The sum of the two participation rates will equal the participation rate for all federal commodity programs.

0/50/92-85 participation should be a function of several variables. These include the projected deficiency payment, the farmer's costs of production for both the program crop and allowed minor oilseeds (due to the program change), the ARP rate, the diversion rate, the normal flex rate, and a shift term for years before 1988 when wheat and feed grains had a 50/92 program. Some of these explanatory variables can be combined into expected net returns variables. In essence, the decision to participate in the 0/50/92-85 program depends upon the difference in expected net returns between the regular program and the 0/50/92-85 program. The functional form used to model the participation rate should restrict the rate to lie between zero and one.

Once a farmer has decided to participate in the 0/50/92-85 program, he then must determine how he will allocate the acres on which he has a choice (i.e., the acres remaining after ARP, diversion, required planted, and conservation usage are taken out). Since flex also applies under the 0/50/92-85 program and this land is being modeled elsewhere, this proposed modeling structure assumes that flex acres are also removed from consideration. Thus, we seek to model only those acres solely affected by the 0/50/92-85 program upon which the farmer has control of how the land is used. The farmer has three choices: he can idle the land, plant the program crop, or plant specified minor oilseeds. We model the idled and program planted acres, leaving the minor oilseed acres as the residual.

The choice among these three options depends upon most of the same variables as are listed for the decision to participate in the 0/50/92-85 program. The farmer's decision depends upon the comparison of the expected net returns of the program crop, the expected net returns of the minor oilseeds, and the opportunity cost of leaving the land idle. If the variables are handled in percentage terms (i.e., the percentage of noncommited land that is idled) with the same base, the model equations must satisfy the constraints that each percentage must be between zero and one and the sum of the percentages must equal one. (Some version of these restrictions will also apply to the participation rate equations listed above and the flex model proposed below.) One possible specification for this system would be to estimate the percentage of acres planted to the program crop using the logit transformation, then estimating the percentage of acres idled under a modified logit form. The modified form would be, in percentage terms,

$$\text{PCTLI} = 1 - \text{PCTLPP} - \exp(f\,(\text{exogenous variables}))$$

where PCTLI is the percentage of 0/50/92-85 noncommited acres idled, PCTLPP is the percentage of 0/50/92-85 noncommited acres planted to the program crop, and f is a linear function of the exogenous variables. This form restricts the percentage of acres idled to be between zero and one minus the percentage of acres planted to the program crop.

Another form that would accomplish the same objective would be to create PCTLI as:

$$\text{PCTLI} = \text{LI} \,/\, (\text{TL-LPP})$$

where LI is the number of 0/50/92-85 noncommited acres idled, TL is the total number of 0/50/92-85 noncommited acres, and LPP is the number of 0/50/92-85 noncommited acres planted to the program crop. Then the traditional logit transformation can be used for both equations since the percentage base is adjusted to insure the model will not produce results implying more acres were allocated than were available. Either specification upholds the restrictions presented above.

Flex Issues

The second problem with the model is the way in which flex is incorporated. The model does not specifically account for the movement of flex acres among program crops and idled flex and the movement to soybeans is generated by synthetic equations with elasticities reflecting nonprogram equations. Actual estimation of flex acres suggests that flex acreage may be two to three times as responsive as nonprogram acreage. For example, in the Iowa model (a state level agricultural model developed at Iowa State University), the elasticity of corn acres flexed to soybeans with respect to market net returns for corn was -0.625 compared with an elasticity of 0.19 of corn nonprogram acres with respect to corn market net returns in the U.S. model. (Note that the sign differences are to be expected since corn flex to soybeans is estimated as a positive quantity; it is the magnitude that is important here.) In addition, in the Iowa model the elasticity of corn acres flexed to soybeans with respect to market net returns for soybeans was 0.625 compared with an elasticity of -0.13 of corn nonprogram acres with respect to soybean market net returns in the U.S. model. Further complicating the problem is that when flex is eliminated from the model, nearly 5 million acres of soybeans are lost. If "free market" scenarios are run for the 1995 Farm Bill, this will continually present a significant problem.

The estimation of flex acreage use should be a very important part of analyzing U.S. farm policy. As Adams and Willott point out in their report, "Preliminary NFA Idled Estimations," crop movements in flex acres may provide some intuition on acreage shifts in a free market scenario, and flex provisions could play a greater role in upcoming farm bills. To improve upon the synthetic equations for net flex acreage for each program crop used in the FAPRI model, they have begun the process of estimating the uses of flex acreage, starting with normal flex acres that are idled.

The specification employed for this analysis is that the percentage of normal flex acreage idled for a given program crop is a linear function of the crop's ARP rate and various indicator (dummy) variables for regions or for years. The data set is a pooled cross-sectional, time-series data set, which yields more degrees of freedom for the estimation. No mention is made about the estimation technique used, but presumably ordinary least squares is performed.

Strengths of the analysis to date are that the authors are beginning to address an important topic in U.S. farm policy that has been virtually ignored, the possibility has been raised that expanded flex may not behave the same as flex now in place, the use of the pooled cross-sectional, time-series data set, and the implementation of the ARP rate as an explanatory variable in normal flex idled. Thus, the right questions about flex are beginning to be asked and the needed data are being found.

However, several weaknesses appear in the work done so far. First, the justification for the pooled data set could have been presented in a more appealing manner, such as stating that the pooled data set will allow for the investigation of regional differences in the use of flex acreage. A beneficial side effect just happens to be the added degrees of freedom.

Second, where is the economics in the model specification? The economic force that drives a farmer to idle land in a free market is that net returns from any crop on that land (given capital constraints, i.e. machinery) are below what the farmer requires. The given specification does not address this force very well. The inclusion of the ARP rate does capture some of this since the most marginal land will be set-aside under ARP, but a measure of possible net returns is needed to fully capture this effect.

Third, in this specification, the percentage of normal flex idled is just a linear transformation of the ARP rate. Thus, given the ARP rate, the percentage of normal flex idled is equal to A+B*(ARP rate), a constant. Farmers do not determine the amount of normal flex idled in this specification; the government does. Fourth, the employed functional form does not restrict the dependent variable, the percentage of normal flex acres idled, to be between zero and one as it should be. And finally, there is no justification given for various year indicator variables (OTD94, CROTD92, SPD94, and DSD94) or what reasoning was behind these variables: drought, flood, or some other regional effect.

An Approach to Estimating the Dynamics of Flex

The single most limiting factor in estimating the response of flex acres to economic incentives is the number of available observations. The flex program was formalized with the Food, Agriculture, Conservation, and Trade Act of 1990 with the first normal flex occurring in 1991. A type of optional flex program was available in 1989 and 1990 where acres could be flexed from base crops into soybeans. Participation in this program during 1989 and 1990 depended primarily on the expected deficiency payments foregone by flexing to soybeans. Further increasing the confusion in flex data is the ability of farmers to change their flex intentions throughout the crop year until their final compliance report is made. For example, in 1991, farmers increased the flex from corn to soybeans during the planting season when wet weather delayed corn planting and reduced corn expected yields. Based on this phenomenon, the argument can be made that preliminary flex intentions reflect economic conditions prior to planting while final compliance data reflect the manner in which economic conditions change over the planting season. To a large extent, yield expectations influence the manner in which economic conditions change and subsequently flex decisions change. It should not be too heroic of an assumption that a farmer's reactions to the same set of economic conditions at any time in the planting season are the same. By utilizing both preliminary and final compliance data, the number of observations increase from three to seven.

Flex data are a bit complicated. First of all, flex can be divided into normal and optional flex. Note that not all of the eligible flex acres actually flex to a different crop. Subsequently, eligible normal flex can be divided into flex into the base crop, flex into soybeans, flex to minor oilseeds, flex to other program crops, and flex idled. Eligible optional flex could be divided up the same way with the exception that idled optional flex does not make sense. The principle problem with these divisions is that the data is not reported in this manner. Instead, the amount of acres in each of these categories is reported for the sum of normal and optional flex. However, since optional flex represents only a small proportion of total flex, a simplifying assumption is to treat total flex as normal flex. Once this assumption is made, the next data difficulty is determining how acreage "flexes" among program crops. Data is reported on total flex out to program crops and total flex in to a program crop but not specifically on flex from one program crop to another. Interestingly though, a pretty good idea of the shifting patterns in flex can be obtained by matching flex out with flex in keeping in mind where the major crop tradeoffs occur. Once the flexing among program crops is determined, the flex data set is well defined.

Flex response is expected to vary regionally because of different biological conditions unique to each region. For example, soybeans may represent a competitive flex alternative in Iowa while cotton may be the preferred flex alternative in Arkansas due to relative yields. This suggests that flex should be estimated regionally. This also helps in the degrees of freedom problem as using a pooled data set will yield additional degrees of freedom. To maximize degrees of freedom state level data could be used concentrating on the major producing states.

Because errors across crops and across states are likely to be correlated, the equations could be estimated using generalized least squares or seemingly unrelated regressions. In addition, by viewing flex as total eligible flex, each division of flex could be estimated as a share. Further, the share could be restricted to lie between zero and one using a logit or exponential form. The basic functional form would be:

$$\text{JJFPIISS} = f\{\text{IIRNTSS/JJRNTSS, JJFENSS, EXOG}\}$$

where $0 \leq \text{f} \leq 1, f_1 > 0, f_2 > 0$, and the variables are defined as:

JJFPIISS: proportion of total flex from crop JJ to crop II for region SS,

IIRNTSS: expected net returns for crop II in region SS,

JJRNTSS: expected net returns for crop JJ in region SS,

JJFENSS: eligible total flex for crop JJ in region SS, and

EXOG: other exogenous variables.

This functional form has these desirable characteristics:

1. flex responds to economic conditions,
2. flex is meticulously managed,
3. regional differences in flex responsiveness are incorporated, and
4. greater insight into the dynamics of flex is provided.

The biggest drawback of this specification is that it still provides only limited information about flex responsiveness if flex rates are increased. It could be that analytical results would not be robust to significant changes in flex rates because estimated coefficients may not accurately represent behavior when productivity changes at the margin. It is difficult to address this problem with no variation in historical flex levels.

Soybean Sector Issues

In doing policy analysis over the past year, problems with the soybean sector have continually appeared. While the problem has not been identified precisely, it seems that for large policy changes that affect soybean prices, soybean acreage does not respond as much as it should and the soybean-to-corn price continually has to be brought back in line by add-factoring soybean planted acreage. Compounding the problem is lack of responsiveness in the soybean meal and soybean oil sectors.

Approaches to the Soybean Sector

As has been discussed, some of the problems in the soybean acreage response may be solved by handling flex better. But another possibility may be the further division of soybean acreage into acres planted on complying farms, acres flexed into soybeans, and soybeans planted on noncomplying farms. (Unfortunately, the data on soybeans planted on complying farms are rather sketchy, but further research into this area may clear up this problem.) This specification has worked quite well for the state of Iowa. In the Iowa model the three parts are estimated as outlined here.

Soybeans Planted on Complying Farms

SBAPCIA = .5385 * COATBIA * COGPRIA

Mnemonics Defined As:

COATBIA = Corn Total Base Acres, Iowa

COGPRIA = Corn Participation Rate, Iowa

Soybeans Planted on Noncomplying Farms

$$
\begin{aligned}
\text{SBANPIA} = \; & \underset{(12.43)}{7763.48} - \underset{(-19.60)}{.939} * (\text{SBAPCIA} + \text{COAFSIA}) \\
& + \underset{(1.51)}{552.82} * \text{SBRMNIA/PDIGNPW} - \underset{(-2.59)}{664.50} * \text{CORNMIA/PDIGNPW} \\
& - \underset{-(7.38)}{2335.52} * \text{DUM7173} + \underset{(3.28)}{1728.48} * \text{DUM73} - \underset{(-1.48)}{683.71} * \text{DUM77}
\end{aligned}
$$

$R^2 = .985$ D.W. = 1.566

Elasticities:

elasticity with respect to market net returns for soybeans: 0.247

elasticity with respect to market net returns for corn: -0.232

Estimation Period: 1970 - 1992

Mnemonics Defined As:

SBAPCIA = Soybean acreage planted on complying farms, Iowa

COAFSIA = Corn acreage flexed to soybeans, Iowa

SBRMNIA = Soybean market net returns, Iowa

CORMNIA = Corn market net returns, Iowa

PDIGNPW = GNP deflator, U.S.

DUM7173 = Indicator variable for program differences in 1971 - 1973

DUM73 = Indicator variable for program differences

DUM77 = Indicator variable for program differences

Corn Flexed to Soybeans

$$
\text{COAFSIA} = 175.35 + \underset{(4.67)}{270.06} * \text{SBRMNIA/CORMNIA}
$$

$R^2 = .88$

Elasticities:

elasticity with respect to corn price:	-1.254
elasticity with respect to soybean price:	0.883
elasticity with respect to corn market net returns :	-0.625
elasticity with respect to soybean market net returns:	0.625

Mnemonics defined as:

SBRMNIA = Soybean market net returns, Iowa

CORMNIA = Corn market net returns, Iowa

For the demand side of the soybean model, it may help to add competing products into specifications, particularly in the case of oils. This would involve the development of minor oilseed models such as sunflowers, rapeseed/canola, flaxseed, and possibly others. This would also improve linkages with the international sector.

Concluding Remarks

One of the objectives of FAPRI is to model U.S. agriculture through an intricate modeling system. Changes in federal farm policies necessitate the review of previous work and the adaptation of the modeling structure to incorporate these policy changes. This paper reviews three weaknesses in the FAPRI U.S. crops model. These are the modeling of the 0/50/92-85 programs, flex acreage use, and the soybean sector. Accurate, in-depth analysis of these areas will be needed for the upcoming 1995 Farm Bill debate. Suggestions have been put forth for the improvement of these areas in the current modeling structure.

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