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RESEARCH NOTES

UTILITY APPROACH TO THE ANALYSIS OF RISKY FARM DECISIONS*

Enough empirical evidence is available in making rational farm decisions under certainty. The underlying assumption in making such decisions is that farm input-output coefficients and prices as well as the weather in a particular day are either known with certainty or are distributed NI(u, σ^2) in terms of sampling theory. Thus, under the assumption of certainty, farm decisions are made and executed as if the price and weather risks do not exist. But it is common knowledge that the decision-makers, especially farmers make decisions under extreme price and weather risks. The problem of decision-making becomes even more complex when—as is invariably true—a farmer has multiple goals. The situation is further complicated when risky choice prevails, that is, when the consequences of actions are uncertain due to stochastic influences and each action may have many potential consequences which can only be described in terms of a probability distribution of outcomes.

Several studies conducted outside India have concluded that the decision-maker in general and the farmer in particular have an aversion to risk. Those who have made significant contribution are Friedman and Savage (11), Dillon and Burley (8), Davidson and Mighell(5), Officer *et al.* (20), Officer and Anderson(17), Officer and Dillon(18), Officer and Halter(19), Anderson(1), McArthur and Dillon(15), Dillon(6), Dillon and Anderson(7), Francisco and Anderson(9) and Makeham *et al.* (14). Some of these workers quantified farmers' risk aversion or preference via utility analysis for use either in making recommendations to farmers or for evaluating the possible outcomes of farmers' risky choice with a view to finally helping the farmer in making rational farm decisions.

In India only a few empirical studies have made explicit the significance of risk in farmers' managerial decisions. For example, Jai Krishna and Desai (12) applied probabilistic, game theoretic and diversification models of risk and uncertainty to problems of selecting crop fertilization programmes and crop combination. Schluter (21) studied the interaction of credit and uncertainty in determining the allocation of resources and incomes on small farms of Surat district. Singh (23) concluded that farmers' tendency of risk aversion is reflected in their attempt to diversify farm enterprises. In other studies Singh (22, 24) used historical data on crop yields to establish the probabilities of the outcomes of the risky prospect.[1]

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[1] Any action or choice possibility with a probability distribution of outcomes is a risky prospect.

In the Indian farming context, the author is not aware of any work done to quantify risk in terms of utility function except the recent work initiated by Binswanger (3) and his associates (4). This paper uses the utility function approach to analyse risky outcomes as an aid for better farm decisions. In this approach, the problem of decision-making is solved by using the criterion of maximizing expected utility. The solutions to such problem are consistent with the decision-maker's preferences among risky actions (13, 16). This consistency makes utility analysis an efficient tool of quantifying risk as a parameter in practical decision-making (20, p. 172).

BERNOULLI'S PRINCIPLE

The criterion of maximizing expected utility uses Bernoulli's principle which is also known as the Expected Utility Theorem. For quantifying risk or uncertainty, Bernoulli's principle allows personal valuation of consequences and personal strengths of beliefs about the occurrence of uncertain events. This principle also has the normative justification of being a logical deduction from a small number of postulates or axioms which are acceptable and reasonable to many people to the extent that these people would like their choices to conform with these normative postulates.

Bernoulli's principle may be deduced from the following three postulates for the case of risky prospects with one dimensional utility measure (*i.e.*, a real number) or consequences. For risky prospects with multi-dimensional consequences extension of the postulates is necessary (10).

(1) *Ordering and Transitivity*

A person confronted with two risky prospects A_1 and A_2 prefers one to the other or is indifferent between them. In ordering of more than two risky prospects A_1, A_2 and A_3, if a person prefers A_1 to A_2 (or is indifferent between them) and prefers A_2 to A_3 (or is indifferent between them), he will prefer A_1 to A_3 or be indifferent between them.

(2) *Continuity*

If a person prefers A_1 to A_2 to A_3, then there exists a subjective probability $P(A_1)$ other than zero or one that he is indifferent between A_2 and a gamble with a probability $P(A_1)$ of yielding A_1 and A_3 with probability $1-P(A_1)$.

(3) *Independence*

If A_1 is preferred to A_2 and A_3 is some other risky prospect, then a gamble with A_1 and A_3 as its outcomes will be preferred to a gamble with A_2 and A_3 as outcomes if the probability of A_1 and A_2 occurring is the same in both the cases. In other words, preference between A_1 and A_2 is independent of A_3.

Now Bernoulli's principle or the Expected Utility Theorem may be stated as follows: if decision-maker's preferences are consistent with the axioms of ordering, continuity and independence, there exists a utility function U which associates a single real number (utility index or utility value) with any risky prospect faced by the decision-maker. This function has the following properties:

(*i*) If the risky prospect A_1 is preferred to A_2, then the utility index of A_1 will be greater than the utility index of A_2, that is $U(A_1) > U(A_2)$ and vice versa.

(*ii*) The utility of a risky prospect is its expected utility value. Thus, if A_j is the risky prospect with a set of outcomes $\{a\}$ distributed according to the probability distribution f(a), then the utility of A_j is equal to the expected utility of A_j. That is,

$$U(A_j) = EU(A_j) \tag{1}$$

the expectation being based on the decision-maker's subjective distribution of outcomes. In the case of discrete distributions of outcomes,

$$EU(A_j) = \sum_a U(a)\ f(a) \tag{2}$$

and if f(a) is continuous,

$$EU(A_j) = \int_{-\infty}^{\infty} U(a)\ f(a)da \tag{3}$$

The axioms logically imply use of the decision-maker's subjective probability distribution for utility evaluation of outcomes of the risky prospect.

(*iii*) Utility is measured on an arbitrary scale, analogous to various scales used for measuring temperature. This makes comparisons of inter-personal utility values meaningless because the utility function is defined only up to a positive linear transformation. That is, given a utility function U, any other function U^* where $U^* = aU + b$, $a > 0$, will serve as well as the original function.

Thus Bernoulli's principle provides the means for ranking risky prospects in order of preference, the most preferred prospect being the one with the highest utility implying the maximization of utility. This is equivalent to maximization of expected utility or minimization of expected disutility according to the Expected Utility Theorem. It, thus, brings together explicitly the decision-maker's degrees of belief (or probability) and his degrees of preference (or utility) which are important subjective inputs in an analysis of decision-making (2, p. 68).

DATA USED FOR EMPIRICAL EXAMPLE

In order to quantify risk by applying Bernoulli's principle, data were used from a ten-hectare irrigated farm in Karnal district of Haryana State (25, pp. 77-81). The farmer's problem is to decide whether it will pay him to grow wheat by applying fertilizers according to the local cultivation practices, partial (25 per cent) package practices, half (50 per cent) package practices or full package practices. These four practices of applying fertilizers involve a per hectare expenditure of Rs. 150, Rs. 300, Rs. 400, and Rs. 600, respectively. The wheat yields and net income per hectare to fertilizer application will depend on whether the weather is excellent, good, normal or bad. The farmer's personal strengths of conviction about the weather conditions are that there is a 0.2 chance of a bad season, a 0.3 chance of a normal season, a 0.4 chance of a good season and only a 0.1 chance of an excellent season (26). With these expectations about the weather conditions as well as the response of wheat crop to fertilizer application, the budgeted net incomes per hectare are shown in Table I.

TABLE I—MONEY PAY-OFF TABLE FOR FERTILIZER INVESTMENT DECISION

Type of season (event)	Subjective probability	Possible actions and money pay-offs.			
		Spend Rs. 150/ ha.	Spend Rs. 300/ ha.	Spend Rs. 400/ ha.	Spend Rs. 600/ ha.
Bad	0·2	300	200	100	—200
Normal	0·3	600	800	820	1,500
Good	0·4	1,000	1,500	1,700	2,000
Excellent	0·1	1,600	3,000	3,300	3,600
Expected money value* ..		800	1,180	1,276	1,570

* Following Bernoulli's principle, the expected money value (utility) of different possible actions were calculated as follows :

U(spend Rs. 150/ha.) = 0·2 u(300) + 0·3 u(600) + 0·4 u(1,000) + 0·1 u(1,600) = 800.
U(spend Rs. 300/ha.) = 0·2 u(200) + 0·3 u(800) + 0·4 u(1,500) + 0·1 u(3,000) = 1,180.
U(spend Rs. 400/ha.) = 0·2 u(100) + 0·3 u(820) + 0·4 u(1,700) + 0·1 u(3,300) = 1,276.
U(spend Rs. 600/ha.) = 0·2 u(–200) + 0·3 u(1,500) + 0·4 u(2,000) + 0·1 u(3,600) = 1,570.

Data in Table 1 satisfy the ordering, continuity and independence postulates of the Expected Utility Theorem. Thus, for a farmer who abides by these postulates, Bernoulli's principle says that there exists a utility function U which associates a single real number (utility index) with each of the available actions. This utility index will correctly rank the actions in order of the farmer's preference and the utility of an action will be equal to its expected utility. Thus, our immediate concern is to obtain the farmer's utility curve by using the concept of certainty equivalent.

CERTAINTY EQUIVALENT

In order to draw the decision-maker's utility curve, we ask his certainty equivalents for a series of 50:50 gambles. A certainty equivalent is the amount exchanged with certainty that makes the decision-maker indifferent between this exchange and some particular risky prospect. For example, our farmer faced with the fertilizer investment problem might be indifferent between (*i*) taking a risky prospect, that is applying fertilizer having a 0.3 chance of gaining Rs. 10,000 and a 0.7 chance of losing Rs. 6,000 and (*ii*) a sure prospect, that is, applying fertilizer giving a gain of Rs. 3,300. Thus, his certainty equivalent for the risky prospect is Rs. 3,300. Through the process of reasoning, introspection and questioning, we ascertain the decision-maker's certainty equivalents for a series of 50:50 gambles. Then the risky prospects are arranged and related to each other in such a way that the decision-maker's utility curve could be drawn directly from his answers. The certainty equivalents of the money gains and money losses along with their utility values are shown in Table II.

TABLE II—DATA FOR PLOTTING THE FARMER'S UTILITY CURVE

Question	Certainty equivalent[1] (Rs.)	Utility value[2]
	Money gains	
	10,000	100
7	9,250	87·5
3	7,520	75
6	6,125	62·5
1	3,500	50
5	2,475	37·5
2	1,700	25
4	825	12·5
	0	0
	Money losses	
7	—410	—12·5
3	—746	—25
6	—955	—37·5
1	—1,800	—50
5	—2,610	—62·5
2	—3,220	—75
4	—4,825	—87·5
	—6,000	—100

1. *Source:* Appendix 1.
2. *Source:* Appendix 2.

EMPIRICAL UTILITY FUNCTION AND THE UTILITY CURVE

On the basis of data contained in Table II the utility functions of the following form were fitted separately which exhibited the farmer's risk aversion for money gains and his risk preference for the avoidance of money losses:

1) For the farmer's risk aversion for gains:

$$U(x) = ax + bx^2 \tag{4}$$

2) For the farmer's risk preference for the avoidance of money losses:

$$U(x) = ax - bx^2 \tag{5}$$

where U(x) is the utility value of the certainty equivalent x, x is the certainty equivalent of the risky prospect whose utility is equal to U(x), x^2 is the square term of x showing the curvature of the utility curve and a and b are the constant utility coefficients or the regression coefficients.

The order of asking questions was over two separate ranges, *viz,* Rs. 0 to Rs. 10,000 and Rs. 6,000 to Rs. 0 (Appendix 1). Therefore, due to this ordering of questions, two separate utility functions (6) and (7) were estimated. However, if ordering of the questions for money gains and money losses is over the continuous range from minus Rs. 6,000 to Rs. 10,000, only one utility function could be estimated.

The following utility functions were estimated:

1) For money gains:

$$U(x) = \underset{(0.00123477)}{0.01434124x^{***}} - \underset{(0.00000014)}{0.00000050x^{2*}}$$

$$\bar{R}^2 = 0.993 \qquad (6)$$

2) For money losses:

$$U(x) = \underset{(0.00188479)}{0.03208361x^{***}} + \underset{(0.00000038)}{0.00000267x^{2**}}$$

$$\bar{R}^2 = 0.994 \qquad (7)$$

Figures in parentheses indicate the standard errors of the estimates of the coefficients.
* Significant at 10 per cent level of significance.
** Significant at 2·5 per cent level of significance.
*** Significant at 1·0 per cent level of significance.

The values of the coefficient of determination (adjusted R^2) in the above utility functions show that the quadratic equation is an adequate fit (7, p. 31). By differentiating these estimated utility functions with respect to X which is the expected money value (gain or loss) or the certainty equivalent of the risky prospect, we get decreasing marginal utility (dU/dx) for $X > 0$ and increasing dU/dx for $X < 0$. However, $dU/dx \geqslant 0$ must always hold true since people prefer more money value than the loss. The value of $b < 0$ shows diminishing marginal utility reflecting the fact that variability in X is disliked. The value of $b > 0$ shows that variability in X is preferred. If $b = 0$, it shows the farmer's indifference to risk. In other words, if $b > 0$, the decision-maker is a risk preferer, if $b < 0$, he is a risk averter and if $b = 0$, he is risk indifferent. Thus, the coefficient b is a coefficient of risk preference or aversion.

It may be mentioned that because of the rounding of the decimal points in equations (6) and (7), the money gains and losses estimated from these equations and plotted in Figure 1 do not correspond to the utility value of 100 on the graph. However, Figure 1 suffices to indicate the fact that the farmer obtains diminishing satisfaction (utility) from every extra rupee of gain but increasing satisfaction from every extra rupee reduction in loss. Figure 1 can also be used to derive the certainty equivalent for a given risky prospect. For example, the risky prospect of spending Rs. 300 per hectare having an expected money value of Rs. 1,180 (Table I) has a utility of 15.9228. The utility curve (Figure 1) indicates that a utility of 15.9228 corresponds to a sure gain of Rs. 1,157.16 which can also be calculated by making use of the equation.[2] Under the linear transformations of the utility functions such as equations (6) and (7), the utility value (certainty equivalent) of the original risky prospect remains constant. Thus, for our farmer, indifference would exist between an action with a sure gain of Rs. 1,157.16 and the action to spend Rs. 300 per hectare with its specified probability distribution of consequences.

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[2] The equation used to find out such values is: $ax^2 + bx + c = 0$ or

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

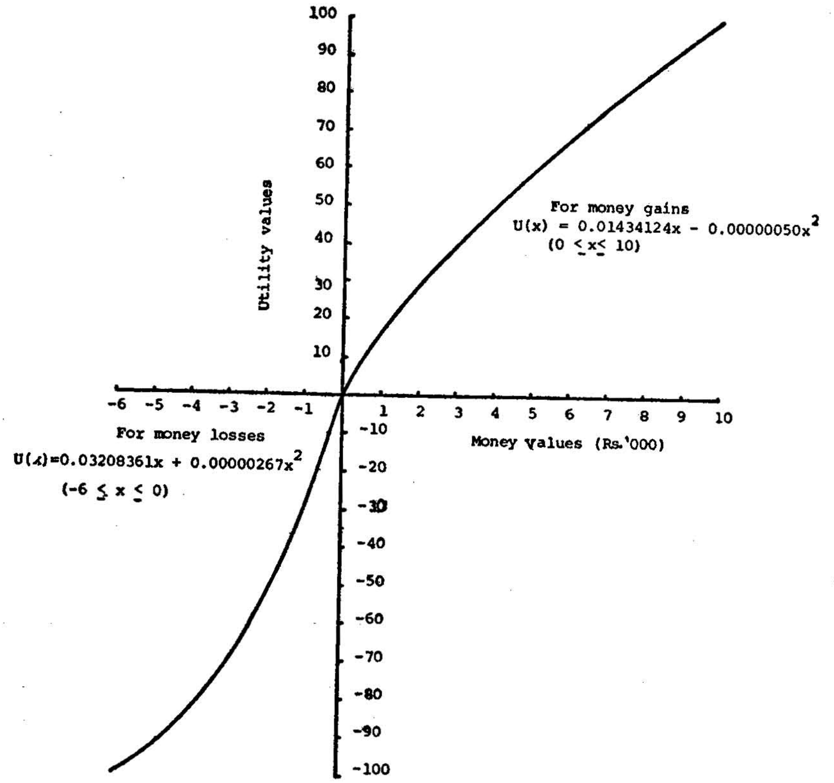

Figure 1—Utility Curve of the Farmer Showing Risk Aversion for Money Gains and Risk Preference for the Avoidance of Losses

THE PREFERRED (OPTIMAL) DECISION

The utility indices for each possible action of Table I may now be calculated by making use of equations (6) and (7) or from the utility curve in Figure 1. Ranking of these utility indices would correspond to the farmer's preferred or optimal decision for fertilizer investment.

Thus:

$$
\begin{aligned}
\text{U(Spend Rs. 150/ha.)} &= 0.2\text{U(Rs. 300)} + 0.3\text{U(Rs. 600)} + \\
&\quad 0.4\text{U(Rs. 1,000)} + 0.1\text{U (Rs. 1,600)} \\
&= 0.2(3.8524) + 0.3(6.8048) + \\
&\quad 0.4(9.3413) + 0.1(10.1460) \\
&= 0.7705 + 2.0412 + 3.7365 + 1.0146 \\
&= 7.5628.
\end{aligned}
$$

$$\begin{aligned}
\text{U(Spend Rs. 300/ha.)} &= 0.2\text{U(Rs. 200)} + 0.3\text{U(Rs. 800)} + \\
&\quad 0.4\text{U(Rs. 1,500)} + 0.1\text{U(Rs. 3,000)} \\
&= 0.2(2.8483) + 0.3(11.1530) + \\
&\quad 0.4(20.3869) + 0.1(38.5237) \\
&= 0.5697 + 3.3459 + 8.1548 + 3.8524 \\
&= 15.9228. \\
\text{U(Spend Rs. 400/ha.)} &= 0.2\text{U(Rs. 100)} + 0.3\text{U(Rs. 820)} + \\
&\quad 0.4\text{U(Rs. 1,700)} + 0.1\text{U(Rs. 3,300)} \\
&= 0.2(1.4292) + 0.3(11.4236) + \\
&\quad 0.4(22.9351) + 0.1(41.8811) \\
&= 0.2858 + 3.4271 + 9.1741 + 4.1881 \\
&= 17.0751. \\
\text{U(Spend Rs. 600/ha.)} &= 0.2\text{U(—Rs. 200)} + 0.3\text{U(Rs. 1,500)} + \\
&\quad 0.4\text{U(Rs. 2,000)} + 0.1\text{U(Rs. 3,600)} \\
&= 0.2(-2.8883) + 0.3(20.3869) + \\
&\quad 0.4(26.6825) + 0.1(45.1485) \\
&= -0.5777 + 6.1161 + 10.6732 + 4.5149 \\
&= 20.7265.
\end{aligned}$$

These utility indices when ranked correspond to the farmer's preference for spending Rs. 600/ha. over spending Rs. 400/ha. over spending Rs. 300/ha. over spending Rs. 150/ha. Therefore, the farmer's optimal or the best-bet decision is to spend Rs. 600/ha. to fertilize his wheat crop. This would also conform to the existing fertilizer recommendations to the farmers by the local extension agencies.

CONCLUSION

The above discussion is primarily methodological in nature and the decision problem discussed is rather simple. Such a simple problem could be solved by estimating certainty equivalents (27) for a restricted number of risky choices facing the decision-maker. In that case, it is not necessary to estimate the utility function. However, many decision problems are not so simple. Most of them are so complex and the data are so large that the certainty equivalent approach requiring the decision-maker's intuition breaks down. Under such a situation, if the decision-maker abides by the postulates of ordering, continuity and independence, Bernoulli's principle can be used to quantify risk for arriving at the optimal decision under uncertainty.

I. J. Singh*

APPENDIX 1

Questions to Ask:

The questions to be asked from the farmer amount to ascertaining his certainty equivalent for a series of 50: 50 gambles. These risky prospects are arranged and related to each other in such a way that we can draw the farmer's utility curve directly from his answers. Each question is of the following form, with specific money amounts rather than x, y and z:

> "If you had a 50: 50 chance of getting Rs. x or Rs. y, versus the certainty of getting Rs. z, which alternative would you prefer? The risky prospect of Rs. x or Rs. y or the sure prospect of Rs. z?"

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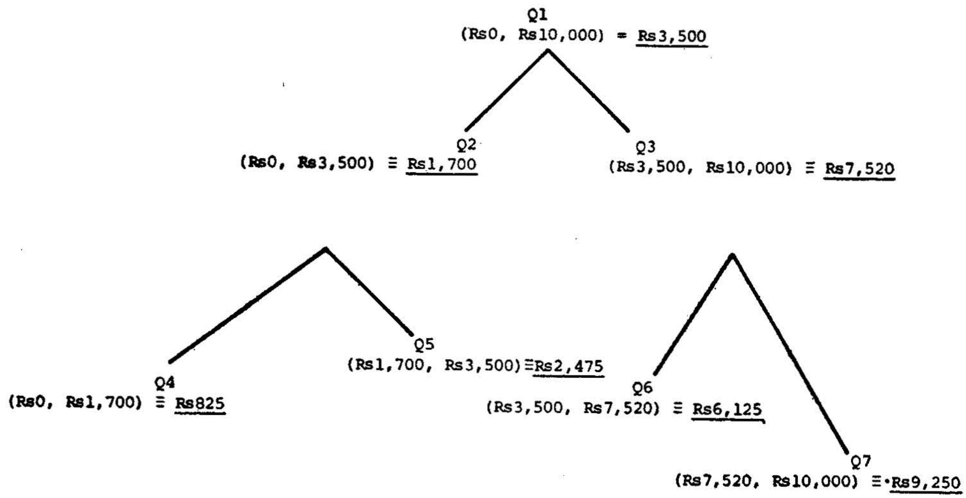
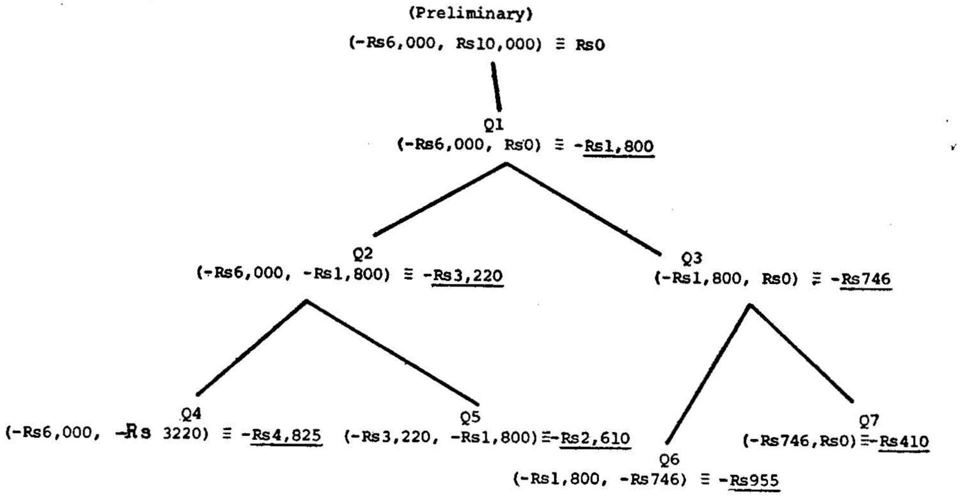
Here the aim is to find the size of z which just makes the farmer indifferent between the sure prospect of Rs. z and the 50:50 prospect of Rs. x or Rs. y. In other words, we want the farmer's certainty equivalent for the risky prospect. Thus, if the farmer prefers the gamble, then this shows that initially the size of z was set too high. We must go on repeating the question with a higher or lower size of z until we find that size of z which just makes the farmer indifferent. Once we have found this particular z value (certainty equivalent), we use it in our next set of questions. In this fashion we build a chain of 50:50 gambles each involving some base value and the certainty equivalent from our prior set of questions. Thus, the certainty equivalent value from each prior question becomes one of the elements in the 50:50 gamble of the next question.

The numerical example of the sequence of questions* used to ascertain the farmer's utility function for money gains is over the range Rs. 0 to Rs. 10,000. For money losses the range is —Rs. 6,000 to Rs. 0. Underlined numbers are the finally ascertained answers (certainty equivalent) at each stage of the question sequence.



(2) For money losses:



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* The question sequence used here is the one developed by Makeham *et al.* (14).

APPENDIX 2

Utility values for money gains and losses for the sequence of questions in Appendix 1 were obtained by using the following formula:

$u(\text{Rs. } z) = 0\cdot5\ u(x) + 0\cdot5\ u(y)$

where z is the certainty equivalent, that is, the finally ascertained answer for the sequence of questions in Appendix 1, for the 50:50 gamble of x or y. Thus, the utility values for the sequence of questions are:

(1) For money gains:

Q. 1
$$\begin{aligned} u(\text{Rs. } 3{,}500) &= 0\cdot5u(\text{Rs. } 0) + 0\cdot5u(\text{Rs. } 10{,}000) \\ &\quad \text{By arbitrarily assigning:} \\ u(\text{Rs. } 0) &= 0 \text{ and } u(\text{Rs. } 10{,}000) = 100 \\ &\quad \text{we get;} \\ u(\text{Rs. } 3{,}500) &= 0\cdot5(0) + 0\cdot5(100) \\ &= 50 \end{aligned}$$

Q. 2
$$\begin{aligned} u(\text{Rs. } 1{,}700) &= 0\cdot5u(\text{Rs. } 0) + 0\cdot5\ u(\text{Rs. } 3{,}500) \\ &= 0\cdot5(0) + 0\cdot5(50) \\ &= 25 \end{aligned}$$

Q. 3
$$\begin{aligned} u(\text{Rs. } 7{,}520) &= 0\cdot5\ u(\text{Rs. } 3{,}500) + 0\cdot5\ u(\text{Rs. } 10{,}000) \\ &= 0\cdot5(50) + 0\cdot5(100) \\ &= 25 + 50 \\ &= 75 \end{aligned}$$

Q. 4
$$\begin{aligned} u(\text{Rs. } 825) &= 0\cdot5u(\text{Rs. } 0) + 0\cdot5\ u(\text{Rs. } 1{,}700) \\ &= 0\cdot5(0) + 0\cdot5(25) \\ &= 12\cdot5 \end{aligned}$$

Q. 5
$$\begin{aligned} u(\text{Rs. } 2{,}475) &= 0\cdot5\ u(\text{Rs. } 1{,}700) + 0\cdot5\ u(\text{Rs. } 3{,}500) \\ &= 0\cdot5(25) + 0\cdot5(50) \\ &= 37\cdot5 \end{aligned}$$

Q. 6
$$\begin{aligned} u(\text{Rs. } 6{,}125) &= 0\cdot5\ u(\text{Rs. } 3{,}500) + 0\cdot5\ u(\text{Rs. } 7{,}520) \\ &= 0\cdot5(50) + 0\cdot5(75) \\ &= 62\cdot5 \end{aligned}$$

Q. 7
$$\begin{aligned} u(\text{Rs. } 9{,}250) &= 0\cdot5\ u(\text{Rs. } 7{,}520) + 0\cdot5\ u(\text{Rs. } 10{,}000) \\ &= 0\cdot5(75) + 0\cdot5(100) \\ &= 87\cdot5 \end{aligned}$$

(2) For money losses:

From preliminary question:
$$\begin{aligned} u(\text{Rs. } 0) &= 0\cdot5\ u(-\text{Rs. } 6{,}000) + 0\cdot5\ u(\text{Rs. } 10{,}000) \\ u(0) &= 0\cdot5\ u(-\text{Rs. } 6{,}000) + 0\cdot5(100) \\ 0 &= 0\cdot5\ u(-\text{Rs. } 6{,}000) + 0\cdot5(100) \\ 0 &= u(-\text{Rs. } 6{,}000) + 100 \\ \therefore\ u(-\text{Rs. } 6{,}000) &= -100 \end{aligned}$$

Q. 1
$$\begin{aligned} u(-\text{Rs. } 1{,}800) &= 0\cdot5\ u(-\text{Rs. } 6{,}000) + 0\cdot5\ u(\text{Rs. } 0) \\ &= 0\cdot5(-100) + 0\cdot5(0) \\ &= -50 \end{aligned}$$

Q. 2
$$\begin{aligned} u(-\text{Rs. } 3{,}220) &= 0\cdot5\ u(-\text{Rs. } 6{,}000) + 0\cdot5\ u(-\text{Rs. } 1{,}800) \\ &= 0\cdot5(-100) + 0\cdot5(-50) \\ &= -75 \end{aligned}$$

Q. 3
$$\begin{aligned} u(-\text{Rs. } 746) &= 0\cdot5\ u(-\text{Rs. } 1{,}800) + 0\cdot5\ u(\text{Rs. } 0) \\ &= 0\cdot5(-50) + 0\cdot5(0) \\ &= -25 \end{aligned}$$

Q. 4
$$\begin{aligned} u(-\text{Rs. } 4{,}825) &= 0\cdot5\ u(-\text{Rs. } 6{,}000) + 0\cdot5\ u(-\text{Rs. } 3{,}220) \\ &= 0\cdot5(-100) + 0\cdot5(-75) \\ &= -87\cdot5 \end{aligned}$$

Q. 5
$$\begin{aligned} u(-\text{Rs. } 2{,}610) &= 0\cdot5\ u(-\text{Rs. } 3{,}220) + 0\cdot5\ u(-\text{Rs. } 1{,}800) \\ &= 0\cdot5(-75) + 0\cdot5(-50) \\ &= -62\cdot5 \end{aligned}$$

Q. 6
$$\begin{aligned} u(-\text{Rs. } 955) &= 0\cdot5\ u(\text{Rs. } 1{,}800) + 0\cdot5\ u(-\text{Rs. } 746) \\ &= 0\cdot5(-50) + 0\cdot5(-25) \\ &= -37\cdot5 \end{aligned}$$

Q. 7
$$\begin{aligned} u(-\text{Rs. } 410) &= 0\cdot5\ u(-\text{Rs. } 746) + 0\cdot5\ u(\text{Rs. } 0) \\ &= 0\cdot5(-25) + 0\cdot5(0) \\ &= -12\cdot5 \end{aligned}$$

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