Risk Considerations in U.S. Supply Response

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ERS/USDA

Does Risk Matter?

- Are risk and/or risk attitudes important in agricultural production decisions?

- Partially decoupled payments (e.g., CCPs)
  - Lower price risk and affect risk attitudes indirectly through wealth effect

- Decoupled payments (e.g., DPs)
  - Affect risk and/or risk attitudes indirectly through wealth effect
Purposes of the Study

- Revisit an earlier study of acreage decisions under risk for U.S. corn and soybeans by Chavas and Holt (*AJAE*, 1990)
  - Estimate a risk response model for major field crops in the Northcentral region using more up-to-date data

- Assess the effects of initial wealth and risk on producers’ acreage response

- Draw implications for effects of decoupled payments (DPs, CCPs) on production decisions
Other Related Studies

• Modeled risk using variance, standard or absolute deviation of prices or net returns

• Risk quite significant in acreage response for California field crops less strictly regulated by government programs (Just, *AJAE*, 1974)

• Risk was statistically significant for Kansas wheat—a 1% decrease in standard deviation leads to an increase of 0.06% in wheat acreage (Lin, *AJAE*, 1977)

• Risk was found to be moderately significant for onions (Traill, *JAE*, 1978)
• Acreage response model under expected utility maximization

• Specified and estimated a system of acreage response equations with risk for U.S. corn and soybeans, 1954-85

• Included farm value of proprietor’s equity as the proxy for initial wealth, an explanatory variable

• Gave particular attention to the truncation effects of commodity loan programs on the distribution of commodity prices

• Applied symmetry restrictions
• Risk and wealth variables play an important role in corn-soybean acreage decisions

• Risk elasticities w.r.t. variances of prices are small
  – Not statistically significant for corn
  – -0.087 for soybeans

• Elasticities w.r.t. initial wealth are generally small
  – 0.087 for corn
  – 0.270 for soybeans
Theoretical Framework

• Chavas-Holt theoretical model was adopted

• Model maximizes expected utility for a farm household subject to a budget constraint

• Planted acreage is a function of
  – Expected net returns,
  – Second and (possibly) higher moments of the distribution of net returns, and
  – Farm household’s wealth

• Unless risk neutrality is assumed, homogeneity restrictions do not apply

• Symmetry restrictions apply to the acreage equations
Homogeneity and Symmetry Constraints

\[ A_c = a_{11} + b_{11} \text{NRT}_c + b_{12} \text{NRT}_s + b_{13} \text{NRT}_w \]
\[ A_s = a_{21} + b_{21} \text{NRT}_c + b_{22} \text{NRT}_s + b_{23} \text{NRT}_w \]
\[ A_w = a_{31} + b_{31} \text{NRT}_c + b_{32} \text{NRT}_s + b_{33} \text{NRT}_w \]

where \( A \) = acreage planted,
\( \text{NRT} \) = expected net returns
subscripts \( c, s, w \) refer to corn, soybeans, and wheat

Homogeneity: (applies only under risk neutrality)
\( \text{e.g., } b_{13} = -(b_{11} + b_{12}) \)

Symmetry constraints:
\( b_{21} = b_{12}; \ b_{31} = b_{13}; \ b_{32} = b_{23} \)
Estimation of the Empirical Model

- **Forward looking**
  - Expected farm prices are based on new crop futures prices

- **Acreage response for corn, soybeans, and wheat**

- **The model is estimated using**
  - Pooled time-series (1991-2001) and
  - Cross-section (8 states) state-level data for the Northcentral region

- **Symmetry constraint is imposed**

- **“Farm operator household net worth” is used as proxy for initial wealth**
• (Untruncated) expected net returns equal the expected farm price times the trend yield, minus a covariance term and variable costs of production.

• (Untruncated) price variances are a weighted sum of the squared deviations of past prices from their expected values, with weighting scheme:
  - t-1, 0.5
  - t-2, 0.3
  - t-3, 0.2

• Truncated expected net returns, variances, and covariances of commodity prices are included as explanatory variables.
Corn farm price distribution in Illinois, 2001

Loan rate ($1.89/bu.)

Untruncated mean ($2.26/bu.)

Truncated mean ($2.36/bu.)

Variance:
  Untruncated $0.13/bu.
  Truncated $0.08/bu.
Soybean farm price distribution in Illinois, 2001

- Untruncated mean: $4.34/bu.
- Truncated mean: $5.45/bu.
- Loan rate: $5.26/bu.
- Variance:
  - Untruncated: $0.24/bu.
  - Truncated: $0.03/bu.

$/bu.

1991 1993 1995 1997 1999 2001

Untruncated
Truncated

<table>
<thead>
<tr>
<th></th>
<th>Corn</th>
<th>Soybeans</th>
<th>Wheat</th>
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<tbody>
<tr>
<td><strong>Expected net returns:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>0.072</td>
<td>-0.064</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(2.99)**</td>
<td>(-3.23)**</td>
<td>(-0.16)</td>
</tr>
<tr>
<td>soybeans</td>
<td>-0.064</td>
<td>0.060</td>
<td>0.0003</td>
</tr>
<tr>
<td></td>
<td>(-3.23)**</td>
<td>(3.10)**</td>
<td>(0.05)</td>
</tr>
<tr>
<td>Wheat</td>
<td>-0.001</td>
<td>0.0003</td>
<td>0.010</td>
</tr>
<tr>
<td></td>
<td>(-0.16)</td>
<td>(0.05)</td>
<td>(1.58)</td>
</tr>
</tbody>
</table>

- Net returns for corn and soybeans are highly significant with expected signs
- Net returns for wheat also has expected sign, but is not as significant

Figures in parentheses are t-ratios
* , ** , *** Statistically significant at 10%, 5% and 1% level
Estimated acreage share equations: 1991-2001 (Cont.)

<table>
<thead>
<tr>
<th></th>
<th>Corn</th>
<th>Soybeans</th>
<th>Wheat</th>
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<tbody>
<tr>
<td><strong>Variance of prices:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>3.411</td>
<td>-11.917</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>(0.16)</td>
<td>(-0.65)</td>
<td></td>
</tr>
<tr>
<td>Soybeans</td>
<td>6.134</td>
<td>-8.701</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>(1.38)</td>
<td>(-2.31)**</td>
<td></td>
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<tr>
<td>Wheat</td>
<td>--</td>
<td>--</td>
<td>-2.437</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>(-1.13)</td>
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- Of all estimated coefficients of price variances, only the variance of soybean prices is significant with expected sign in soybean acreage equation.
Estimated acreage share equations: 1991-2001 (Cont.)

<table>
<thead>
<tr>
<th></th>
<th>Corn</th>
<th>Soybeans</th>
<th>Wheat</th>
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</thead>
<tbody>
<tr>
<td><strong>Covariance of prices:</strong></td>
<td></td>
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<tr>
<td>Corn and soybeans</td>
<td>-26.772</td>
<td>32.087</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>(-0.92)</td>
<td>(1.33)</td>
<td></td>
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<tr>
<td>Corn and wheat</td>
<td>--</td>
<td>--</td>
<td>13.841</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(1.94) *</td>
</tr>
<tr>
<td>Soybeans and wheat</td>
<td>--</td>
<td>--</td>
<td>-3.345</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(-0.94)</td>
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- Of all estimated coefficients of the covariance of prices, only the covariance of corn and wheat prices is significant.
Estimated acreage share equations: 1991-2001 (Cont.)

### Wealth effect:

<table>
<thead>
<tr>
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<th>Corn</th>
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<th>Wheat</th>
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<tbody>
<tr>
<td>Wealth</td>
<td>-0.191</td>
<td>0.397</td>
<td>1.546</td>
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<tr>
<td></td>
<td>(-1.77) *</td>
<td>(6.41)***</td>
<td>(6.39)***</td>
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- While initial wealth has positive effects on soybean and wheat plantings and is highly significant, the effect is negative for corn.
- An increase in initial wealth would lead to greater plantings of major field crops, consistent with the risk preference of decreasing absolute risk aversion.
Interpretations of Results

- The risk elasticity with respect to the variance of soybean prices in soybean equation is small
  - -0.044 at mean values
  - Somewhat smaller than previous studies’ findings—-0.087 (Chavas and Holt) and -0.06 (Lin)

- The wealth elasticity, however, differs
  - -0.063 for corn
  - 0.139 for soybeans
  - 0.003 for wheat

- Own-price elasticities
  - 0.331 for corn
  - 0.253 for soybeans
Implications for CCP Effects on Acreage

Because of high soybean prices in recent years,

- No impact of variance of soybean prices on soybean acreage if expected soybean farm price is at the 2002/03-2004/05 average ($6.23/bu.)

- No impact on soybean acreage even if the expected farm price is 90% of the 2002/03 – 2004/05 average ($5.61/bu.)
Implications for CCP Effects on Acreage
(Scenario Analysis)

• CCP will kick in when the national average farm price falls below the target price minus direct payment rate ($5.36/bu.)

Scenario:
Soybean farm price = 80\% of the 2002/03 – 2004/05 average ($4.98/bu.)

• A $0.36/bu. CCP will kick in
  — CCP would lower variance of soybean farm prices by 49.9\%

• CCP effect on soybean acreage would be small—an increase of 2.94\%
  — increase of 2.20\% through risk reduction
  — increase of 0.74\% through higher price
Conclusions

- Preliminary results suggest that the effects of risk on supply response for major field crops are not strong.
- However, risk could be significant for individual farms in the U.S. as well as those in the EU.
- An increase in initial wealth would lead to greater acreage of major field crops, consistent with the risk preference of decreasing absolute risk aversion.
- Expanded soybean and wheat acreage associated with an increase in wealth comes partly at the expense of corn plantings.
- Need to further study risk/wealth effects in farm households, particularly with regard to DPs and CCPs.