Modeling Agricultural Risk, Risk Preferences and Perceptions

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Introduction and Objectives

Estimating farmers' risk preferences based on observed production decision has long been of interest in the literature. However, it is often assumed that risk preferences and risk perceptions are homogenous across individuals.

The objective of this research:

➢ Show that risk preferences differ across individuals and propose a specification to model the heterogeneity and investigate factors affecting risk preferences;

➢ Show that heterogeneous risk perceptions matter in risk preference analysis and propose a general framework that allows heterogeneous risk perceptions and correlation between risk preferences and perceptions.

Production Decision Under Uncertainty

Farmers face both price risk and yield risk in crop production. The yield risk can be modeled using the Just-Pope specification of production technology:

(1) $$y=f(x, z)+g(x, z)\varepsilon$$

where y is output, x variable input vector, z quasi-fixed input vector, ε is white noise, with mean zero and variance 1.

We specify price risk as an expected price plus a random error:

(2) $$p = p^+ + e$$

Farmers maximize the expected utility when making production decision:

(3) $$Max\ H=max_x\ E[U(W_1)\ ]$$

where $U(\cdot)$ is utility function, W_1 is the end-of-period wealth.

(4) $$W_1 = W_0 + p\ y - r'\ x - C$$

where W_0 is real initial wealth, r is the vector of variable inputs price, C is fixed costs of production.

Substitute (1) and (2) into (4) and take the first order condition of (3) with respect to variable input j:

(5) $$E[U'(W_1)((p^+ + e)f_j + (p^+ + e)g_j\varepsilon - r_j)] = 0$$

Take te first-order approximation of the term $U'(W_1)$ at the point

$$\pi= W_0 + p^+y - r'\ x - C$$

which is the end-of-period wealth in (3) setting $\varepsilon=e=0$.

Substitute the first-order approximation of $U'(W_1)$ into (5) :

(6) $$p^+f_j - r_j -[f_j(x)f(x)+g_j(x)g(x)]\cdot V_e\cdot RA - p^{+2}g_j(x)g(x)\cdot RA + \varphi_j=0$$

where f_j and g_j are the first derivatives of $f(.)$ and $g(.)$ w.r.t. input j. r_j is price of input j. V_e is the price risk (variance) perceived by the producer. RA is the Arrow-Pratt absolute risk aversion $-U''(\cdot)/U'(\cdot)$.

We argue that farmers' risk preferences are affected by different factors; and we specify RA as a function of demographic and socioeconomic characteristics of farmers and institutional factors:

(7) $$RA=\gamma_0+\gamma_1\pi+ \gamma_2\ AGE+\gamma_3\ EDU+ \gamma_4\ FAM+\gamma_5\ SUB+\zeta$$

where *AGE* is farmer age, *EDU* is farmer education level, *FAM* is the number of family members participating, *SUB* is the subsidy rate (as a percentage of revenue). We allow fixed effects for *RA to* capture unobservable factors.

We further allow the perceived risk to be individual-specific and specify the variance of market price of output as a random coefficient, with a mean and a multiplicative error term:

(8) $$V_e =\sigma^2\ exp(\xi)$$

where σ^2 represents mean risk perception, and $exp(\xi)$ is a random variable having a covariance *Cov* with the risk preference error ζ.

Finally combining eq. (6), (7) and (8), the first order condition can be rewritten as:

(9) $$p^+f_j - r_j -[f_j(x)f(x)+g_j(x)g(x)]\cdot \sigma^2 \cdot(Cov+\underline{RA})\ - p^{+2}g_j(x)g(x)\cdot \underline{RA}\ + \tau =0$$

Where $\underline{RA}$ is the average of *RA, and* τ captures the approximation error and errors associated with the fixed effects of *RA*.

Estimation and Results

The empirical application uses data from cash crop farms in the Netherlands 1990-1999.

We specify f(.) as a quadratic function, and g(.) as an exponential function. Eq. (1) is estimated and the parameters are then used to compute the value of f(.) and g(.) and their first derivatives which are needed to estimate (9). GMM is used in all estimations.

Para.	γ_1	γ_2	γ_3	γ_4	γ_5	*Cov*
Estimates	-.000002***	.0001***	-.0094***	.0057***	-0.0994***	.0127***

Conclusions

➢ Farmers' risk preferences are found to be heterogeneous.

➢ Farmers have decreasing absolute risk aversion; Farmers' risk aversion increases with age and the number of family members depending on farm income; it decreases with farmers' education level and when production is more subsidized.

➢ Farmers' risk preferences and risk perceptions are positively correlated, i.e., more risk averse farmers tend to perceive higher risk.

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