Crop Price Volatility Impacts on Farmers' Cropping Patterns:

A Dynamic Optimal Crop Rotation Model

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Background

- Recent increased instability in agricultural commodity prices are complicating producers' profit-maximizing calculus.
- For maximizing these returns, producers will reallocate their acreage among crops based on commodity prices with a constraint of crop rotation considerations.
- Crop rotation maintains crop yields by controlling for disease and pests and promoting nutrients for growth.
- Research on crop rotation is generally focused on agronomy studies, while little effort has been directed toward an economic analysis.

Motivation

- For maintaining yields, producers establish a multi-year crop rotation scheme based on stable markets and production technologies. However, with volatile commodity prices, such schemes may no longer be optimal.
- If producers switch from a crop rotation scheme to mono cropping when expecting high mono crop prices, the current enhanced price may not offset any future yield reduction.
- Economic models designed to aid in such decisions would provide assistance to producers faced with uncertain price shifts.

Model

- For maximizing expected returns, at period *t*, the producer will forecast each crop price along with its yield. The single period choice problem is:

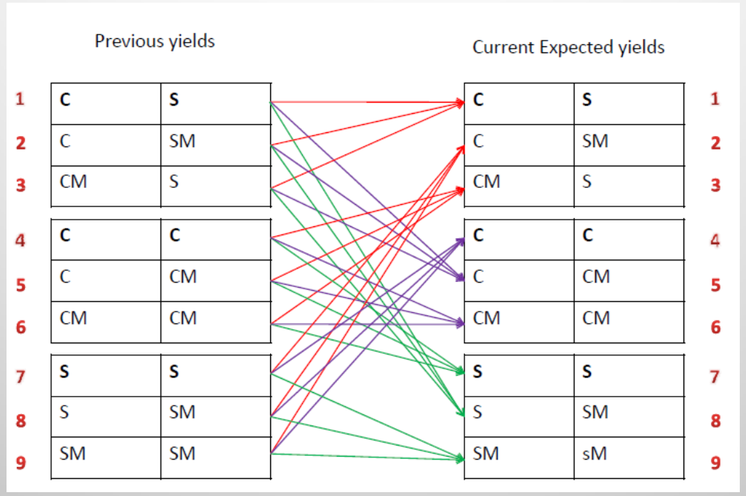
$$V(y_{c0}, y_{s0}) = \max_{\{\delta_{ct}\}} \sum_{t=0}^{T} \beta^t \pi_{it}(y_{ct}, y_{st}; \delta_{ct}) \quad \text{s.t.}$$

$$\delta_{ct} \in \Gamma(y_{ct}, y_{st}),\ y_{i(t+1)} = T(y_{ct}, y_{st}; \delta_{ct}),\ \text{for } \forall i = c, s;\ \forall t = 1, 2, 3, \ldots T;$$

- Based on F.O.C.s, the solution to the crop choice is:

$$\delta^*_{it} = \delta_{it}(p_{ct}(E_{ct}), w_{ct}, \delta_{i(t-1)}, y^*_{\alpha}(\theta_{ct}(\sum_{j=1}^{t} N_{c(t-j)}, \sum_{j=1}^{t} N_{s(t-j)}, \delta_{i(t-1)})), p_{st}, w_{st}, y^*_{st}(\theta_{st}(\sum_{j=1}^{t} N_{c(t-j)}, \sum_{j=1}^{t} N_{s(t-j)}, \delta_{i(t-1)}))$$

Rotation Design



Simulation Results

- Simulation results indicate that $4.6 per bushel is the break-even price of corn for farmers to act in acreage response. The highest price in the next ten years is 4.5 which is very close to this break-even price.
- Results indicated inelasticity of producer actions in acreage allocation to volatility in crop prices.
- The results of this research are expected to provide a foundation for future related research to aid producers' crop rotation decision in an unstable price environment.

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