RISK ATTITUDES AMONGST AUSTRALIAN FARMERS: A COMMENT

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Bond and Wonder (1980) claim to have developed a procedure for measuring risk attitudes in terms of risk coefficients, and that these coefficients may be usefully employed in risk programming models. While attempts to measure risk attitudes are to be welcomed, Bond and Wonder's approach seems to contain some inconsistencies and undefined implicit assumptions. They are discussed in this comment. Some thoughts on a possible alternative approach are given.

A decision maker's attitude to risk is an inherent characteristic, revealed through his choices in decision problems involving risks. If a decision maker accepts the von Neumann-Morgenstern axioms of choice, it follows that the decision maker's attitude to risk is implicit in his utility function, namely his evaluation of alternative quantities of sure income, or other reward. The shape of this function implies certain behaviour, for choices are made to maximise expected utility. For example, if it is everywhere strictly concave, the decision maker will always pay a premium to avoid risk; if it is everywhere strictly convex, he will always pay a premium for risk. Decision makers who reveal this consistent behaviour for all possible risks can be called risk averse, and risk preferring, respectively. Other decision makers may be risk neutral (never pay a premium for or against risk), or may display a mixture of behaviour in the face of risk.

A decision maker need not have an implicit attitude to risk. Instead, he may hold an explicit attitude. For example, he may have an inherent dislike for variability of income, where this variability might be measured by variance, standard deviation, mean absolute variation, semi-variance, or other means. In general, decision makers who have explicit risk attitudes make decisions which do not conform to the von Neumann-Morgenstern axioms. In particular, decision makers who trade off expected income and variability of income in a linear manner violate the independence axiom.[1] There is no utility function for income corresponding to this form of trade-off. To assume that decision makers have a utility function for income, as Bond and Wonder do, and then to postulate various mean-variability models, is inconsistent.[2] It is not

[1] For example, consider a decision maker who trades off expected income and variance at a rate $A = -1$. Given three risks, each with two equally likely outcomes, namely (25, 35), (5, 5) and (0, 20), the decision maker is indifferent between risks 1 and 2, both of which are preferred to risk 3. Consider the probability mix of $p_3 = 0.5$ of risk 3, and $(1 - p_3)$ of risk 1; and a probability mix of p_3 of risk 3 and $(1 - p_3)$ of risk 2. The independence axiom means that the decision maker should be indifferent between these two mixes. This decision maker, however, prefers the second mix.

[2] The only occasions when this would be consistent are: (a) when the utility function is quadratic; or (b) when the risks to be assessed belong to a family of risks in which the mean and variance uniquely define the risk.

possible to estimate meaningfully the parameters of these latter models using aspects of expected utility theory. It is clear, for example, that π, and Bond and Wonder's estimates of ϕ and γ, as measures of explicit risk attitudes, all depend on the variance of the risks used in measuring these attitudes. Thus the measurement is not independent of the measuring tool. Neither can π, ϕ or γ be regarded as measures of implicit risk attitudes in the expected utility framework. In this framework, an individual's attitude to risk is encompassed in his utility function, or more basically, his absolute risk aversion function, $r(X) = -u''(X)/u'(X)$. Insofar as Bond and Wonder define A as $\frac{1}{2}u''(X^*)/u'(X^*)$, A does measure local risk attitude. But π, ϕ and γ are not constants, even locally. They vary with risk itself.

Because of the estimating procedures adopted by Bond and Wonder, the estimates of ϕ, A and γ are all linear transformations of π. Thus, certain relationships should be observed between the distributions of these estimates. First, the coefficients of variation reported by Bond and Wonder in Table 3 should be constant (apart from sign) for a given risk. That they are not presumably reflects incorrect use of rounded figures. Similarly, where one coefficient is significant for a given risk, all should be significant. Rounding errors again appear to be the cause of discrepancies. In one case, Risk 4, Response Code 2, the mean and standard deviation of π are inconsistent with those for ϕ, A, and γ. If the values for π are correctly reported, then the values for ϕ, A and γ are underestimated by a factor 1.66. The cumulative distribution functions of the measures are also related for a given risk and should be identical, in fact, except for the scale of the horizontal axis. The discrimination between risks, or the dispersion of median values of a coefficient for different risks, should be identical (allowing for scale) for ϕ and γ, but different from that of A. While A reflects variation only in $u''(X)/u'(X)$ as X changes, ϕ and γ reflect this and, as well, the changing variances of the risks. Since the variances of the risks differ relatively more in Response Code 2 than in Response Code 1, it is not surprising that the discrimination provided by A in Code 2 is quite different from that for ϕ and γ.

What significance discrimination has is not made clear by Bond and Wonder. Presumably, for an explicit risk attitude model, the less discrimination provided by the risk coefficient the better, in that the risk coefficient is less affected by the risk itself. Indeed, if a particular explicit risk attitude model applies for all individuals, then the distribution of the risk coefficient should be identical no matter what the risk. Variation in the distribution between risks would imply that the risk coefficient for some (perhaps all) individuals was not constant, and that the corresponding model did not apply for them. In the alternative expected utility framework, the discrimination provided by A reveals the extent to which absolute risk aversion is changing.

Bond and Wonder's apparent aim is to assess risk attitudes in an expected utility framework without having to elicit utility functions. However, in this framework, any statement about an individual's risk attitudes amounts to a statement about his utility function. If one makes such statements without eliciting the utility function, then one is necessarily assuming something about the utility function. What assumptions did Bond and Wonder implicitly make in assessing risk attitudes on the basis of four risk premiums?

Of course, any practical procedure for eliciting a utility function necessarily needs some assumptions in order to infer general behaviour from limited observed behaviour. Once these assumptions are made explicit, suitable systematic elicitation procedures can be devised. One way to do this is to assume a particular form of utility function. The familiar elicitation procedures then provide a systematic study of this function, enabling estimation of its parameters, and an assessment of its adequacy of fit. For individual-oriented, normative decision analysis, this approach appears satisfactory. An alternative starting point, and one which may be more satisfactory for modelling risk attitudes for positive analysis, is to assume a particular form of absolute risk aversion function, $r(X)$. This has the advantage of making explicit the assumption regarding the decision maker's risk attitudes. Further, with suitable specification, it may be possible to interpret the estimated parameters of the absolute risk aversion function as cross-sectional measures of risk aversion.

Suppose that a decision maker's absolute risk aversion function depends on a parameter, β, such that $r(X) = r_*(X, \beta)$, where $\partial r(X)/\partial\beta > 0$ for all X, and for all β. Since the size of the risk premium for any given risk is greater the higher the function $r(X)$, it is clear that β measures risk aversion in a cross-sectional sense. That is, given two individuals whose $r(X)$ functions differ only in their β values, the one with the greater β value always pays a greater risk premium than the other to avoid a given risk.[3] If $\partial r(X)/\partial\beta > 0$ only for $X_1 \leq X \leq X_2$, or for $\beta_1 \leq \beta \leq \beta_2$, β is a measure of risk aversion in a weaker sense. Thus the individual with the higher β is more risk averse to risks whose outcomes fall in the range $X_1 \leq X \leq X_2$ in that he will always pay the greater risk premium to avoid any such risk. For practical purposes, a weaker version of risk aversion will often be all that is required. Many of the possible risks are practically irrelevant, and attitudes to them are of little interest. Some specific examples of the function $r(X)$, having the required derivative, include:

(i) $r(X) = \beta r_*(X)$, $r_*(X) > 0$;
(ii) $r(X) = [r_*(X)]^{\beta}$, $r_*(X) > 0$;
(iii) $r(X) = \beta^{r_*(X)}$, $\beta > 0$, $r_*(X) > 0$;
(iv) $r(X) = \beta$;
(v) $r(X) = \beta/(X - \alpha)$, $\alpha < X_1$; and
(vi) $r(X) = -2\beta/(1 + 2\beta X)$, $\beta \geq -1/2X_2$ if $X_2 \geq 0$, $\beta \leq -1/2X_1$ if $X_1 < 0$

Examples (i) to (iii) are special forms in that $r(X)$ is a function of the function $r_*(X)$ common to all decision makers. Example (iv) is the constant absolute risk aversion case. Example (v) includes two special cases.

[3] The risk is defined in terms of income, not wealth. In terms of wealth, the risks faced will differ if their initial wealth levels differ. Note too, that an individual with everywhere higher $r(X)$ does not necessarily have everywhere higher $r(W)$, where W is wealth. An individual who is everywhere more risk averse to wealth variation is not necessarily everywhere more risk averse to income variation, and vice versa. The focus on income is because individuals are more likely to face the same income risks, rather than the same wealth risks.

First when $\alpha = 0$, it is the case of constant partial risk aversion. Binswanger (1978) has used this assumption in his work on measuring risk attitudes in India. When α is an individual parameter, $\alpha = -W_I$, where W_I is the decision maker's initial wealth position, then $r(X) = \beta/(X + W_I)$. This is the case of constant relative risk aversion. In this case, both β and $-W_I$ are partial measures of risk aversion. Risk premiums will depend on both parameters. Finally, example (vi) corresponds to the quadratic utility function, $u(X) = X + \beta X^2$. The quadratic coefficient thus provides a cross-sectional measure of risk aversion.

For a given individual, and having chosen the risk aversion model for $r(X)$, β could be estimated by first deducing the form of the utility function and second fitting it to a set of points determined by any of the questioning procedures. The criticisms made by Bond and Wonder would not apply since detailed questioning would not be needed. Alternatively, β could be bounded using an individual's choice from a set of alternatives, in the type of approach used by Binswanger.

The variety of $r(X)$ functions could be extended, if needed, by defining two or more parameters, $\beta_1, \beta_2, \ldots$, each of which would be a dimension of risk attitudes. Relating one risk measure, β, to socio-economic and other determining factors (parameters) is one form of a multi-parameter risk aversion function. The need for more dimensions, the most appropriate choice of functional form $r(X)$ and, indeed, whether the expected utility framework should be retained, are matters for empirical investigation.[4]

One important finding of the Bond and Wonder study is that a significant proportion of individuals, more than many observers might have expected, had negative risk premiums in one or more of the risks. There seem to be three possible explanations: (a) many decision makers do prefer risk on some occasions; (b) the respondents mis-interpreted the choices; or (c) decision makers are often unable to assess risky alternatives, properly, even when these are simple two-point risks. If the first is true, various classes of decision makers may have to be considered in policy determination. If the second is true, the questionnaire needs improvement. If the third is true, then doubts are cast on all the elicitation procedures, since they all entail assessment of risks by the decision maker. Those procedures involving very simple fifty-fifty gambles would presumably have some advantage. But if simple risks cannot be properly assessed, what chance is there that a decision maker will make real decisions consistent with the von Neumann-Morgenstern axioms? How appropriate, then, are the implicit risk attitudes of the expected utility framework as measures of risk attitudes for use in policy analysis?

References

Binswanger, H. P. (1978), 'Risk attitudes of rural households in semi-arid tropical India', *Economic and Political Weekly* 13(25), A49-A62.

Bond, G. and Wonder, B. (1980), 'Risk attitudes amongst Australian farmers', *Australian Journal of Agricultural Economics* 24(1), 16-34.

[4] The assumptions about the absolute risk aversion function for income could be replaced by an alternative set about the absolute risk aversion function for wealth, thus further enlarging the possibilities (cf. footnote 3).