20

Decision Making in an Environment of Risk And Uncertainty

This chapter provides a very basic introduction to how risk and uncertainty can be incorporated into farm planning, with an emphasis on the marginal analysis developed in Chapters 2 to 18. Risk and uncertainty are defined. The role of farmer attitudes and objectives in determining particular strategies for dealing with risk and uncertainty is discussed. Expected prices and yields might be used to replace actual prices and yields in marginal analysis models. A simple marginal analysis model incorporating income variability is developed. Alternative strategies for dealing with risk and uncertainty at the farm level are compared.

Key terms and definitions:

Risk
Uncertainty
Risk Uncertainty Continuum
Probability
Expected Income
States of Nature
Action
Consequences
Utility
Utility Function
Variance
Expected Price
Expected Yield
Income Variability
Insurance
Contract
Flexible Facilities and Equipment
Diversification
Government Program

20.1 Risk and Uncertainty Defined

Farmers face situations nearly every day in which the outcomes are uncertain. Nature has a significant impact on farming. For example, it may not rain or it may rain too much. Crops can get hailed out or insects and disease can destroy a crop. An apple or orange crop may get frost, and animals develop diseases and die. Thus farming is inherently linked to the path of nature.

The markets affect farmers to a great degree as well. Farmers complain that prices are high when they have nothing to sell and that prices are low when crop yields are high. Prices for agricultural commodities are largely determined by forces outside the control of the individual farmer. Farming takes place in an environment characterized by risk and uncertainty.

Frank Knight was the one initially responsible for making a distinction between the term *risk* and the term *uncertainty*. He argued that in an uncertain environment, possible outcomes and their respective probabilities of occurrence were not known. In a risky environment, both the outcomes and the probabilities of occurrence are known.

Some economists have suggested that to deal with risk, all that is needed is an insurance policy. The insurer can discover the outcomes and the probabilities of their occurrence and write a policy with a premium sufficient to cover the risk and net a profit to the insurer.

Uncertainty cannot be dealt with as easily. If the outcomes and the probabilities associated with each outcome are not known, the insurer would not be able to write a policy with a premium sufficient to cover the risk. Recently, some insurance companies have written policies designed to pay for losses resulting from the occurrence of very unusual events. It is difficult to believe that insurance companies have complete knowledge of the probabilities associated with these events, so distinguishing between risk and uncertainty on the basis of insurability is not the final answer.

Rather than to think of *risk* and *uncertainty* as dichotomous terms, it may be more appropriate to think of a risk uncertainty continuum (Figure 20.1). At one end of the continuum lie risky events, in which the outcomes and the probabilities attached to each outcome are known. At the other end of the continuum lie uncertain events, in which neither outcomes nor probabilities of their occurrence are known. Many events taking place in farming lie between the polar extremes of risk and uncertainty. Usually, some but not all of the possible outcomes are known, and some but not all outcomes have probabilities attached to them. Much of farming lies midway on the risk uncertainty continuum.

20.2 Farmer Attitudes Toward Risk and Uncertainty

One of the problems in dealing with risk and uncertainty is that individuals, including farmers, vary markedly in their willingness to take on, and preferences for, risk and uncertainty. No one would normally enter an environment characterized by risk and uncertainty without expectations of gains greater than would be the case in the absence of risk and uncertainty.

Figure 20.1. A Risk and Uncertainty Continuum

That individuals vary markedly in their willingness to take on risk and uncertainty can be illustrated with a simple class game. Suppose that a person is confronted with four different strategies. Each strategy will produce varying levels of income and have probabilities attached to each income level. The four strategies are outlined in Table 20.1. The outcomes and the probability of each outcome are known with certainty. The probability assigned to each strategy represents the expected proportion of times the specified income is expected to occur, relative to the total t times the particular strategy (A, B, C, or D) is pursued. For each strategy, the probabilities sum to 1, indicating that for each strategy, only the three income levels are possible. Each member of the class might vote on the strategy that he or she would pursue.

One way to determine which strategy to pursue would be to calculate the expected income occurring as the result of each strategy. The expected income is the income resulting from the strategy weighted by its probability of occurrence. For strategy A, the expected income is (0.3 x 1,000,000) + (0.2 x !500,000) + (0.5 x 0) = $200,000. For strategy B, the expected income is (0.3 x 100,000) + (0.4 x 50,000) + (0.2 x 0) + (0.1 x !20,000) = $48,000. For strategy C, the expected income is (0.7 x 50,000) + (0.2 x 30,000) + (0.1 x 0) = $41,000. For strategy D, the expected income is (0.4 x 30,000) + (0.4 x 25,000) + (0.2 x 15,000) = $25,000. So based on expected income, strategy A would always be pursued, despite the fact that strategy A also allows for the greatest potential losses.

The strategy that is pursued depends in part on the person's particular financial situation. Suppose that if a positive income was not achieved, the person would lack funds necessary to meet the basic needs of life, and would starve. Such a person would be reluctant to pursue any strategy other than D, but a person with a $1 million already in the bank would probably choose strategy A. The worst that person could do is lose half of what he or she already had.

The strategy each person chooses is largely unrelated to intelligence or education. There is probably no relationship between the strategy that each person selects and his or her score on the last hour exam in agricultural production economics. College graduates would not necessarily tend to choose strategies different from high school graduates. All millionaires are not college graduates. Those in bankruptcy are not all high school dropouts.

Table 20.1 Alternative Income-Generating Strategies

Strategy	Income	Probability
A	$1,000,000	0.3
	−500,000	0.2
	0	0.5
B	100,000	0.3
	50,000	0.4
	0	0.2
	−20,000	0.1
C	50,000	0.7
	30,000	0.2
	0	0.1
D	30,000	0.4
	25,000	0.4
	15,000	0.2

Each person thus has a different preference for risk and uncertainty versus certainty that is very much intertwined with his or her own psychic makeup. So also it is with farmers. Anyone can cite examples of farmers who pursued high-risk strategies that paid off. Examples of farmers who pursued high risk strategies and went bankrupt are also commonplace, and there are numerous examples of farmers who pursued secure strategies, made a living at farming, but never became wealthy. Self-made millionaires vary widely in intelligence and education, but share a common characteristic in that they are willing to assume large amounts of risk with little, if any, fear if things should not go their way.

Professions vary in the amount of risk. The race car driver assumes enormous amounts of risk in the pursuit of a potentially high payoff. College professors and others in secure, stable occupations are frequently quite risk averse.

Farmers as a group probably prefer to take on more risk than college professors as a group. Nearly every extension agricultural economist has had the opportunity to work with farmers whose incomes exceed the income of the extension agricultural economist several times over. If farmers were not willing to assume some risk, they would have long ago chosen an occupation with a steady income with little variability from year to year. Rather, they let the whims of nature and the marketplace in large measure determine their annual incomes. Students from farm backgrounds sometimes attend an agricultural college in hopes of securing a job that has less income variability than was present on the farm back home.

20.3 Actions, States of Nature, Probabilities, and Consequences

A farmer must have alternatives open in order to make a decision. If two or more alternatives are not available, a decision cannot be made. The alternatives available to a farmer represent the *actions* or *strategies* open to the farmer. The set of actions should encompass the full range of alternatives open to the farmer. In the game in Section 20.2, the actions were represented by the alternative strategies. There are usually a finite number of actions or strategies open to the manager.

The *states of nature* represent the best guess by the decision maker with regard to the possible events that might occur. States of nature are assumed to be outside the control of the decision maker, and in combination with the decision maker's actions determine the outcomes for the decision maker.

Probabilities can be attached to each outcome. They represent the manager's guess as to the number of occurrences of a particular outcome relative to the total number of possible outcomes resulting from a particular strategy. For example, if a particular outcome is expected to occur 3 times out of 10, a probability of 0.3 will be assigned. If all outcomes for each strategy are delineated, then the sum of the probabilities associated with each strategy will be 1. This was the case in the game in Section 20.2.

Consequences represent outcomes that are produced by the interaction of the manager's actions and the states of nature. Consequences represent what could happen to the manager. The various income levels represented the outcomes or consequences associated with each strategy in the game.

These terms can be further illustrated with another game. Suppose that the farmer is faced with two options, to grow wheat or soybeans. Assume that nature also has two states, one producing high yields and the other producing low yields. The income resulting from each combination of decision!maker strategies and states of nature, and the corresponding subjective probabilities attached to each state of nature. The resultant matrix is:

State of Nature and Probabilities

Action	High Yields: 0.6	Low Yields: 0.4
Grow Soybeans	\$20,000	\$ 3,000
Grow Wheat	\$15,000	\$10,000

The expected income if the farmer grows soybeans is

$$(0.6)(\$20{,}000) + (0.4)(\$3000) = \$13{,}200$$

The expected income if the farmer grows wheat is

$$(0.6)(\$15{,}000) + (0.4)(\$10{,}000) = \$13{,}000$$

If the farmer is interested in maximizing expected income, he or she would be better off to grow soybeans than wheat. However, the farmer might also be concerned with income variability.

20.4 Risk Preference and Utility

The farmer's willingness to take on risk is in large measure linked to his or her psychic makeup. The satisfaction or utility that a farmer receives from each outcome in large measure determines the strategy that he or she will pursue. The maximization of utility subject to constraints imposed by the availability of income is the ultimate goal of a farmer, or for that matter, anyone.

A utility function links utility or satisfaction to the amount of one or more goods that are available. Utility maximization becomes the criterion by which choices are made by the manager. A farmer's utility or satisfaction is not unrelated to his or her expected income, but it is not the same thing as his or her expected income either. If utility and expected income were the same thing, the farmer interested in utility maximization would always choose the strategy that yielded the highest expected income.

In the game outlined in section 20.2, consider a possible strategy *E* that yielded $300,000 with a 0.5 probability, and $100,000 with a 0.5 probability. If expected income and utility were the same, everyone would be indifferent between this strategy and strategy A presented in Table 20.1. Most people probably would strongly prefer strategy *E* to strategy A, despite the fact that both strategies yield the same expected income of $200,000. Clearly, there is more to maximizing utility than maximizing expected income.

A good deal of effort by economists has been devoted to proofs that utility functions exist for individuals and, in particular, for farm managers. Figure 20.2 illustrates three possibilities with respect to possible functions linking utility to income. Assuming that the farmer can achieve greater income only at the expense of taking on greater risk or uncertainty, the risk averter will have a utility function that increases at a decreasing rate as income rises. The utility function for the risk neutral person will have a constant slope. The utility function for the risk preferrer will increase at an increasing rate.

One utility function that is sometimes assumed is the quadratic utility function

†20.1 $$U = z + bz^2$$

where z is some variable of concern that generates utility for the manager, such as income. Suppose that there exists uncertainty with regard to the income level, so that z is replaced by an expected z or $E(z)$. Therefore, expected utility is

†20.2 $$E(U) = E(z) + bE(z^2)$$

The expected value of a squared variable is equal to the variance of the variable plus the square of the expected value. Therefore,

†20.3 $$E(z^2) = F^2 + [E(z)]^2$$

Hence

†20.4 $$E(U) = E(z) + b[E(z)]^2 + bF^2$$

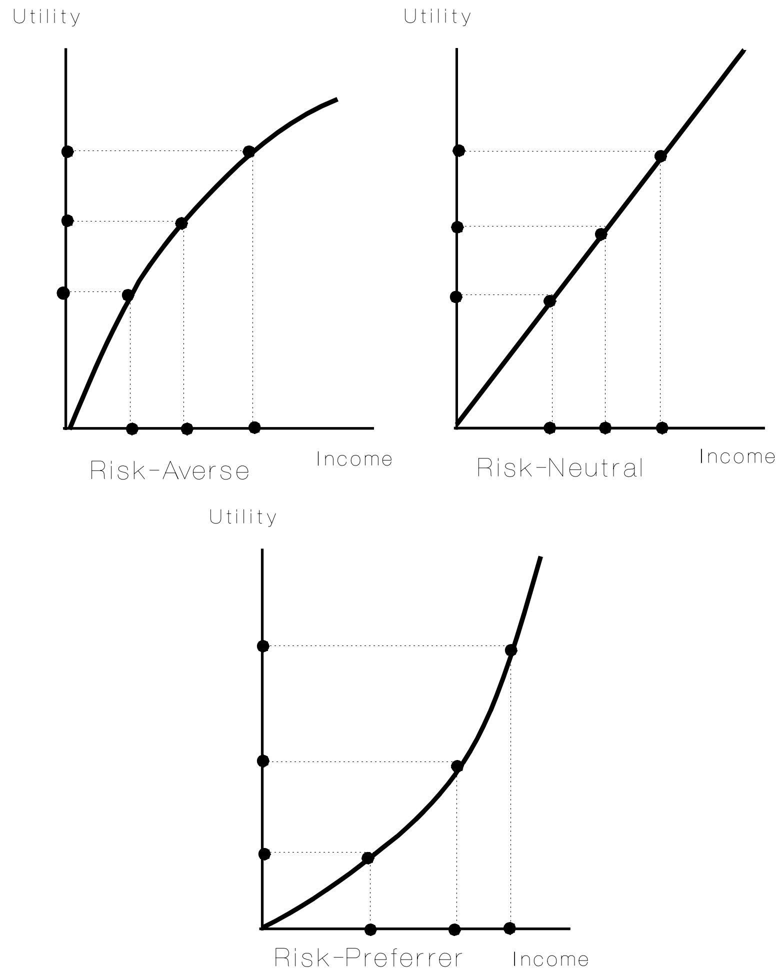

Figure 20.2 Three Possible Functions Linking Utility to Income

Thus utility is a function not only of expected income, but also its variance. Indifference curves that show possible combinations of income and its variance that yield the same amount of utility for the manager might be obtained by assuming that U equals U° and taking the total differential of the utility function

†20.5 $$dU^{\circ} = 0 = (1 + 2b)\, dE(z) + b\, d(\sigma^2)$$

Therefore,

†20.6 $$dE/d\sigma^2 = -b/[1 + 2bE(z)]$$

The denominator $[1 + 2bE(z)]$ will always be positive. The shape of the indifference curves will depend on the value of *b*. If *b* is zero, the farmer neither desires nor dislikes risk. The farmer is risk neutral. If *b* is positive, the farmer loves risk, and indifference curves will have a negative slope. If *b* is negative, the farmer is risk averse and will have indifference curves sloping upward to the right. Figure 20.3 illustrates some possible relationships suggested by this utility function.

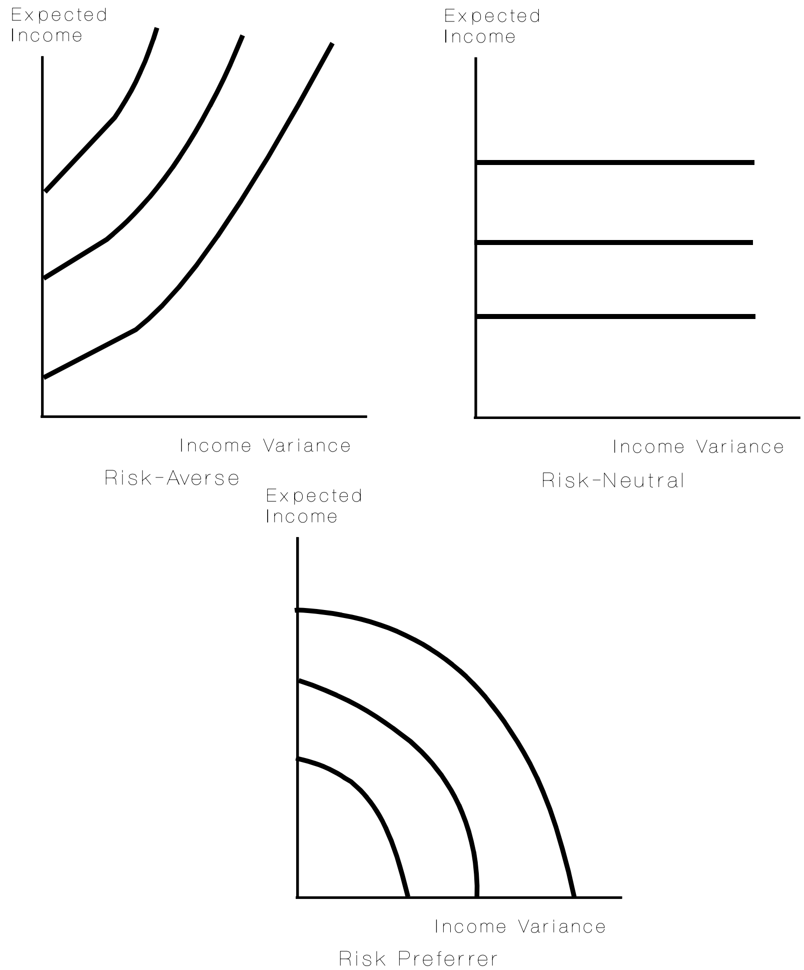

Figure 20.3 Indifference Curves Linking the Variance of Expected Income with Expected Income

20.5 Risk, Uncertainty and Marginal Analysis

The models in this text that used marginal analysis all assumed that input prices, output prices, and outputs were known with certainty. There exist several ways of incorporating risk and uncertainty into these models, while relying on marginal analysis as the basic tool for decision ! making information.

One of the simplest ways of incorporating risk and uncertainty into a model might be to use expected prices or yields rather than actual prices or yields within the model. Just how yield and price expectations are formulated by farmers has been a topic of great concern to some agricultural economists.

An agricultural economist interested in the futures market might argue that one way a farmer formulates price expectations is by studying the prices on futures contracts for the month in which the crops or livestock are expected to be marketed. The futures market does not necessarily predict with a high degree of accuracy what the cash price will be some time in the future. However, the prices for futures contracts are an additional piece of information that the farmer might be able to use at least as a partial basis for developing expectations with regard to prices at marketing time. The farmer might also take advantage of the futures market to determine specific prices at the time of delivery, and these prices could be treated the same as a certain price within the model.

Farmers have many other sources of information with regard to expected prices. The news media, farm magazines, the agricultural extension service, the federal government, and private price forecasting agencies all devote considerable effort to providing price and general outlook information for farmers. One problem with this information is that the quality can vary widely. The farmer must not only study the forecasts obtained from each source, but also attach subjective probabilities with respect to its accuracy.

Farmers rely heavily on current and recent past prices as a means of formulating price expectations. If the cash price of corn at the start of the production season is high relative to soybeans, almost certainly there will be an increase in corn acreages irrespective of what prices are forecasted to prevail at the time the crop is marketed. Current and recent past cash prices may not accurately represent the prices that should be included in a profit maximization model.

Yield or output expectations are usually largely based on past experience with the particular commodity. Suppose that a farmer experienced corn yields of 130 bushels per acre last year, 114 bushels per acre the year before, and 122 bushels per acre the year before that. A simple way of formulating a yield expectation might be to average the yield over the past three years. This would treat each of the past three years as equally important in the formulation of the yield expectation. In this example, the expected yield would be 122 bushels per acre.

Another way would be to weight more heavily data from the recent past relative to earlier data. Expected output becomes a distributed lag of past output levels. For example, a farmer might place a weight of 0.6 on last year's data, 0.3 on the year before, but 0.1 on the year previous to that. The weights representing the relative importance of each year's data are highly subjective but should sum to 1. The expected yield in this example is

†20.7 $y = 0.6(130) + 0.3(114) + 0.1(122) = 124.4$ bushels per acre.

Once price and output expectations have been formulated, they could be inserted directly into the model. The marginal conditions would then be interpreted based on expected rather than actual prices.

The major disadvantage of using expected price and output levels as the basis for formulating economic models is that the approach fails to recognize that price and output variability leads to income variability for the farmer. Only if the farmer is risk neutral is the expected profit maximum optimal for the farmer. Despite the fact that a model using expected prices and output levels leads to maximum profits when expected prices and outputs are realized, income variability when expected prices and yields are not realized may lead to severe financial problems for the farmer. Even if expected prices and outputs are accurate over a planning horizon of several years, the farmer must survive the short run variability in order to make the long run relevant.

One way of incorporating such variability into a model would be to add additional constraints. Suppose that the farmer used an input bundle to produce two outputs, y_1 and y_2. Due to price and output instability, there is income variability associated with both y_1 and y_2. The income variability associated with y_1 is $y_1\mathsf{F}_1^2$, and the income variability associated with y_2 is $y_2\mathsf{F}_2^2$. The income variability associated with the first commodity may partially offset or add to the income variability from the second commodity. An interaction term or covariance term is needed. This term that adjusts for income variability interaction is $2y_1y_2\mathsf{F}_{12}$.

The total income variability (*) is

†20.8 $$* = y_1\mathsf{F}_1^2 + y_2\mathsf{F}_2^2 + 2y_1y_2\mathsf{F}_{12}$$

The farmer is interested in maximizing revenue subject to the constraint that income variability not exceed a specified level *°, and the constraint imposed by the availability of dollars for the purchase of the input bundle *x*. So the Lagrangean is

†20.9 $$L = p_1y_1 + p_2y_2 + \mathsf{R}(*° \ ! \ y_1\mathsf{F}_1^2 \ ! \ y_2\mathsf{F}_2^2 \ ! \ 2y_1y_2\mathsf{F}_{12})$$
$$+ \mathsf{0}[vx° \ ! \ vg(y_1, y_2)]$$

The corresponding first order conditions are

†20.10 $$\mathsf{M}L/\mathsf{M}y_1 = p_1 \ ! \ \mathsf{R}(\mathsf{F}_1^2 + 2y_2\mathsf{F}_{12}) \ ! \ \mathsf{0}vg_1 = 0$$

†20.11 $$\mathsf{M}L/\mathsf{M}y_2 = p_2 \ ! \ \mathsf{R}(\mathsf{F}_2^2 + 2y_1\mathsf{F}_{12}) \ ! \ \mathsf{0}vg_2 = 0$$

†20.12 $$\mathsf{M}L/\mathsf{MR} = *° \ ! \ y_1\mathsf{F}_1^2 \ ! \ y_2\mathsf{F}_2^2 \ ! \ 2y_1y_2\mathsf{F}12 = 0$$

†20.13 $$\mathsf{M}L/\mathsf{M0} = vx° \ ! \ vg(y_1, y_2) = 0$$

If there were no income variability, the first-order conditions would be the same as the standard first-order conditions in the product-product model. Income variability could reduce or increase the output of y_1 relative to y_2. The signs on the income variance covariance terms are indeterminate. Income variability can be incorporated into a standard model, but the key problem with this is that the farmer would need to be able to provide an indication of the variances and covariances associated with the incomes obtained from the commodities being produced.

20.6 Strategies for Dealing with Risk and Uncertainty

A farmer has a number of strategies available for ameliorating the impacts of risk and uncertainty. Each of these strategies reduces losses when nature is unfavorable or the markets turn against the farmer, but also reduce potential profits when nature and the markets are favorable.

20.6.1 Insure Against Risk

If an insurance policy is available, income variability due to that source of risk can be reduced by purchasing the policy. People purchase fire insurance not because they expect their house to burn down, but because the cost of the insurance is low relative to the potential loss that could occur should the house burn. Insurance policies work best when the probability attached to the occurrence of the event is low, but if the event occurs, the result would be catastrophic. In other words, insurance should be used in situations where there is a low probability of a large loss.

Crop insurance plans have the effect of making the farmer's income from one year to the next more even, despite the fact that the farmer may pay in the form of premiums somewhat more than is returned in the form of claims over a 10 year period. The premium cost reduces potential profits in years without a crop loss. Only if the risk of crop failure on a particular farm substantially exceeds the risks on which the premiums were based will returns from the insurance policy more than offset premium costs.

20.6.2 Contracts

The futures market can be thought of as a device which allows farmers to contract for the sale of a specified commodity at a specified price for delivery at some future point in time. Thus the futures market is a mechanism to reduce or eliminate price uncertainty by determining prices to be paid after harvest, or at the point when the commodity is ready for market. Although price and income variability will be reduced, in a rising market, the farmer will limit potential gains if prices are determined at the start of the production season.

The futures market is but one contractual arrangement for eliminating price uncertainty. Any contractual arrangement that at the start of the production season specifies a price to be received at the end of the production season will eliminate price uncertainty. Contractual arrangements are commonly used for commodities such as broilers, horticultural crops, and sunflowers. Any contractual price would work well in a marginal analysis model, since it represents price certainty.

20.6.3 Flexible Facilities and Equipment

If a farmer is to adjust to changing relative product and input prices, it must be possible to adapt buildings and equipment lasting more than one production season to alternative uses as input and output price ratios change. Figure 20.4 illustrates some possibilities. The long!run product transformation function represents the possibilities open to the farmer before buildings are built and equipment is purchased (curve A). Once the durable items have been built and capital committed, two possibilities exist.

Specialized facilities will allow production to take place on the long run planning curve if relative price ratios turn out to be as expected over the long term. But production drops off dramatically if the use of the buildings and equipment is changed to produce another mix of outputs in response to changing relative prices (curve B). A milking parlor is an example of a livestock facility ill adapted to other uses. Specialized harvesting equipment for a new crop not previously grown by the farmer (such as sunflowers in a farming area devoted to wheat and other small grains) is another example.

If a good deal of price variability is expected, a better strategy might be to construct buildings and to purchase machinery and equipment adapted to a wide variety of uses with little additional cost (curve C). A point on the long!run planning curve is never achieved under any conceivable output price ratio. A barn suited for the production of many different classes of livestock is an example of a flexible facility. In grain production, planting tillage

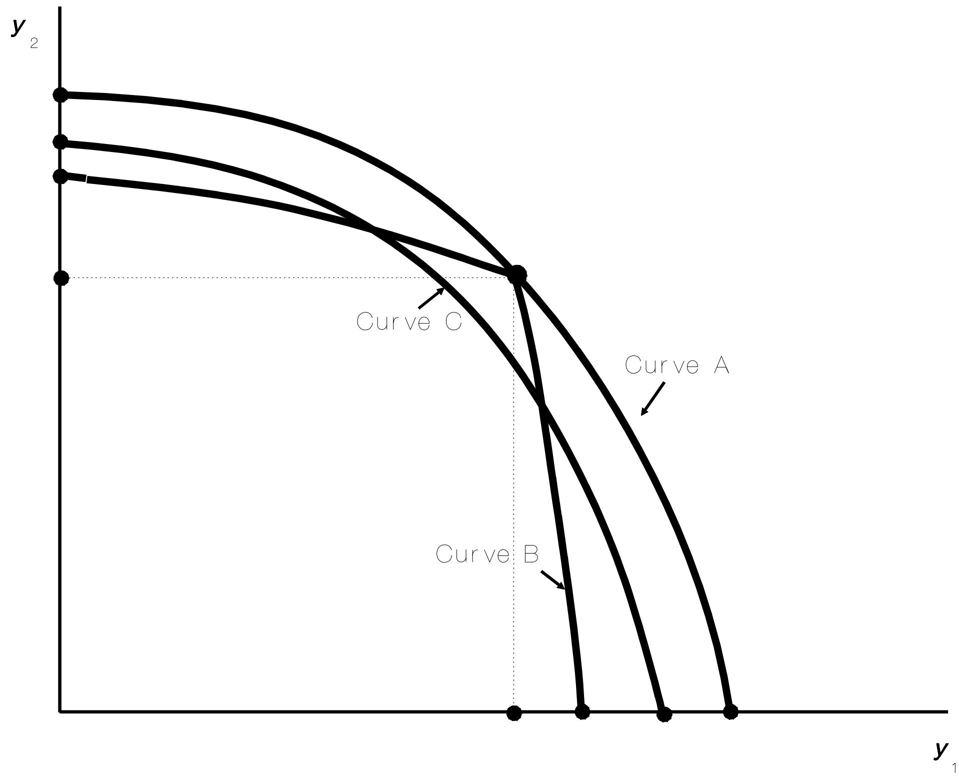

Figure 20.4 Long Run Planning: Specialized and Nonspecialized Facilities

and harvest equipment adapted to an array of different crops represents flexible equipment. The farmer is better off under extreme price variability with flexible facilities and equipment. The farmer is better off with the specialized facilities if price variability is not extreme.

A farmer who attempts to deal with price uncertainty by choosing to build or purchase machinery and facilities adaptable to a diverse array of uses is, in effect, choosing facilities allowing for a greater elasticity of substitution on the product side. A facility suitable only for the production of one commodity, or two commodities in an exact fixed proportion to each other, would lead to a zero elasticity of substitution on the product side.

20.6.4 Diversification

Diversification is a strategy long used by farmers for dealing with both price and output uncertainty. The idea behind a diversification strategy is to let profits from one type of livestock or crop enterprise more than offset losses in another enterprise. Diversification may also make more effective use of labor and other inputs throughout the year, thus increasing income in both good years and bad. To deal most effectively with price and income variability, the enterprises on the diversified farm must have prices and outputs that move opposite to each other.

It does little good to attempt to reduce output variability by both growing wheat and raising beef cattle, if wheat yields are low when rainfall is inadequate, and at the same time, beef cattle cannot be adequately fed on pastures with inadequate rainfall. To guard against uncertainty associated with drought, the farmer would need to find an enterprise in which the output is not as rainfall dependent, and this may be difficult.

The strategy may be more effective for dealing with price uncertainty. Beef and grain prices sometimes move together, but not always, nor do beef and pork prices always move in tandem. The ideal strategy would involve locating commodities whose prices always move in opposite directions. While a farmer who diversifies may substantially reduce income variability and make more effective use of certain inputs, income could also be reduced relative to what would have occurred had production of only the high ! priced commodity taken place. The diversified farmer also bears a cost in not as effectively being able to take advantage of pecuniary and other internal economies open to the specialized counterpart.

20.6.5 Government Programs

The federal government long has been heavily involved in programs that provide price and income support for farmers. Agricultural policy during the 1970s moved away from mandatory programs and toward programs that allow the farmer to decide for himself or herself whether or not to participate. Most government programs have been directed toward the reduction of price, rather than output uncertainty, but the wheat and feed grain disaster programs of the 1970s are examples of programs designed to support farm incomes when output levels are low.

Net farm income for the United States is rather unrelated to output in a particular year. The 1983 drought throughout much of the midwestern grain producing areas dramatically reduced output of key crops such as corn, although net farm income was higher in 1983 than in 1982, when drought was not widespread but prices were lower. A farmer's income increases when success is achieved at growing a crop in which other farmers had widespread failures.

Government price support programs that place floors under which commodity prices are supported are usually thinly disguised mechanisms for supporting farm incomes. Such programs increase incomes and support the welfare of every farmer who participates, large and small. Participation in a program will normally reduce income variability, and to the extent that tax revenues for supporting prices come from nonfarm consumers, long ! term income may also be larger than would have been the case if the program had not been in place.

When given a choice, occasionally farmers will find it to their advantage not to participate in a government program. The decision can be made by first calculating net revenue when the farmer participates. This usually means a restricted output (y) at a high price. Net revenue based on nonparticipation is then calculated assuming more output but a lower price. However, the decision by the farmer to participate or not participate will be based both on the extent to which participation in the program will reduce income variability as well as increase net income.

Recently, the federal government has been making attempts to move away from federal price support programs. For programs that remain, increasingly farmers are being asked to pay for the full cost of government price support programs, including the cost of storage of commodities in excess supply. The recent move toward a no net cost tobacco program could be an indication of potential programs for other commodities.

When government support prices exceed levels at which supply and demand are in equilibrium, surpluses of the price-supported commodities occur. Most commodities cannot be stored indefinitely, and storage costs can quickly become rather high. In the past, the government has used the school lunch program to dispose of surplus, government owned commodities. Recently the government has distributed surplus dairy products occurring as a result of the price support program to low income and elderly residents. Unfortunately, the federal government does not have the option of giving away cigarettes to low ! income or elderly people, or making chewing tobacco an approved vegetable on the school lunch menu.

In the past, government programs have both reduced income variability and raised net farm incomes. Utility is increased because incomes rise and variability in incomes is reduced. A no-net-cost program would only reduce income variability. Therefore, a no-net-cost government program could increase utility if farmers were not risk neutral. However, incomes to farmers (and utility) over the long term would be reduced because of the cost to farmers of operating the government program.

20.7 Concluding Comments

This chapter has provided a very basic introduction to the problem of taking into account risk and uncertainty in economic analysis. Specific models incorporating risk and uncertainty could easily fill an entire textbook. The simplest approaches for including risk and uncertainty involve replacing actual prices and yields with the respective expected values. However, price and income variability leads to income variability, which in turn, affects the farmer's utility or satisfaction.

While marginal analysis can form the basis for some models that include risk and uncertainty, other models are based on approaches that do not require the traditional framework. Included in the latter category are approaches involving games such as those outlined in Section 20.3. The reading list at the end of this text includes a number of articles dealing with risk and uncertainty using a variety of modeling approaches.

Problems and Exercises

1. Calculate the expected income on the basis of the following data:

Income	Probability
$100,000	0.2
20,000	0.5
! 50,000	0.3

2. Why are expected income and utility not the same thing?

3. Why do farmers not always choose to pursue the strategy with the greatest expected income?

4. Discuss possible states that nature might assume in farming, and possible actions a farmer might take in dealing with these states of nature.

5. Suppose that an enterprise with a greater expected income also resulted in a greater input variability than that for another enterprise. How could this situation be considered within a marginal analysis framework?

6. Suggest strategies that a farmer might use to deal with risk and uncertainty.

Reference

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