Acreage Decisions When Risk Preferences Vary

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<u>Overview of Problem</u>

A Linear Utility function (EV) with constant risk aversion is often used to represent non-risk neutral producers who allocate acreage.

Often it is assumed net revenues are constant per acre, which can lead to corner solutions where producers allocate all their land to one crop, and which is not realistic.

Corner solutions would be more likely if the coefficient of risk aversion is small or if prices have low variances.

We **offer two innovations:**

A) We introduce the function of risk aversion g(.), whose arguments are prices, yields and acreage.

B) We represent the level of risk to be a constraint that producer face rather than a preference.

The producer decision is:

$$\underset{Ai}{Max} \sum_i p_i * Yd_i A_i - C(w, Yd * A_i)$$

$$Subject\ to: G(Var(p_1)*(A_1 * Yd_1) \ldots Var(p_n)*(A_n * Yd_n)) = K$$

where *K* represents the maximum level of risk that the producer is willing to take on, and g(.) is a function of the variances of prices, yields, and acreages.

The solution to the producer acreage equations of the form:

$A^* i(P_1 .. P_n, w_1 .. w_m, Vp_1 .. Vp_n, K)$.

Substituting A*(.) into the objective function produces an indirect utility (profit function).

Problem: we have no suitable variable to represent *K*, (each producer's tolerable level of risk).

However, the dual problem does produce acreage equations for which data is readily available:

$$\underset{Ai}{Min}\, G(Var(P_1)*(A_1*Yd_1)^2 \ldots Var(P_n)*(A_n*Yd_n)^2)$$

$$St:(\sum(P_i*Yd_i A_i - C(w_1..w_m, Yd_1 A_1..Yd_n A_n)) = \overline{\pi}) \;,$$

i.e., producers minimize risk subject to the constraint that a predetermined level of profits is reached.

The solution are acreage equations that are a function profits, a variable which is observed:

$$\breve{A}(P_1..P_n, w_{1....} w_m, Vp_1....Vp_n, Yd_1.Yd_n\ \overline{\pi})$$

Substituting $\breve{A}_j$ into the above optimization problem produces the indirect risk preference (IRP) function:

$$\breve{G}(P_1..P_n, w_1..w_m, Vp_1..,Vp_n, Yd_{1.}..Yd_n, \overline{\pi}).$$

The following envelope relation exists:

$$\left(\frac{-\partial \breve{G}(.)/\partial P_j}{\partial \breve{G}(.)/\partial \pi_i} \right) = Yd_j \breve{A}_j(P_1 \ldots P_n, w_1 \ldots w_n, Var(P_1) \ldots Var(P_n), \overline{\pi})$$

Compensated acreage equations or output equations can be derived from parameters of the indirect risk preference function.

The uncompensated acreage response to price changes is:

$$\partial \breve{A}_j(.)/\partial P_j + (\partial A_j(.)/\partial \pi) * \partial \pi / \partial P_j = \partial \breve{A}_j(.)/\partial P_j + (\partial A_j(.)/\partial \pi) * y_j$$
$$= \partial A_j^* / \partial P_j$$

A similar relationship exists for area response to price variances.

We specify an indirect risk preference function as a flexible functional form with prices, expected yields, price variances, and profits as arguments.

We then use the envelope relationship to derive acreage equations. Doing so and exploiting adding up conditions produces the following compensated acreage equations which we estimate:

$$A_i / \overline{A} = AS_i =$$

$$(a_{1i} + \sum_{j \neq i} \beta_{ij}(P_j / Y_j) + \beta_{ii} P_i + \sum_j \nu_{ij} w_j + \sum_j \kappa_{ij} V p_j + d_{1i} \pi) / z$$

$$for\; i = 1, 2 \ldots n$$

Where AS equals acreage shares and $z = \Sigma a_{1I}$

(note: the equations are viewed as compensated because they are a function of a target level of profits.)

Estimated Acreage Equations For Counties (that grow Corn, Soybeans, and Winter Wheat)

SYSTEM R-SQUARE = 0.87

Corn			Soy		Winter Wheat	
Variable	Coef	T-stat	Coef	T-stat	Coef	T-stat
Constant	0.808	24.77	0.9495	25.95	0.317	17.00
RD	-0.036	-15.61	-0.101	-7.44		
P-Corn	0.023	1.87	-0.063	-12.45	-0.064	-9.18
P-Soy	-0.051	-11.36	0.016	1.95	0.023	8.98
p-w-wht	-0.050	-6.80	0.0003	5.82	0.019	4.43
P-Grz	0.0001	1.99	0.373	8.99	-0.0001	-2.97
Vp-Corn	0.487	13.21	-0.023	-2.87	-0.114	-5.37
Vp-Soy	-0.001	-0.16	-0.062	-9.00	-0.003	-0.86
Vp-w-wht	-0.129	-20.98	0.0027	30.57	0.037	10.61
Profits	0.004	44.81	0.0007	6.49	0.0002	5.15
Y^d-CRN	-0.004	-33.64	0.040	14.82	0.0000	0.85
Y^d-Soy	0.005	13.30	-0.015	-31.82	-0.009	-38.76
Y^d –w-wh	0.0004	2.41	-0.0002	-1.42	0.0021	23.31
Y^d GRZ	-0.648	-8.49	0.246	2.87	-0.030	-0.68
P-fuel	-0.008	-1.53	-0.036	-6.47	-0.0115	-4.05
P-fert	-0.076	-10.16	-0.008	-0.98	-0.002	-0.45
Imr	16499000	46.56				

1/ Prices and VP's are normalized on wages

2/$Y^{d,'s}$ are expected yields

3/w-wht is winter wheat, Grz is pasture land

4/ RD Rotation Dummy, is 1 if county share in corn land was greater than average in county share in the previous year

5/ Imr is inverse mills ratio.

Category 1 Uncompensated Elasticities

Counties that grow Corn, Soybeans, and Winter Wheat

	A-Corn	A-soy	A-w-wht
P-Corn	1.68	0.797	-0.65
P-soy	0.82	0.380	1.37
P-wht	0.68	0.851	0.71
vp1	-1.402	0.002	-0.002
vp2	-0.787	-0.003	0.002
vp3	-0.506	-0.003	0.004

Counties that grow Corn, Soybeans, and Spring Wheat

	A-Corn	A-soy	A-s-wht
P-Corn	0.66	0.84	0.06
P-soy	0.59	0.42	-1.38
P-wht	0.28	0.11	0.61
vp1	-0.394	-0.656	0.172
vp2	-0.220	-0.371	0.098
vp3	-0.505	-0.251	0.063

A-acres, P-price, Vp-price variances
ww-winter wheat, sw-spring wheat

Data

County level data for corn, soybean, winter and spring wheat, and pasture, over 1975 to 2007. Crop prices are drawn from the futures markets.

Price and yield densities are converted into within season deviates (Cooper (RAE, 2009).

The price deviate: (Harvest price-planting price)/planting price

The yield deviate: (Actual yield-expected yield)/expected yield.

Expected yield is predicted from a linear trend regression.

For each year in the regression, the previous 10 years of price and yield deviates are used to generate the non-parametric price and yield density functions.

These are converted to density functions for actual price and yields, centered around the planting price and expected yield.

Hence, the density functions for price and yield are forward looking.

Generated prices for each commodity are truncated by their respective loan rates.

Other variables include input prices indices for fertilizer, agricultural chemicals, farm machinery, which were supplied by the USDA.

Data broke into two category counties to create two samples.

Sample 1: the 345 counties that produce corn, soybeans and winter wheat.

Sample 2: the 35 counties that produce corn, soybeans, and spring wheat.

Given that the previous 10 years of data are used to generate the means and variances of price and yields for each year, the time span for the econometric analysis covers 1985 to 2007.

Summary:

We develop a risk preference function to replace a constant coefficient of risk aversion.

We estimate compensated acreage equations and elasticites for county level data for corn, soybeans, spring and winter wheat.

We learned that it is possible to estimate compensated acre equations and use a Slutksy-supply side decomposition to obtain elasticities in the presence of risk

Problems to work on:

1) **There are practical issues with getting all the parameters of the indirect risk preference function; (beyond those in the acre equations)**

2) **Getting a reliable estimate of changing risk preferences**

Problem 2 is related to problem 1.