FAPRI modeling of farm program impacts on U.S. area planted

Pat Westhoff (westhoffp@missouri.edu)
FAPRI-Missouri (www.fapri.missouri.edu)
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Agenda

- FAPRI approach to determining farm program impacts on area planted
- Some estimated and assumed parameters
- Some results
Some underlying assumptions

- Payments affect production decisions
- The more coupled the payment, the larger the effect on production decisions is likely to be
- Even largely decoupled payments are likely to have some modest impact on production decisions
- Thinking across commodities is critical—total acreage across crops deserves attention
- The world is stochastic, and especially programs with asymmetric effects need to be modeled stochastically
U.S. area planted to 9 major crops

![Graph showing the area planted to 9 major crops from 1993 to 2007, with projected and actual data. The graph indicates a trend of decreasing acreage over time, with a peak in 1997 and a steady decline towards 2007.]
Why worry about total area devoted to major crops?

- Land used for field crop production is not fixed—but most land will be planted to something
- If focus too much on impacts of payments on any one crop, can forget that things have to add up
Basic FAPRI approach

- Try to estimate response of total area to expected returns
- Use this information to calibrate parameters of assumed regional area equations
- Develop national equations consistent with these regional equations for use in stochastic model
- In all cases, incorporate assumptions about how $1 of payments under each program affects production vs. $1 of expected market returns
- Each of these will be discussed in turn
Estimating total area planted

- Use state-level data for 1997-2001 for mixed estimation of regional equations
- Expected net returns = \((\text{lagged prices} + \text{LDPs}) \times \text{trend yields} - \text{variable expenses} + 0.25(\text{PFC} + \text{MLA payments})\)
- Total area planted to major crops = \(f(\text{weighted average expected real net returns, CRP acreage, state dummies})\)
Elasticities of total area planted w/r/t expected net returns

<table>
<thead>
<tr>
<th>Region</th>
<th>Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn Belt</td>
<td>0.02</td>
</tr>
<tr>
<td>Central Plains</td>
<td>0.02</td>
</tr>
<tr>
<td>Lake States</td>
<td>0.03</td>
</tr>
<tr>
<td>Southern Plains</td>
<td>0.06</td>
</tr>
<tr>
<td>Southeast</td>
<td>0.09</td>
</tr>
<tr>
<td>Delta States</td>
<td>0.13</td>
</tr>
<tr>
<td>Northern Plains</td>
<td>0.15</td>
</tr>
<tr>
<td>U.S. weighted average</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Note: weighted average CRP effect: -0.77
Problems with the estimation

- Except for N. Plains & Delta, returns variable not statistically significant
- Should be updated to include 2002-2004 data
- Should use same price expectations utilized elsewhere in model—we don’t just use lagged prices any more
- 0.25 factor on PFC & MLA payments is arbitrary
- BUT results are plausible (to me, anyway), and haven’t caused any huge problems in our projection work
Sidebar—expected prices in the model

- National average expected price = f(lagged price, lagged yield/trend yield)
- Based on estimation of actual national prices as function of lagged price, lagged yield/current yield)
- Regional prices = f (national price, regional production/national production) (estimated)
- Expected regional price = f (expected national price, trend regional share of national production)
- Helps in year like 2004 (farmers should have known bean prices would fall this year) and especially in stochastic work
- Expected price equations have adjustment terms—so can line up to futures, etc. if desired
Regional area equation parameters

- Once we “know” the total area response to changes in returns, we build a matrix of own and cross effects that are consistent with that total area elasticity.

- Although not estimated, we do a lot of calibration to make sure:
  - Own-return elasticities are reasonable (to us)
  - Substitution relationships make sense (to us)
  - Symmetry is imposed
  - Resulting error terms for each area equation are relatively small and random in recent years
<table>
<thead>
<tr>
<th>Net return</th>
<th>Area</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corn</td>
<td>Beans</td>
<td>Sorghum</td>
<td>Wheat</td>
<td>…</td>
<td>Coeff. sum</td>
<td>Total elast.</td>
</tr>
<tr>
<td>Corn</td>
<td>4.00</td>
<td>-3.05</td>
<td>-0.03</td>
<td>-0.19</td>
<td>0.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beans (single)</td>
<td>-3.05</td>
<td>4.00</td>
<td>-0.03</td>
<td>-0.20</td>
<td>0.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sorghum</td>
<td>-0.03</td>
<td>-0.03</td>
<td>0.09</td>
<td>-0.00</td>
<td>0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat (single)</td>
<td>-0.19</td>
<td>-0.20</td>
<td>-0.00</td>
<td>0.55</td>
<td>0.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>…</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coefficient sum</td>
<td>0.56</td>
<td>0.55</td>
<td>0.03</td>
<td>0.14</td>
<td>1.34</td>
<td>0.02</td>
<td></td>
</tr>
</tbody>
</table>
### U.S. area planted elasticities (subset of the full matrix, stochastic model)

<table>
<thead>
<tr>
<th></th>
<th>Corn</th>
<th>Beans</th>
<th>Sorghum</th>
<th>Wheat</th>
<th>Cotton</th>
<th>…</th>
<th>10 crops</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Net return</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>0.18</td>
<td>-0.10</td>
<td>-0.05</td>
<td>-0.05</td>
<td>-0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beans (single)</td>
<td>-0.06</td>
<td>0.15</td>
<td>-0.02</td>
<td>-0.03</td>
<td>-0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sorghum</td>
<td>-0.00</td>
<td>-0.00</td>
<td>0.20</td>
<td>-0.01</td>
<td>-0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat (single)</td>
<td>-0.01</td>
<td>-0.02</td>
<td>-0.05</td>
<td>0.19</td>
<td>-0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cotton</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.05</td>
<td>-0.01</td>
<td>0.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>...All 10 crops</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.06</td>
</tr>
</tbody>
</table>

Note: these are net return elasticities. Gross return or price elasticities would be substantially larger (e.g., corn own-gross return elasticity = 0.39)
Payment effects in the FAPRI model

- Marketing loans: $1 of expected LDP = $1 of expected market net returns
- Direct payments: $1 of DP = same effect on total area as $0.25 of expected market net returns
  - Effect not commodity specific—affects all commodities proportionally, doesn’t affect crop mix
  - Tied to total area response—i.e., very small, given small total area elasticity
  - In model, eliminating all DPs would only change total area for all 10 modeled crops by about 1 mil. acres
Payment effects in the FAPRI model

- Counter-cyclical payments: $1 of expected CCPs has the same effect as
  - $0.25 of expected market returns on total area (i.e., same as DP effect) PLUS
  - $0.25 of expected market returns on commodity-specific acreage (does affect crop mix)
Payment effects in the FAPRI model

- Mechanically
  - Supply-inducing net returns for each crop =
    - Expected price * trend yield – variable expenses +
    - Expected LDP (based on loan rate, expected price, and avg. historical relationship between prices & LDP rates) +
    - 25% of expected CCP (based on expected prices)
  - Each area equation also includes a “decoupled payment” term
    - Regional/national DPs + expected CCPs per acre for all crops
    - Coefficients for each crop picked so sum of effects across all crops is 25% of effect of similar change in per-acre market & LDP returns
Why these weights on various payments?

- Honest answer: judgment that could change based on new information
- LDPs very coupled, likely to have at least as much impact on production as market returns
- DPs relatively decoupled, but may hold some land in production because of wealth effect on risk behavior, base updating rules…
- CCPs in between
  - Decoupled from production like DPs
  - Have insurance effect that should be crop specific
Why FAPRI does stochastic analysis

- Many programs (LDPs, CCPs) have asymmetric effects:
  - Payments can get very large when prices low
  - But payments can’t be negative when price high
- Inadequate to consider policy scenarios vs. single deterministic baseline:
  - Consider change in loan rate
  - If baseline prices a little over loan rate, deterministically a loan rate reduction would have no effect on model
  - But in stochastic world, even if deterministic baseline is mean of prices, will be significant chance of LDP activity
  - If LDPs triggered, has production and price effects
How FAPRI does stochastic analysis

- Not time/place for full discussion
- In brief
  - Make correlated draws from deviations from trend yields, error terms from other important supply and demand equations
  - Solve model for each of 500 draws
  - Uses simplified version of FAPRI system
    - About 900 crop-livestock-accounting equations
    - Only national acreage—not regional as in deterministic model
    - Rest of world represented in reduced-form trade equations
    - Centered so at deterministic baseline values for all exogenous variables, get back deterministic baseline supply and demand
Importance of stochastic analysis: Projections of net CCC outlays

Source: FAPRI January 2004 baseline
Importance of stochastic analysis: Projections of U.S. cotton area planted

Source: FAPRI January 2004 baseline
Corn net returns* and market prices: 500 possible outcomes for 2005/06

* National average net returns over variable expenses from market and payments for a corn base acre planted to corn
Corn gross returns* in 2005/06: 500 outcomes grouped by market price

*National averages for a corn base acre planted to corn
Measures of uncertainty associated with 2005/06 corn returns

<table>
<thead>
<tr>
<th>Description</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>St. dev./mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross market returns (price * yield)</td>
<td>$331.86/a.</td>
<td>$42.35/a.</td>
<td>0.128</td>
</tr>
<tr>
<td>Net market returns (gross-var. costs)</td>
<td>$181.92/a.</td>
<td>$42.91/a.</td>
<td>0.236</td>
</tr>
<tr>
<td>Net market returns + LDP</td>
<td>$193.37/a.</td>
<td>$32.81/a.</td>
<td>0.170</td>
</tr>
<tr>
<td>Net market returns + CCP</td>
<td>$196.16/a.</td>
<td>$32.96/a.</td>
<td>0.168</td>
</tr>
<tr>
<td>Net market returns + LDP + CCP</td>
<td>$207.61/a.</td>
<td>$29.03/a.</td>
<td>0.140</td>
</tr>
<tr>
<td>Net mkt. ret. + LDP + CCP + DP</td>
<td>$231.99/a.</td>
<td>$29.03/a.</td>
<td>0.125</td>
</tr>
</tbody>
</table>

Source: FAPRI January 2004 stochastic baseline
Final comments

- We’re still learning and modifying
  - Expected price approach just added this year
  - We’re not set on current approach to modeling payments
    - Nothing magical about current parameters
    - Some things could be (re-)estimated
    - We’ll look at non-econometric evidence, too
  - Stochastic modeling still as much an art form as science