Risk Considerations in Supply Response: Implications for Counter-Cyclical Payments' Production Impact

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Abstract

This study investigates the role of risk in farmers' acreage decisions in the Northcentral region by revisiting an earlier study by Chavas and Holt and tests the null hypothesis regarding the effects of wealth and draw out implications for farmers' risk attitudes. Estimated model results are used to examine counter-cyclical payments' production impact for major field crops.

Keywords: Risk, supply response, marketing loan programs, counter-cyclical payments, Northcentral region, corn, soybeans, wheat

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The 2002 Farm Act offers producers income support and revenue risk reduction through counter-cyclical payments (CCPs). CCPs are made available to producers of covered commodities whenever the effective price─the sum of the direct payment rate and the national average farm price or loan rate (whichever is higher)─is less than the target price.[1] CCPs received by producers do not depend on *current* commodity production, but on *historical* base acreage and payment yields. However, the risk-reducing effect of CCPs would be related to farmers' enterprise selection because the payment rates vary with commodities' market prices. Hence, farmers' acreage decisions could have bearing on the extent to which revenue risks are reduced for the farm household and CCPs may have an effect on farmers' production decisions. But by how much?

The potential for CCPs to cause production and trade distortions due to wealth and revenue risk reduction effects has been noted in the ongoing agricultural trade policy debate. A seminal study by Chavas and Holt (*AJAE*, 1990) has been cited as the primary evidence of production and trade distortions caused by decoupled payments (such as direct payments) and partially decoupled payments (such as CCPs). The Chavas-Holt study shows that in the context of acreage decisions under risk, wealth and revenue risks are important variables that are statistically significant in affecting U.S. corn and soybean acreage decisions. However, that study is outdated because data used in the empirical model extend only through the mid-1980's. Yet, the policy environment

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[1] For a back-to-back comparison of the 2002 Farm Act with the previous farm legislation, title by title, the reader is referred to Young and Westcott.

has evolved–away from supply controls toward planting flexibility in recent years. More importantly, studies to date are inconclusive. In subsequent research in the mid-1990's, Holt himself found "no compelling evidence of risk effect on farmers' supply response" for corn and soybeans in the North Central region (M. Holt, "A Linear Approximate Acreage Allocation Model," NCSU working paper partially supported by ERS Cooperative Agreement no. 43-3AEK-7-80091, 2000).

In this paper we investigate the role of risk in U.S. farmers' acreage decisions by revisiting the Chavas-Holt study. We also examine whether CCPs, as a risk-reducing policy instrument, have an impact on these decisions. Specific objectives are to: 1) estimate an empirical model of supply response under risk for the Northcentral region, 2) test the null hypothesis regarding the effects of wealth and revenue risks on farmers' supply response and draw out implications for farmers' risk attitudes, and 3) use the empirical model to determine whether and under what market conditions CCPs have an impact on farmers' acreage decisions for major field crops in the Northcentral.

The theoretical framework developed by Chavas and Holt serves as the basis for developing an empirical model of supply response under risk in this study. Aggregate supply response is estimated for major program crops (corn, soybeans, and wheat) in the Northcentral region, including Ohio, Indiana, Illinois, Missouri, Iowa, Minnesota, Wisconsin, and Michigan. Truncated variances and covariances of per-unit output prices are estimated to reflect price support offered to producers through marketing loan programs. The effects of risk and initial wealth on supply response for major field crops are also investigated.

The estimated empirical model is then used to determine whether and under what market conditions CCPs have an impact on plantings of corn, soybeans, and wheat in the region. First, given a market price scenario, moments of commodity price distributions are compared with and without CCPs. In the absence of CCPs, price truncation effects are limited to commodity loan programs. With CCPs, the payments add another truncation to commodity price distributions, in addition to the truncation provided by the loan program. CCPs' potential truncation effects are estimated by recognizing that CCPs are based on base acreage and payment yields, not current production. Second, the effects on moments of the price distributions that are attributed to CCPs, together with price and risk elasticities estimated from this study, are then used to estimate CCPs' production impacts.

Previous Related Studies

Since the mid-1970s, a number of studies have addressed the role of risk in farmers' production decisions. Many of these studies measured risk in terms of variance, standard or absolute deviation of commodity prices or net returns. A central question remains: Does risk matter in farmers' acreage decisions? This section briefly reviews previous related studies, particularly focusing on aggregate supply response analyses for major field crops and recent studies that address the effects of income support programs on farmers' acreage decisions.

In a study of farmers' supply response for California major field crops (including wheat, grain sorghum, barley, cotton, and rice) in the mid-1970s, Just developed an adaptive expectation geometric lag model for analyzing farmers' acreage decisions and measured risk in terms of subjective variances of gross returns. He found risk to be important in farmers' acreage decisions for most of these field crops, especially those that were less strictly regulated (such as feed grains) than cotton and rice by government stabilization programs and wheat.

However, the adaptive expectation geometric lag model presumes a restrictive lagged response pattern arising from the use of a constant coefficient of expectation. To provide flexibility in the lagged response pattern, Lin developed a polynomial lag risk response model which was used to estimate farmers' acreage decisions for Kansas wheat. Risk of per-acre returns was found to be statistically significant—a 1-percent decrease in the moving average standard deviation of gross returns would lead to an increase of 0.06 percent in wheat planted acreage.

Traill uses a polynomial lag to measure onion acreage response at the national level. He utilizes an iterative procedure to first estimate the distributed lag effects of the past price variables, then formulates the risk observations by quantifying the absolute deviations of the actual and expected prices. Expected risk is then specified as a distributed lag function of past observations of risk. He found that a simple two-year moving average standard deviation of past actual prices performs at least as well as the iterative procedure.

In 1990, Chavas and Holt developed an acreage supply response model for U.S. corn and soybeans under expected utility maximization. The model maximizes expected utility for a farm household subject to a budget constraint. They found the household's acreage decision is a function of expected net returns for the own and competing crops, second and (possibly) higher moments of the distribution of the net returns, and farm household wealth. Untruncated expected prices were assumed to follow an adaptive expectation scheme. Symmetry restrictions across the corn and soybean equations were imposed in estimating the coefficients of the expected net returns for the competing crop. Unless risk neutrality is assumed, homogeneity restrictions, which are often imposed in estimating the deterministic supply response model, do not apply in the Chavas-Holt risk response model. Chavas and Holt used farm value of proprietor's equity as the proxy for initial wealth, an explanatory variable, and gave particular attention to the truncation effects of commodity loan programs on the distribution of commodity prices. Truncated mean, variance, and covariance values were used to compute key explanatory variables in the acreage equations--expected net returns, variance and covariance of commodity prices.

Risk and wealth variables were found to play an important role in households' corn and soybean acreage decisions, based on annual time-series data during 1954-85 for U.S. corn and soybeans. Risk is measured in terms of the variance and covariance of commodity prices, where the variance is a weighted sum of the squared deviations of past prices from their expected values, with declining weights. Variances and covariances of commodity prices were found to be statistically significant in most cases, although acreage elasticity with respect to the variance of own prices were small─ -0.087 for soybeans and not statistically significant for corn. Elasticities with respect to initial wealth were also relatively small (0.087 for corn and 0.270 for soybeans) but statistically significant, consistent with decreasing absolute risk aversion (DARA) (Just and Pope; Sandmo).

In 1998, Hennessy developed a theoretical model to show the production effects of income support programs, coupled and decoupled, in input and output markets that are characterized by uncertainty. His study decomposes the production impacts of income support programs under uncertainty into wealth, insurance, and coupling effects. Under the assumption of DARA, the wealth and insurance effects of many income support programs increase optimal input levels even for decoupled programs.

Hennessy showed that an increase in income support increases optimal input levels under three conditions: 1) support-augmented income must increase with the source of uncertainty, 2) risk in the stochastic variable depresses the optimal input levels for the risk-averse producers so that a risk-reducing policy can mitigate the negative effect of risk on optimal input levels, and 3) the impact of a marginal increase in support must be decreasing in the stochastic variable, ensuring that the support policy actually acts to mitigate risk. For decoupled programs which tend to increase expected profit as well as to reduce the risk, DARA is sufficient to ensure an increase in the optimal input level as the magnitude of support increases. In other words, decoupled income support programs may in fact affect production decisions and output. Hennessy simulated the model for a 400-acre Midwestern continuous corn farm and found that the removal of a decoupled target price program for corn would reduce nitrogen use by 7-10 percent and production by 1.3-2.5 percent. The optimal input level would be slightly larger under a coupled program.

In 2004, Goodwin and Mishra provided an empirical evaluation of the acreage effects of U.S. farm program benefits, particularly the Production Flexibility Contract (PFC) and market loss assistance payments. Their study results suggest that PFC payments could have an effect on producers' production decisions because as wealth (due to fixed farm payments) increases, those with DARA risk preferences will be willing to assume more risk (Hennessy).

Goodwin and Mishra developed an empirical model of aggregate supply response for corn, soybeans, and wheat in the Corn Belt using county-level data during 1998-2001. The expected harvest-time farm price is calculated from new crop futures prices adjusted by basis at the state level. The estimated results suggest positive supply elasticities for soybeans and wheat, but the corn acreage response to own price is not statistically significant. Contrary to expectations, the expected soybean farm price is shown to be positively associated with corn acreage. PFC payments are shown to be positively related to soybean acreage (with an elasticity of 0.018) and statistically significant, even though soybeans were excluded from base acres. However, the payments are not statistically significant for corn and wheat acreage decisions. Market loss assistance (MLA) payments are shown to be positively related to corn and soybean acreage decisions, but not wheat, again, even though soybeans did not qualify for MLA payments. The farm financial risk variable, measured as the ten-year coefficient of variation on net farm income for the county, is not statistically significant in any of the three equations.

The Acreage Response Model

The acreage response model employed in this study is an extension of earlier studies, particularly that of Chavas and Holt. The empirical model employs state-level data during 1991-2001, an update from the 1954-85 dataset used in the Chavas and Holt study.

Theoretical Considerations

The theoretical framework of Chavas and Holt is adopted in this study primarily because it bridges a wide gap between the economic theory of risk behavior and aggregate supply response. The conceptual framework assumes that the farm operator household is the decision unit, which maximizes expected utility subject to a budget constraint. Consumption expenditures are limited to expected net returns from farm operations and exogenous income generated either from off-farm income or non-farm investment. Assuming a monotonically increasing utility function for the farm household, the optimization problem implies that acreage decisions are a function of the expected net returns for the own and competing commodities, second and (possibly) higher moments of the distribution of net returns for these crops, and initial wealth (including off-farm sources). Symmetry restrictions apply to cross-net return coefficients for the competing crops across the acreage equations (Barten and Vanloot).

The Empirical Model

The empirical model in this study utilizes State-level data to estimate supply responses for corn, soybeans, and wheat in the Northcentral region. Farmers' acreage decisions are estimated by pooling time-series (1991-2001) with cross-section (individual States in the region) data.
The time-series data cut across both 1990 and 1996 farm legislations, but, to a large degree, reflect the market orientation of policies throughout the entire period. Under the 1990 farm legislation, government payments were largely irrelevant for the cropping choices for program participants once the decision to participate in the program was made (Lin *et al.*). In addition, the 15-percent normal flex acreage appeared to be adequate for most farmers to respond to changing market price signals (Evans). A shift toward market signals and planting flexibility characterized the 1991-95 period, even before the introduction of full planting flexibility under

the 1996 Farm Act. The pooling provides 88 observations, sufficient to overcome the degree-of-freedom problem.

The empirical model treats all acreage response equations as a system of acreage allocation decisions under a risk environment, similar to the equations estimated by Chavas and Holt. The model, with acreage share (S_i) of the major field crops in each state as the dependent variable, has the following structure:

$$S_1 = a_{11} + b_{1i} \sum_{i=1}^{3} NRT_i + c_{1i} \sum_{i=1}^{3} VAR_i + d_{1i} \sum_{i \neq j,1}^{3} COV_{ij} + e_1 W_1 + f_1 Z_1 + \mu_1$$

$$S_2 = a_{21} + b_{2i} \sum_{i=1}^{3} NRT_i + c_{2i} \sum_{i=1}^{3} VAR_i + d_{2i} \sum_{i \neq j,1}^{3} COV_{ij} + e_2 W_2 + f_2 Z_2 + \mu_2$$

$$S_3 = a_{31} + b_{3i} \sum_{i=1}^{3} NRT_i + c_{3i} \sum_{i=1}^{3} VAR_i + d_{3i} \sum_{i \neq j,1}^{3} COV_{ij} + e_3 W_3 + f_3 Z_3 + \mu_3$$

where S_1 = the share of combined (corn, soybeans and wheat) acreage planted to corn (%),

S_2 = the share of combined acreage planted to soybeans (%),

S_3 = the share of combined acreage planted to wheat (%),

NRT_i = expected net returns ($/ac) for ith commodity (i=1, corn; i=2, soybeans; i=3, wheat)

VAR_i = variance of commodity prices ($/bu) for ith commodity

COV_{ij} = covariance of cross-commodity prices ($/bu) between ith and jth commodities for $i \neq j$

W_i = farm operator household net worth (in billion dollars) for ith farms

Z_i = other explanatory variables (e.g., idled acreage under the acreage reduction program (ARP) of the 1990 farm legislation) for ith acreage equation with i=1, corn; i=2, soybeans; and i=3, wheat

The use of acreage shares explicitly recognizes that as the share of the combined cropland planted to one commodity (say corn) increases, that expanded corn acreage has to come from cropland planted to major competing crops, such as soybeans or wheat (that is, the sum of the acreage shares equals one in the model specification).[2] Constraining the sum of acreage shares equals one, however, does not necessarily imply that cropland is fixed.

(Untruncated) expected net returns equal the expected farm price times the trend yield, minus a covariance term between crop yields and farm prices and variable costs of production for the Northcentral region. In this context, both crop yield and farm price are considered as two random variables, which are often negatively correlated. Instead of relying on the adaptive expectation scheme which is built from lagged farm prices, the empirical model in this study is forward looking in that farmers base expectations on futures prices.[3] The expected price is the new-crop, harvesttime futures price, observed in the month when planting decisions are made. In the cases of corn and soybeans, the expected prices are derived from the December corn futures price and the November soybean futures price at the Chicago Board of Trade in mid-March. In the case of winter wheat, the expected price is derived from the July new soft red winter (SRW) wheat futures price at the Chicago Board of Trade in mid-October, previous year. For spring wheat in Minnesota, the expected price is the September futures price at the Minneapolis Grain Exchange in mid-May, current year.[4] Expected prices are further adjusted by a State-specific, 5-year average basis (the difference between futures prices and cash prices

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[2] Over time, total cropland is largely fixed. For example, cropland planted to the three major field crops ranged from 22.05 million acres to 22.65 eight out of the 11 years (1991-2001) in Illinois.
[3] An interesting alternative is to use USDA's projected marketing year average farm prices as reported in *World Agricultural Supply and Demand Estimates*
[4] This applies to spring wheat planting decisions in Minnesota, the only spring wheat producing state in the Northcentral. However, the expected price in mid March is used in corn and soybean equations, instead.

received by farmers in the month right before the delivery month of the futures) to allow for price differentials across States, and to arrive at the farm-price equivalents. The trend yields are estimated for each year of the period 1991-2001 and for each State using data for 1975-90 initially, but augmented by additional annual yield data as they successively became available to producers. This estimation allows producers to fully utilize past yield data prior to any growing season during the study period to form their expected yields.

The expected variance of (untruncated) farm prices is a weighted sum of the squared deviations of past farm prices from their expected values, with a weighting scheme of 0.5 for t-1, 0.3 for t-2, and 0.2 for t-3. This weighting scheme is consistent with the lagged response pattern in the Kansas wheat acreage response study by Lin and the corn and soybean study by Chavas and Holt.

Instead of using the farm value of proprietor equity as a proxy for initial wealth, this study uses "farm operator household net worth" (FOHNW), as reported by USDA's Agricultural Resource Management Survey (ARMS), to measure the household's initial wealth. FOHNW is a more accurate measure of initial wealth because it consists of net worth from both farm and nonfarm sources. In 1995, off-farm financial assets accounted for 18 percent of total farm household assets, up from 14 percent in 1990 (Mishra and Morehart). Similarly, nonfarm net worth in 1999 accounted for 31 percent in 1999, up from 15 percent in 1993, due primarily to the stock market's strong performance. This percentage declined to around 20 percent in recent years.

In addition to the planting flexibility provision, the 1990 farm legislation continued the acreage reduction program (ARP) for program crops, such as corn and wheat. For example, during the first part of this study period, corn programs required that ARPs be set aside by participants as specific percents of their corn base acreage from production: 7.5 percent in 1991, 5.0 percent in 1992, 10.0 percent in 1993, and 0 percent for 1994-95. In the case of wheat, the ARP was 15 percent and 5 percent of wheat base acreage in 1991 and 1992, respectively. No ARP was required for wheat programs during 1993-95. The 1996 farm legislation discontinued annual ARPs for corn and wheat programs.

Finally, a time trend variable is included in the wheat acreage equation to capture the systematic effects of any omitted variables on acreage decisions over time. During the 1990s, wheat planted acreage in the Northcentral region had been trending down, just as had occurred in other regions. The long-term declining share of U.S. wheat in the world market simply reflected stiff foreign competition that U.S. wheat encountered in the marketplace. Expansion of wheat exports from the Black Sea area, such as Russia and Ukraine, has had a systematic negative effect on U.S. wheat planted acreage needed to meet export market demands. Also, conservation reserve program (CRP) has removed wheat cropland from production—about one-fourth of CRP acres in the USDA baseline are cropland that has historically been planted to wheat.

Truncation of Commodity Loan Programs

Commodity loan programs provided producers with price support at the loan rate levels during the study period 1991-2001. Under marketing loan programs, producers received marketing loan gains or loan deficiency payments (LDPs) when farm prices fell below the loan rates. Farmers sold their program commodities at market prices, but received marketing loan gains or LDPs which were the differences between the loan rates and posted county prices. Hence, the commodity loan program truncated (from below) the producer's subjective price distribution at the loan rate. Mean values of truncated commodity price distributions were used to calculate the expected net returns, an explanatory variable in the acreage equations. Similarly, variances and covariances of the truncated price distributions were used to measure risk facing producers' acreage decisions.

The truncated distribution of commodity prices is the part of the distribution above the loan rate. A normal distribution for truncated commodity prices is assumed in this study because it is in this context that the effects of multivariate truncation on price distributions are best understood (Johnson and Kotz, Maddala, Chavas and Holt, Greene). Based on the first and second moments of the truncated normal distribution developed in Greene (chapter 20), truncated mean, variance, and covariance of commodity prices are estimated. Since the truncation is from below, the expected price of the truncated price distribution is greater than the original (untruncated) one. Also, truncation reduces the variance of the price distribution.

To illustrate, figures 1 and 2 show the effects of loan rates on the mean and variance of commodity price distributions for 2001 corn and soybeans in Illinois. In the case of corn, the $1.89/bu loan rate in 2001 truncated the corn farm price distribution in Illinois from below, and the loan rate was located to the left of the mean of untruncated price distribution, where the random variable (price) is expressed in terms of the normalized value. The mean value of the

Figure 1. The effects of loan program truncation on corn farm price distribution in Illinois, 2001

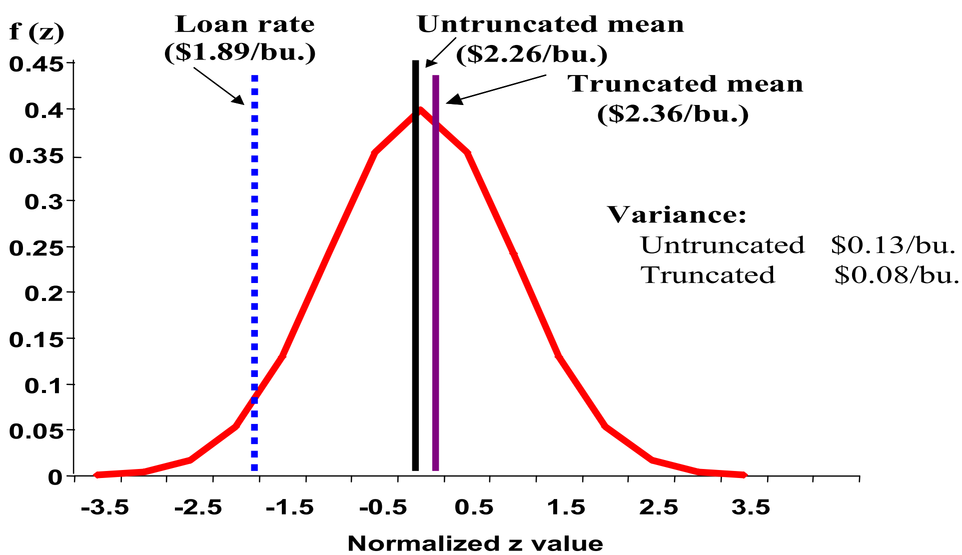
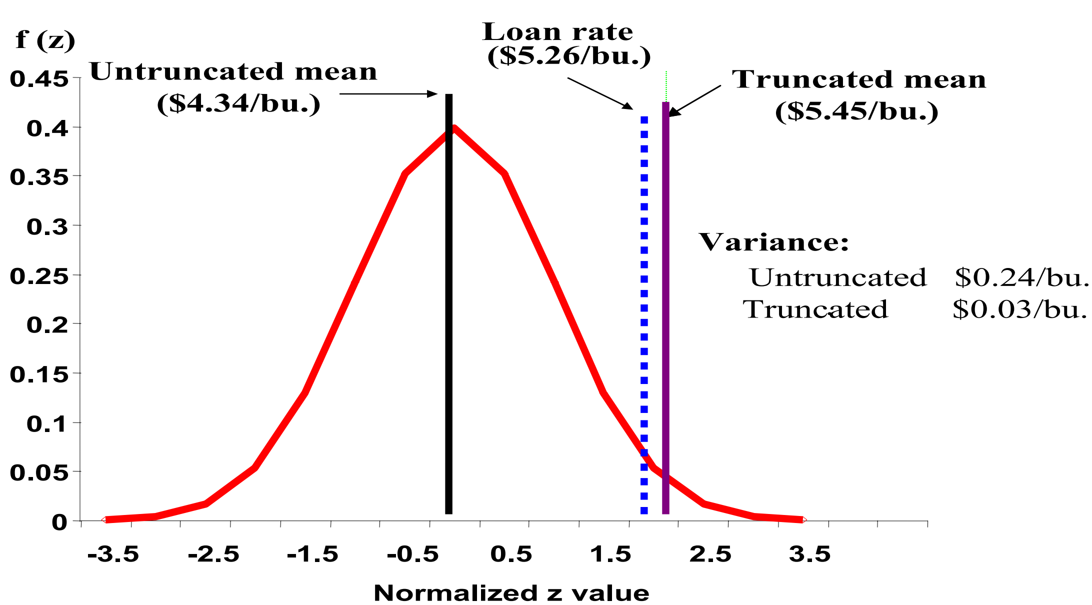


Figure 2. The effects of loan program truncation on soybean farm price distribution in Illinois, 2001



truncated price distribution is estimated at \$2.36/bu, up \$0.10/bu from the untruncated one. Variance of the truncated price distribution is estimated at \$0.08/bu, down from \$0.13/bu.

The effects of the loan program on the mean and variance of 2001 soybean price distribution in Illinois are more dramatic than the case of corn. The loan rate truncated the soybean price distribution from below at the loan rate of \$5.26/bu, but the loan rate was higher than the mean of the untruncated price distribution. The truncation increased the mean value of the soybean price distribution from \$4.34/bu under the untruncated one to \$5.45/bu. Variance of the distribution declined dramatically from \$0.24/bu to \$0.03/bu, approaching the "risk-free farming" scenario portrayed by Babcock and Hart. Clearly, the marketing loan provided a strong safety net (in terms of price protection) for Illinois soybean producers in 2001.

Truncation of price distributions by commodity loan programs had more noticeable effects on the mean and variance of the commodity price distributions towards the last part of the study period—1999, 2000, and 2001 (fig. 3 & 4). Prior to 1999, untruncated expected commodity prices were substantially above the loan rates, keeping the effect of loan programs on moments of the price distribution at a minimum. However, since 1999, untruncated expected farm prices were either slightly above the loan rates or actually below the loan rates, making the effects on moments of the price distributions more pronounced.

Figure 3. Variance of corn farm price distribution in Illinois, 1991-2001

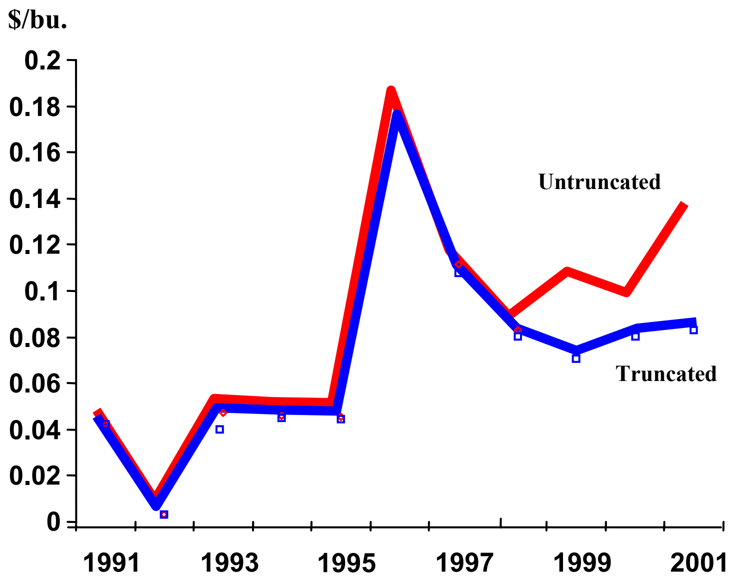
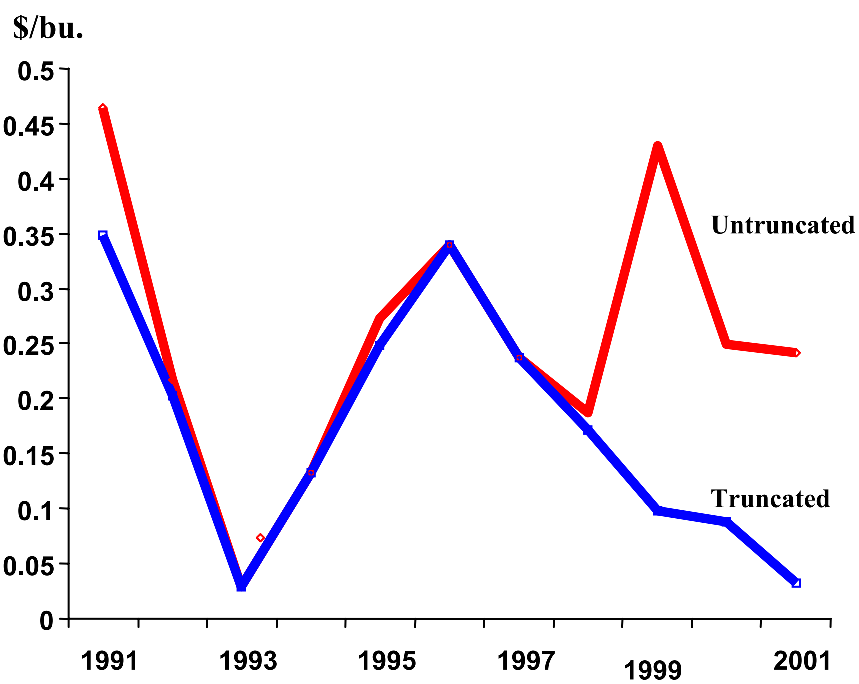


Figure 4. Variance of soybean farm price distribution in Illinois, 1991-2001



Estimated Results

The acreage response model is estimated using Seemingly Unrelated Regressions (SUR) as a system, which is asymtotically equivalent to maximum likelihood. Symmetry restrictions require that cross-net return regression coefficients across the acreage share equations be equal, that is, $b_{21} = b_{12}$, $b_{31} = b_{13}$, $b_{32} = b_{23}$. These restrictions are usually imposed in commodity acreage equations. In the context of acreage share equations, this same theoretical restriction applies if total cropland (including minor crops) is assumed to be largely fixed over time.

As anticipated, truncated expected net returns for corn and soybeans are highly significant with expected signs for own and cross effects in both corn and soybean acreage share equations. The cross effects reflect a strong competitive relationship between corn and soybean plantings in the Northcentral (table 1). The expected net return for wheat also has the expected sign, but is not significant in wheat acreage share equation. Acreage own-price elasticities obtained from this study are generally comparable with those reported in other studies. Based on the procedures described in Lin *et al*., corn's own-price elasticity in the corn acreage share equation is estimated at 0.331, compared with 0.158 reported by Chavas and Holt and 0.248 by Lin *et al*. for the Northcentral region. Similarly, soybeans' own-price acreage elasticity is estimated at 0.253 in this study, compared with 0.441 reported by Chavas and Holt and 0.298 by Lin *et al*. for the Northcentral.

Results in this study suggest that the effects of risk on supply response for major crops in the Northcentral region are not strong. Of all estimated coefficients of variance and covariance variables, only the variance of soybean prices in soybean acreage equation and the covariance

Table 1—Estimated regression coefficients in corn, soybean, and wheat acreage share equations in the Northcentral region, 1991-2001

Item	Acreage share planted to—		
	Corn	Soybeans	Wheat
Intercept	79.239 (2.746)***	19.003 (1.543)***	572.840 (85.297)***
NRT_1	0.072 (0.024)***	-0.064 (0.020)***	-0.001 (0.008)
NRT_2	- 0.064 (0.020)***	0.060 (0.019)***	0.0003 (0.007)
NRT_3	- 0.001 (0.008)	0.0003 (0.007)	0.010 (0.006)
VAR_1	3.411 (21.851)	-11.917 (18.272)	--
VAR_2	6.134 (4.460)	- 8.701 (3.759)**	--
VAR_3	--	--	-2.437 (2.148)
COV_{12}	-26.772 (28.957)	32.087 (24.101)	--
COV_{13}	--	--	13.841 (7.133)*
COV_{23}	--	--	-3.345 (3.577)
Wealth	-0.191 (0.108)*	0.397 (0.062)***	1.546 (0.242)***
Idled	-0.196 (0.602)	--	7.804 (1.094)***
Trend	--	--	-0.287 (0.043)***

[a]Figures in parentheses below the parameter estimates are standard errors. A single, double, or triple asterisk denotes significantly different from zero at 10%, 5%, or 1% significance level.

between corn and wheat prices in wheat acreage equation are statistically significant.[5] Soybeans' own-variance risk elasticity in soybean acreage equation is estimated at -0.044 in this study, compared with -0.087 reported by Chavas and Holt and -0.06 reported by Lin for Kansas wheat acreage response. As noted by Just and Pope, this limited risk response observed from the empirical analysis may not be attributed entirely to farmers' risk aversion. Physical constraints for allocable inputs, financial asymmetries and costs of adjustments caused by imperfect capital markets and consequences of bankruptcy, and possible nonlinear risks due to intertemporal decisionmaking in the adoption of technology could all contribute to the risk response. It is conceivable that the limited risk response found in this study may reflect changes in the structural characteristics of the U.S. farm sector in recent decades—larger, commercial farms increasingly accounted for the bulk of the production of U.S. grains and oilseeds. These larger, commercial farms place more focus on net wealth accumulation in the long-run and less in avoiding production and market risks in the short-run.

All coefficients of the initial wealth variable are statistically significant in the acreage share equations. Overall, an increase in initial wealth would lead to an expanded acreage of all major field crops combined, which implies that farmers in the Northcental region exhibit decreasing absolute risk aversion (DARA). In other words, as farmers become wealthier, their risk aversion is lessened (that is, they are willing to assume more risk). For all the major field crops (corn, soybeans, and wheat) combined, initial wealth elasticity is estimated at 0.03 (0.139 for soybeans,

[5] The relatively more drastic risk-reducing effects from soybean marketing loans during the latter part of 1991-2001 period were associated with a steady upward trend in soybean share of combined soybean and corn acres in the United States (Lin). Expected variances for corn and wheat were smaller than that for soybeans during 1991-97. These factors might explain why risk is significant only in soybean equation.

0.003 for wheat, and -0.063 for corn).[6] The negative wealth effect for corn, while surprising, may reflect effects of programs during part of the estimation period. Additionally, if soybeans were to expand in the Northcentral region, part of this expansion would come from cropland planted to corn. In comparison, Chavas and Holt reported a wealth elasticity of 0.087 for corn and 0.270 for soybeans.

Annual ARP requirements under the 1990 farm legislation applied to corn and wheat programs during 1991 and 1995. In the case of corn, more idled acres under ARP tended to lower corn acreage, but the coefficient is not significant. In contrast, higher idled acres contributed to greater wheat share in the Northcentral, which probably reflects the negative effect of ARP on corn acreage. Higher idled acres of corn land resulting from a larger level of ARP, such as the 10 percent in 1993, would lower corn planted acreage. Since corn accounted for about one-half of the combined corn-soybean-wheat acreage and wheat typically was less than 5 percent in the Northcentral, a reduction in corn acreage caused by ARP would greatly raise wheat share of the major field crops acreage.

Implications for CCPs' Production Impact

The above estimated acreage response results provide a basis for analyzing the effects of CCPs on acreage planted to major field crops in the Northcentral. Results show that the variance of own-commodity prices has a negative (and statistically significant) effect on soybean acreage, but is insignificant in affecting either corn or wheat acreage decisions. Hence, CCPs' production

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[6] Strictly speaking, Sandmo's argument that a positive wealth effect in supply response implies DARA applies to a single commodity case (Sandmo). In this context, the overall wealth elasticity of 0.03 for combined corn, soybeans and wheat acreage decisions is consistent with the DARA assumption commonly assumed in the literature (e.g., Arrow).

impact through the program's risk-reducing effect is largely limited to soybeans, although has an indirect effect on corn acreage as well. Additionally, if CCPs increase farm household's income and wealth and affect the household's initial wealth position in subsequent years, then the payments could have positive effects on soybean and wheat shares, partly at the expense of corn.

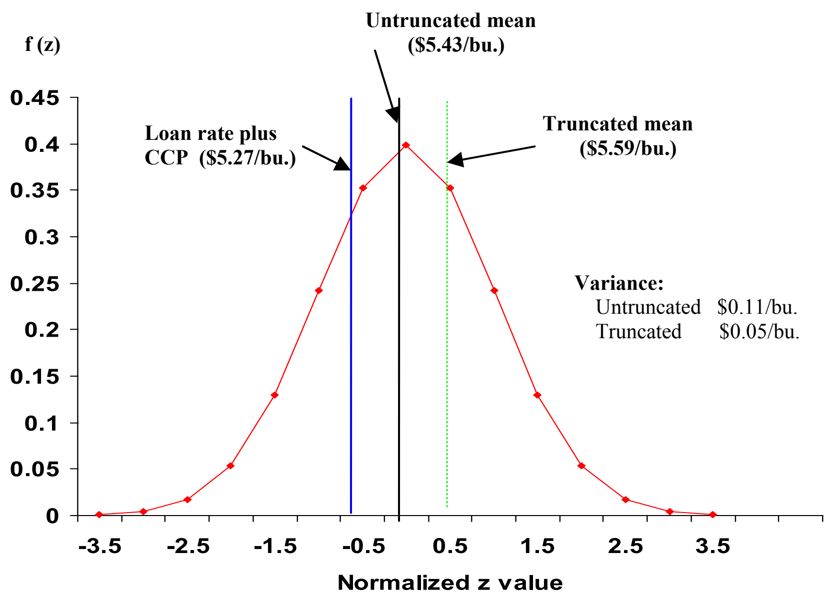
Farmers receive no CCPs if the national average farm price is equal to or exceeds the effective CCP threshold price—target price minus direct decoupled payment rate. Under the 2002 farm legislation, this threshold price for soybeans is $5.36/bu, or $5.80 (target price) minus $0.44 (direct payment rate). In an *ex post* sense, CCPs would appear to have little or no production impact when soybean farm prices exceed this threshold, as in recent years.

However, in an *ex ante* context, CCPs could have potential effects on soybean acreage and indirectly on corn acreage even if prices exceeded the threshold due to the reduction of the variance of soybean prices. Additional effects would result in relatively weak market conditions such as in the 2004/05 and ensuing marketing years, as projected in the USDA baseline (USDA). To illustrate, first, the truncation effects from soybean loan program on soybean price distribution are examined. If farmers were to expect the national soybean farm price at $4.98/bu (based on new crop futures prices in February 2005), which is close to the $5.00/bu loan rate level and about 82 percent of the average during the 2002/03 -2004/05 period, the soybean loan program would truncate the farm price distribution from below at $5.00/bu. Assuming an untruncated standard deviation of $0.55 for soybean farm prices—the average over the 1999 – 2001 period and a normal distribution, the loan program would yield a truncated mean value of soybean farm prices at $5.43/bu and reduce the variance from $0.30/bu to $0.11/bu. This higher truncated mean and lower truncated variance reflect the truncation effects of the soybean loan program on moments of the truncated price distribution.

Next, CCPs' production impact is examined by comparing how moments of the soybean farm price distribution differ with and without CCPs. In the absence of CCPs, price truncation effects are limited to the soybean loan program. However, with CCPs, truncation of the price distribution includes the effects of both loan program and CCPs. A \$0.36/bu CCP rate would be in effect if farmers' price expectation for soybeans (\$4.98/bu) materialized. However, it is important to note that CCPs are based on historical base acreage, which may differ from actual planted acreage. Specifically, CCPs are made only on 85 percent of base acreage and the payment rate applies to the CCP payment yield, instead of actual yield. Because CCPs are paid on less than full production, the \$0.36/bu payment rate amounts to a lesser amount if apportioned to actual production. For illustration, we assume \$0.27 per production bushel is apportioned to actual production partly based on the estimated soybean acreage share equations and the above-mentioned soybean farm price scenario. Hence, combined loan program and CCPs would truncate soybean price distribution from below at \$5.27/bu. The effect of CCP truncation to the price distribution increases the mean value from \$5.43/bu to \$5.59/bu, and lowers the variance from \$0.11/bu to \$0.05/bu (see figure 5).

Under this soybean price scenario, CCPs would lower the variance of soybean farm prices by 49.9 percent, that is, (0.0538 – 0.1074)/0.1074 = - 49.91%. Given the risk elasticity of -0.044, this reduction of 49.91 percent in soybean price variance would imply an increase of 2.20 percent in soybean acreage. In addition, the truncation caused by the extra \$0.27/bu CCP per

Figure 5. **CCP effects on soybean farm price distribution: untruncated vs. truncated**



bushel apportioned to actual soybean production also increases the mean value of soybean prices by $0.159/bu—a 3-percent increase in soybean's expected farm price. Given the own-price acreage elasticity of 0.253 for the Northcentral region, this 3-percent increase in soybean's expected farm price would increase soybean acreage by 0.74 percent. As a result, CCPs would increase soybean acreage by 2.94 percent (2.20% + 0.74%) in this scenario.

The higher mean and lower variance of soybean farm prices that are attributed to CCPs might have an indirect effect on corn acreage in the region. Because the variance of soybean prices is not statistically significant in corn acreage, as shown in table 1, the lower variance of soybean prices would not trigger an indirect effect on corn acreage. However, given the cross-price elasticity of -0.227 with respect to soybean prices in corn acreage equation obtained from table 1, a 3-percent increase in the expected soybean prices triggered by CCPs would lead to a decrease of 0.68 percent in corn acreage.

Concluding Remarks

Preliminary results from this study suggest that the effects of risk on supply response for major field crops in the Northcentral region are not strong. Large, commercial farms have steadily increased their share of grain and oilseed production in the United States. These commercial farms tend to pay more attention to the accumulation of net worth in the long-run than short-term risk involved in farming. However, risk could still be important for individual farms.

This study reaffirms that an increase in initial wealth would lead to greater acreage of major field crops, consistent with decreasing absolute risk aversion. In the context of DARA, an increase in initial wealth would lessen producers' risk aversion. Hence, the positive wealth effect on soybean share is expected because expected variance of soybean prices was considerably higher than that for corn and wheat during 1991-97. In addition, the expansion of soybean acreage resulting from the wealth increase is consistent with the rising trend in soybean's share of the combined corn and soybean acres during the 1990s. In contrast, corn acreage contracts, as corn and soybeans compete for the same cropland.

CCPs appear to have a modest impact on production of major field crops in the Northcentral region. However, effects of CCPs may go beyond their short-run effects on farmers' acreage decisions; longer term, there may be structural implications to the extent that these payments keep farmers in business. In addition to commodity loan programs, CCPs are another safety net measure that protects farmers from adverse effects of weak market prices. To farmers who are financially distressed, CCPs could provide help necessary for them to remain in farming.

Finally, CCPs would likely exert additional production impacts in an intertemporal framework if they increase farm households' income and wealth accumulation (Burfisher and Hopkins, ed. 2003, 2004). As demonstrated by Chavas and Holt and this study, initial wealth is shown to have an important effect on farmers' acreage decisions. More research is needed to understand risk/wealth effects in farm households, particularly with regard to decoupled payments and CCPs.

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